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Tool Support for Substitutions in DIY Tutorials

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Abstract

The rise of the Do-It-Yourself movement has brought hobbyists, craftspeople, and designers together. They formed communities around makerspaces and DIY tutorial platforms, which they use to publish their work and find inspiration for future projects. These platforms are at the heart of the maker movement as they allow knowledge sharing and collaboration. However, research shows that it is often challenging for users to replicate tutorials they find on these platforms, as they often need to adapt the tutorial to their goals and needs. Substituting materials, tools, and techniques is a common practice among makers, as they do not always have access to the same resources used in the tutorial, lack the knowledge or experience for certain techniques, or wish to customize the project to their liking.

Currently, DIY tutorial platforms do not support the documentation of substitutions. Users of these platforms are limited to comments, or they would have to publish a new tutorial for their project, which cannot be linked to the previous tutorial. Having to create a new tutorial for each variation can hinder the progression of new ideas and improvements, thus making it hard for users to collaborate effectively.

In this thesis, we want to research how hobby-crafters use different digital tools to report substitutions into DIY tutorials that they are replicating. We conducted a study to explore the needs and expectations of makers concerning digital tools that allow the documentation of substitutions, by asking participants to complete a project using a different material, tool, or technique and editing or rewriting the tutorial in a way that matches their process and needs. We also gathered quantitative and qualitative data through semi-structured interviews with the participants to better understand their experience. We then analyzed the data in order to provide guidelines and suggestions for future digital tools that can improve the experience of DIY platform users.

Überblick

Das Aufkommen der Do-It-Yourself-Bewegung hat Bastler, Handwerker und Designer zusammengebracht. Sie haben Gemeinschaften um Makerspaces und Do-it-yourself-Plattformen gebildet, auf denen sie ihre Arbeit veröffentlichen und Inspiration für zukünftige Projekte finden. Diese Plattformen sind das Herzstück der Maker-Bewegung, denn sie ermöglichen Wissensaustausch und Zusammenarbeit. Die Forschung zeigt jedoch, dass es für die Nutzerinnen und Nutzer oft schwierig ist, Anleitungen, die sie auf diesen Plattformen finden, zu reproduzieren, da sie oft das Tutorial an ihre Ziele und Bedürfnisse anpassen müssen. Das Ersetzen von Materialien, Werkzeugen und Techniken ist eine gängige Praxis unter den Handwerkern, da sie nicht immer Zugang zu denselben Ressourcen wie im Tutorial haben, ihnen das Wissen für bestimmte Techniken fehlt oder sie das Projekt nach ihren eigenen Vorstellungen anpassen möchten.

Derzeit unterstützen DIY-Tutorial-Plattformen nicht die Dokumentation von Substitutionen. Die Nutzer dieser Plattformen sind auf einen Kommentar beschränkt oder sie müssen eine neue Anleitung für ihr Projekt veröffentlichen, die nicht mit der vorherigen Anleitung verlinkt werden kann. Die Notwendigkeit, für jede Variante ein neues Tutorial zu erstellen, kann das Fortschreiten von neuen Ideen und Verbesserungen behindern, was eine effektive Zusammenarbeit zwischen den Nutzern erschwert.

In dieser Arbeit wollen wir untersuchen, wie Hobbybastler verschiedene digitale Werkzeuge nutzen, um Ersetzungen in DIY-Anleitungen, die sie nachbauen, zu melden. Wir haben dafür eine Studie durchgeführt, um die Bedürfnisse und Erwartungen von Bastlern an digitale Werkzeuge die es ihnen ermöglichen, Substitutionen zu dokumentieren, zu erfahren. Wir haben die Teilnehmer gebeten, ein Projekt unter Verwendung eines anderen Materials, Werkzeugs oder einer anderen Technik durchzuführen und die Anleitung so zu bearbeiten oder umzuschreiben dass diese ihrem Prozess und ihren Bedürfnissen entspricht. Wir haben auch quantitative und qualitative Daten gesammelt durch halbstrukturierte Interviews mit den Teilnehmern, um ihre Erfahrungen besser zu verstehen. Anschließend

haben wir die Daten analysiert, um Richtlinien und Vorschläge für zukünftige digitale Tools zu erstellen, die die Erfahrungen der DIY-Plattform-Nutzer verbessern können.

Acknowledgements

First of all, I would like to thank Prof. Dr. Jan Borchers and Prof. Dr. Ulrik Schroeder for examining this thesis.

I would also like to thank my supervisor Marcel Lahaye for all the insightful advice, constructive feedback and encouraging words.

Last but not least, this endeavor would not be possible without the people who participated in the study, which is why I am grateful to all the participants. Thank you for your time and effort!

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. For the first person, the pronoun "we" is used and for the third person the pronoun "they".

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Chapter 1

Introduction

What are makers and the maker community?

People have been creating, assembling, and repurposing materials in new and innovative ways for as long as humanity existed. Individuals who enjoy tinkering often share their ideas and production process, which led to the Do-It-Yourself movement (Buechley et al. [2009]). The rise of the Internet has brought designers, hobbyists, and makers together around makerspaces and DIY platforms where online communities have formed. These communities include individuals interested in areas ranging from arts and crafts to digital fabrication, hardware or software hacking, and even knitting, underpinned by the common principle of skill sharing rather than a commercial benefit. The maker culture values creativity, collaboration, learning, and open sharing (Kuznetsov and Paulos [2010]). In addition to supporting innovation and knowledge transfer, it also plays a wider role in the social life and overall well-being of the community(Taylor et al. [2016]).

Importance of DIY platforms and the need for knowledge sharing

For this reason DIY platforms are vital for exchanging knowledge within these communities. Designers are now able to share their creations and reach a large audience, while makers can get inspired by the shared ideas and tutorials, which they can now use as a resource and appropriate in their projects (Tseng and Resnick [2014]).
This has helped democratize the making process and changed the way we look at production and designs by empowering amateurs to become the new producers and de-

signers (Wakkary et al. [2015]). They can now give back to the community by documenting and sharing their project ideas, receiving feedback, and serving as an inspiration for others (Torrey et al. [2007]).

Motivations behind looking at documentation on DIY tutorial platforms

Every project starts with an idea. Users of multiple maker platforms have ranked their motivations behind using such platforms in order of importance. They listed "inspiration and new ideas for future projects" as the main reason (Kuznetsov and Paulos [2010]) while finding a tutorial to follow step-by-step was ranked last. Makers explained that recreating a project can be challenging, as modification is often a necessity arising from differences in resources and goals (Tseng and Resnick [2014]).

The need for tool and material substitution in DIY projects

Modifying tutorials by means of substituting materials, tools, and techniques is a widespread behavior in the maker community, and the motivation behind these decisions varies from the availability of resources (Lakier et al. [2018]) to the lack of skill or knowledge (Wakkary et al. [2015]) and the desire for customization (Dix [2007]). The necessity of modification will lead to makers having to improvise. A maker will often substitute a missing tool or material for what is on hand, which could lead to differences throughout the rest of their project ranging from the techniques that will now be required, to the overall structure of the project. This can be especially problematic for inexperienced makers.

DIY platforms offer limited support for the documentation of substitution

Although substitution is such a common practice among makers, DIY tutorial platforms currently offer limited possibilities for users to work their substitution back into the tutorial. If makers wish to document the changes that have occurred in their process due to substitution and share them with the community, they are required to publish a new tutorial. This will result in a large number of similar tutorials on the platform, which are not linked together. It also hinders the natural progression of new ideas. By having to create a new tutorial for each variation, makers cannot effectively collaborate on improving the projects. Another negative effect is that users could be less inclined to publish a new tutorial in order to share the substitution they made while following someone else's documentation.

In this thesis, we want to explore how makers use different digital tools to report substitutions into a tutorial that they are recreating. We will achieve this by conducting an empirical study in which hobbyists and crafters include a substitution into a project that they are building and document their process by rewriting or editing the tutorial. The goal of this study is to get a better understanding of the needs and expectations of makers concerning digital tools that facilitate the documentation of substitutions.

RQ : How are hobby-crafters (makers) using digital tools to report their substitutions into DIY tutorials which they are replicating?

Chapter 2

Related work

There has been some research previously done regarding the maker culture and the behavior, needs, and preferences of DIY enthusiasts, which we will discuss in this chapter. We will explore mainly the behavior patterns of makers, the role of DIY tutorial platforms, and some limitations of such platforms. We will focus on the needs of makers and the limitations of DIY platforms regarding tool and material substitution in tutorials.

Existing research on DIY culture, maker behavior, and tutorial platforms

2.1 Motivations behind the Maker Movement

The term maker culture describes the movement started by hobbyists worldwide, who use a mix of digital fabrication, traditional crafts, and hardware or software hacking to create and innovate for themselves. In their research, Taylor et al. [2016] explain how crafters from various areas of DIY all share a common interest in creating in the name of innovation and open sharing instead of commercial benefit. They believe that by learning from each other, they can develop the necessary skills to provide better and cheaper solutions than mass-produced products. In figure 2.1 a visual representation of the motivations and outcomes of working on DIY projects can be seen. Wolf and Mc-

Motivations for undertaking DIY projects

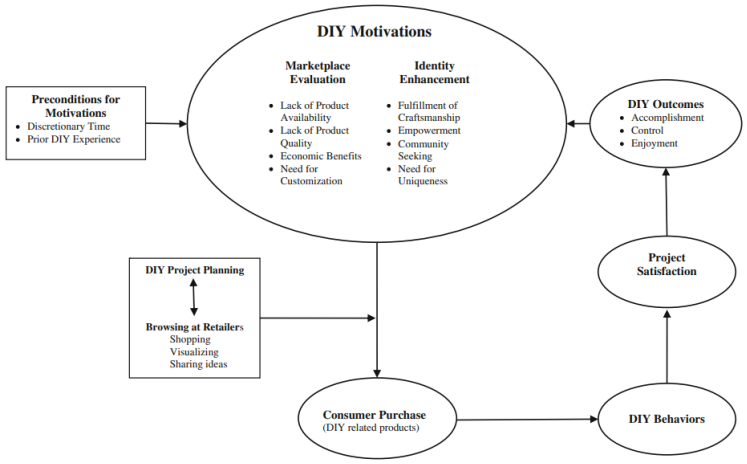


Figure 2.1: Conceptual model of the motivations and outcomes of DIY taken from Wolf and McQuitty [2010]

Quitty [2010] worked towards a better understanding of the do-it-yourself consumer. During their research, they created this conceptual model. From interviews with makers, they derived two main sources of motivation for DIY: marketplace evaluation of goods and services and identity enhancement.

Motivations related to "Marketplace Evaluation"

The first category that we will discuss is "Marketplace Evaluation". DIY behavior arises from four types of marketplace evaluations lack of availability of certain products and resources, poor quality of available products, perceived economic benefit, and the need to customize the project to personal preferences and needs.

Motivations related to "Identity Enhancement"

"Identity Enhancement" portrays motivators that bring makers a sense of gratification. During the interviews, the following factors have been depicted as meaningful: a sense of empowerment, fulfillment of craftsmanship, belonging to a community, and the need to be unique.

Applicability of motivations in this thesis

This is relevant for this thesis, not only because it helps us better understand the motivators behind the maker movement, but also, as we will discuss later on because they coincide with the reasons for tool and material substitutions in DIY tutorials.

In their research, Kuznetsov and Paulos [2010] analyzed the practices and sharing mechanism of the maker community. By interviewing users of various DIY platforms, they derived a list of values shared between individuals of the community. The DIY culture relies on creativity, a low barrier of entry, learning, and open sharing.

Characteristics and values of the maker community

Both the projects and the community are driven by creativity. Makers create and share their ideas not for commercial gain but to express themselves through their creations and get inspired by others. As mentioned in the research of Wolf and McQuitty [2010], makers are motivated by the need for uniqueness and the fulfillment of their craftsmanship.

Creativity

The low barrier of entry refers to both economic and knowledge-related challenges. A majority of DIY projects do not require a substantial financial investment and as we discussed previously one of the motivations for making instead of buying is a perceived economic benefit. When it comes to skills, maker communities lower the barrier by exchanging ideas and techniques with novices as well as with practitioners of a different craft.

Low barrier of entry

This knowledge exchange leads us to the next characteristic of the culture, learning. DYI communities provide the instruments for learning new skills from tutorials and engaging in discussions with other crafters. This underlines the significance of DIY websites and forums as they provide the necessary platforms for the information transfer between practitioners.

Learning

In their study, they found that asking and answering questions on online platforms is what generates new methods and ideas. This is the reason why in the DIY culture open sharing is valued. The use of online platforms allows makers to contribute to the information exchange and contribute to the community. Individuals can use forums and tutorial platforms to share their projects, receive feedback, and get inspired by the work of their peers. This knowledge transfer is what propagates innovation and improvements. A visual representation of the motivations behind joining online DIY communities, concluded by Kuznetsov

Open Sharing

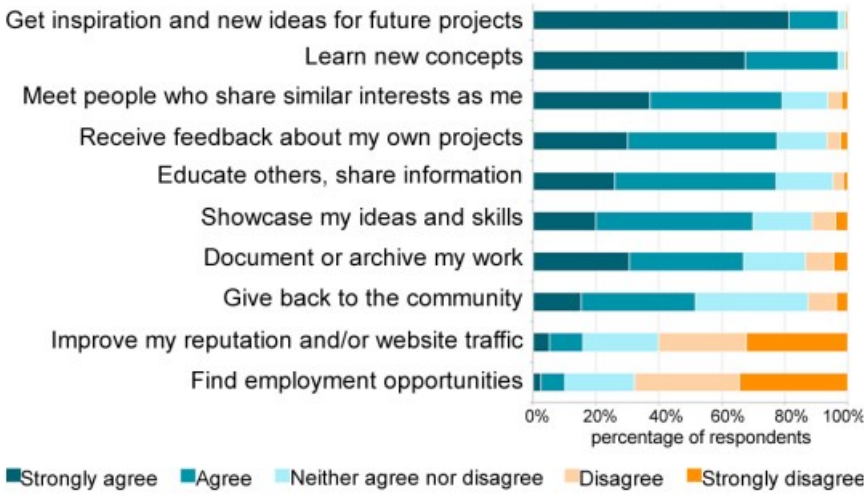


Figure 2.2: Motivations for contributing to DIY communities (Kuznetsov and Paulos [2010]
)

and Paulos [2010] in their interviews with users can be seen in Figure 2.2.

Social aspects and the sense of community

As can be seen in the graph, makers contribute to the communities motivated by social aspects as well. Users of DIY platforms stated that a meaningful reason for their activity on the platform is to meet like-minded individuals and to gain a sense of community. The social benefit is highlighted also in the work of Taylor et al. [2016]. They explored the role of maker communities and concluded positive implications for the social life and well-being as a consequence of being part of such communities.

Enjoyment of sharing tutorials

Interviews with makers show that they are motivated to document and share their work because it allows them to give back to the community and receive feedback on their ideas. They explained the joys of seeing their project recreated and personalized or improved by others. The documentation process is often viewed as one of their projects, given the amount of effort and thought they put into making the tutorials (Torrey et al. [2007]).

Importance of online tutorial platforms

All of the mentioned motivations and characteristics of the

maker culture accentuate the importance of DIY platforms. Platforms such as Instructables [a], Etsy, Dorkbot, Ravelry, Adafruit or Crafster allowed makers to build communities around them. These websites provide the possibility of interaction and discussion between users, as well as a platform for them to share their projects and ideas.

2.2 Need for Substitution

In this section, we will discuss behavior patterns of makers that emphasize the necessity of adapting tutorials to personal needs and the various reasons for tool and material substitutions in DIY tutorials.

Makers wish to adapt tutorials rather than replicate them

In their research, Tseng and Resnick [2014] focused on the way project documentation is created and used. They conducted interviews with users of the platform Instructables [a] in order to gain knowledge about the online behavior of the community. Makers were asked during the interview to rank the reasons why they look at tutorials on the website, in order of importance. The three main reasons they were asked to rank are getting ideas for a project, learning a particular technique, and looking for projects to recreate. A visual representation of their answers can be seen in Figure 2.3. What stands out is that getting inspiration for a project was rated by most as the main reason to look at an instructable, while searching for projects to recreate was seen as the least important reason out of the three. When participants were asked to explain their choices, they explained that they use the tutorials as a reference rather than a guide. The makers stated that modification is often a necessity caused by differences in goals and resources. The unavailability of tools and materials can lead to the need for substitution. They also described wanting to customize the project to their liking as a reason for not replicating the tutorial. Replicating without modification or substitution can be a challenging or undesired activity.

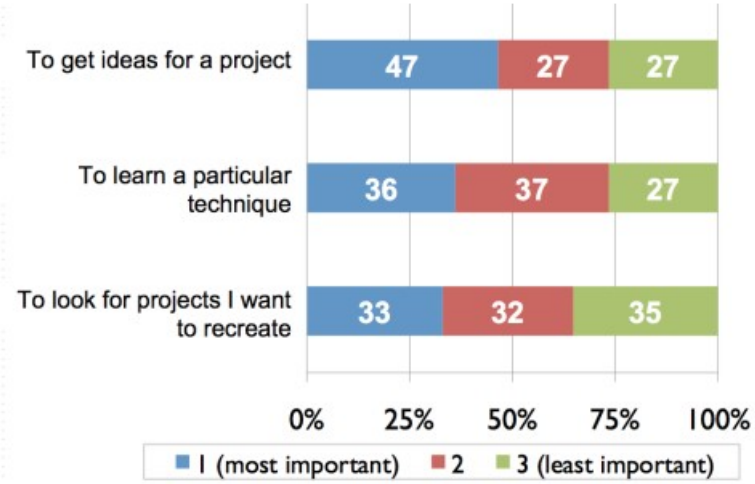


Figure 2.3: Ranking, in order of importance, of reasons why users look at Instructable taken from Tseng and Resnick [2014]

2.2.1 Availability of Tools and Materials

Global DIY communities and local sourcing of materials

The DIY community is comprised of non-professionals and hobby-crafters worldwide. Given the differences in resources over the world, not everyone will have access to the same materials. It can be challenging for makers to anticipate what is available to readers while writing their tutorial. In their paper Wakkary et al. [2015] stated, that a challenge of global DIY is considering the local sourcing of materials. Saakes [2009] also touches on this problem in his research on makers using Ikea products to build creative DIY projects. Although Ikea products are available worldwide, the importance of checking the accessibility of the other products used in the process is underlined.

Substitution as an alternative to buying

The problem of availability is not limited to local differences in resources, it also translates to the individual level. Not every crafter has access to the same tools or materials. This problem is brought forward in the paper of Torrey et al. [2009] on the search and use of information online by DIY practitioners. According to Lakier et al. [2018], lack of available raw materials and accessibility to a specific tool are leading issues with following instruction sets today.

Sourcing the materials and tools used in a tutorial, if not on hand, can be costly and time-consuming. When dissimilarities in the resources arise, makers will often substitute the tools and materials used in the tutorial with what is easily accessible. This can be problematic as substitutions can lead to differences in the overall structure of the project and a wrong use of a substitution can cause problems throughout the rest of the design.

2.2.2 Skill and Knowledge

Even if the tools and materials are available, a maker can lack the proper training or knowledge to use the resources. The risks of improper material handling and disposal are highlighted in the work of Lakier et al. [2018]. If a maker is not trained in the use of a tool or material, they can pose a threat to themselves or others. Authors of tutorials cannot effectively assess the reader's level of expertise or assume what skills constitute a level of expertise. This challenge is put forward in the work of Wakkary et al. [2015], where it is stated that a tool is only as useful as the builder's competencies to use it. Tutorials are recreated by people of all ages. Tools that are suitable for adults to use in a project, can be dangerous for children to manipulate. As competencies and skills vary between makers and cannot be anticipated, substitution is often a requirement in order to keep the creation process safe.

2.2.3 Customization

When discussing the motivators behind DIY, the need for uniqueness and the desire to be creative was mentioned. Makers want to express themselves through their projects. Participants of the study conducted by Tseng and Resnick [2014] expressed their desire to personalize their creations to their own liking, rather than replicating a tutorial found online. They stated this as one of the main reasons for substituting in their projects. Remixing and appropriating designs is a common practice among makers. Part of

DIY is trying out new techniques, materials, and designs while getting inspired by the work of peers. Dix [2007] and Oehlberg et al. [2015] discuss the prevalence of this behavior in their papers and further articulate the necessity of designing for appropriation. The results of the study done by Buechley et al. [2010], showcase the way modifications of shape, materials, and functionality seem to reflect participants' skills, interests, and relative accessibility of various fabrication processes.

2.2.4 Improvement of the project

Another prevalent reason behind the substitution of tools and materials in DIY tutorials is the development of the project. Innovation is a result of people sharing their take on how to optimize the building process and enhance the quality of the resulting product. Interviewed makers described the joy of trying to improve tutorials they found online (Tseng and Resnick [2014]). They apply their knowledge and expertise on projects shared online in order to better the result. The inputs of makers on how to use substitutions for the improvement of the project propagate the advancement of the craft. In order to support a collaborative community, platforms need to enable makers to contribute their changes to the project. According to Tseng and Resnick [2014], these changes include material and tool substitution as well as process optimizations.

2.2.5 Limitations of DIY Platforms

Limited tool support for documenting substitutions

As previously mentioned, DIY tutorial platforms lie at the heart of the communities. Although they benefit the community by facilitating information exchange and offering makers the possibility to reach an audience, such platforms do not always reflect the needs and behaviors of their users. Currently, there is limited support for the documentation of tool and material substitutions in tutorials. Makers are limited to the comment section or they would have to write and share a new tutorial that includes their adaptations.

Figure 2.4: Contributions to DIY community, by frequency [Kuznetsov and Paulos [2010]]

Proposal of dynamic tutorials as a solution

Lakier et al. [2018] proposed the idea of dynamic tutorials as a solution for this problem. Their goal was to innovate the format of fabrication tasks by making them adaptable to the context of the maker. The possible adaptations should include substitutions, changes in dimensions, error recovery, and global awareness. They succeeded in their task, however, their resulting dynamic manual had some limitations. The author of the tutorial has to provide all the data. The collaboration of multiple makers on the writing of the instruction set is not supported. This results in a cumbersome and time-consuming generation of tutorials.

Hardships of documenting

In their study, Kuznetsov and Paulos [2010] researched the online behavior of makers on DIY platforms. Their results show that most contributions to the community take place in the comment section, where makers engage in discussions about projects and post pictures of their take on a tutorial. A visual representation of the contributions and their frequencies can be seen in Figure 2.4.

While over 90% of participants contribute to the DIY community by asking and answering questions in the comment section of tutorials and 87% of them shared pictures of their take on a project, only a fraction is sharing step-by-step instructions. Participants expressed that the main reasons for not sharing tutorials are lack of time and the sense that their project is not novel or creative enough.

Goal of this thesis

For these reasons, we want to explore the way makers use digital tools to document tool and material substitutions in

tutorials that they are recreating. We want to get a better understanding of their needs and expectations regarding the documentation process, in order to gain insight into the ways we can improve their experience and encourage them to share their take on projects with the community.

Chapter 3

Study Setup and Results

In order to gain insight into ways that facilitate the communication of adaptations, we first explore the ways makers currently use digital tools to document substitutions of tools, materials, and techniques into DIY tutorials that they are replicating. We conducted an empirical study to answer the following research question:

RQ : How are hobby-crafters (makers) using digital tools to report their substitutions into DIY tutorials which they are replicating?

In this chapter, we will report the structure of the experiment, the methodology, and the results.

3.1 Methodology

3.1.1 Experimental Procedure

The study we conducted was comprised of three main parts: a 5 minute interview, a task, and a semi-structured interview. The study was held in person and lasted between 60 and 90 minutes per participant. Upon arrival, participants were informed about the nature of the study. Once participants were ready, the experiment started with

a 5 minute interview, with the goal of assessing their previous experience with DIY projects and tool or material substitution. After the interview, they were instructed on their task. The task consisted of building a DIY project while substituting a tool, material, or technique, and documenting the changes that occurred in their process. After completing the task, we conducted a semi-structured interview with the aim of gathering information about the participant's thoughts and approach to documenting the substitution process. A more detailed look at the study protocol can be found in AppendixB.

3.1.2 Variables

In the study, we measured and controlled multiple variables, which we categorized according to their source.

Participants

- **Level of expertise.** As participants have various skill sets and previous experience, their level of expertise was asked.

Complexity of substitution

The participants were asked to build one of three possible projects. The type of substitution, that they were asked to implement, had different complexity levels. The substitution types were as follows

- **Changing a material**
- **Adding a step**
- **Substitution of materials and techniques**

Figure 3.1: Picture of the wallet taken from the tutorial provided to the participants [Instructables [d]](right). Picture of a wallet made by a participant (left).

Figure 3.2: Picture of the laptop stand taken from the tutorial provided to the participants [Instructables [c]](right). Picture of a laptop stand built by a participant (left).

Documentation

- **Approaches to working substitutions back into the tutorial.** Participants could choose the way they include the substitution in their project.
- **Changes in the documentation.** Parts of the tutorial, participants edited.
- **Instruction format.** The ways in which the instructions were formulated and structured.

3.1.3 Task

The participants were assigned one of three projects and were asked to complete it. The possible projects are a wallet[Instructables [d]], a laptop stand[Instructables [c]], or a desk lamp [Instructables [b]]. They were provided with a tutorial for the project and with the tools and materials nec-

Figure 3.3: Picture of the desk lamp taken from the tutorial provided to the participants[Instructables [b]](right). Picture of desk lamp built by a participant(left)

essary. However, they had to include a substitution in their project. For the wallet they were asked to substitute the oilcloth material with upholstering fabric, for the laptop stand they used PVC fittings instead of the 3D-printed parts used in the provided tutorial and for the desk lamp they built the lampshade themselves, instead of 3D printing it the way it is shown in the tutorial. A side-by-side comparison of the project given as a reference and examples of a final product built by a participant can be seen in Figure 3.1, Figure 3.2, and Figure 3.3. The participants were asked to document these changes by editing or rewriting the tutorial so that it matches their process. For the documentation, the participants used their personal laptops or they were provided with one when necessary, and they used a digital tool of their choosing.

3.1.4 Participants

For our study, we recruited n=12 participants. The participants were recruited on the university campus. Since the maker community is diverse, we decided on a heterogeneous participant group. Participants had ages between 21 and 26 and had various previous experiences with DIY. An overview of the participant demographic, previous DIY experience, and proficiency can be seen in Table 3.1.

3.1.5 Experimental Design

Our empirical study had a between-group design. There were three different projects of different complexity levels assigned to the participants. Each participant completed one project, with 4 participants completing the wallet, 5 participants the laptop stand, and 3 participants building the desk lamp. Each participant took part in a 5 minute interview before completing the project, documented their work, and was interviewed upon completing the task. The study was held in English, recorded, and then transcribed.

3.2 Preliminary Study

Design and goal of the preliminary study

In preparation for our study, we conducted a preliminary study. This consisted of a short survey with the aim of finding out what digital tools makers would use for the documentation of substitutions in DIY tutorials, which they are recreating. This way we could estimate what digital tools would be necessary for the study. Participants of this preliminary study were presented with the following scenario:

”You found a text-based tutorial about a DIY project online (E.g., On www.instructables.com). While crafting the project, you substitute a material or tool from the tutorial with something different (E.g. Using nails instead of glue).”

Participants were then asked the following questions:
Q1 :How would you attempt to incorporate your substitution into the original tutorial or how would you attempt to re-publish the tutorial with your substitution? Which software would you use for this?

Q2 :Now imagine this scenario with a video-based tutorial (E.G., on TikTok). Which software would you use for documenting your substitution?

3.2.1 Results

A total of n=22 participants took part in this survey. They were recruited on the university campus. The participants answered both questions. For the text-based tutorial, 14 of the 22 participants (63.6%) stated, they would use Microsoft Word (Microsoft [2023a]) for the documentation, and the remaining 8 (36.4%) explained, they would opt for Pages (Inc. [2023]). When asked about digital tools they would use to document substitutions in a video-based tutorial with TikTok as the provided example, all participants answered, they would film their tutorial on TikTok, as it also provides a video editor.

3.3 5 Minute Interviews

Aim of the interview

The goal of this interview was to assess the participant's proficiency with making and their previous experience with substitution in DIY projects. The participants were asked about the frequency of working on DIY projects as well as the amount of time they were engaged in DIY. Furthermore, they were interviewed on how often they need to make substitutions in their projects, what their approach is to having to substitute, and the reasons behind it. The questionnaire can be found in Appendix A.

3.3.1 Results

Demographic and DIY proficiency

An overview of the participant demographic and previous experience with DIY resulting from the interview can be seen in Table 3.1. Most participants, 11 out of the 12, are students with an average age of 22.75. The previous experience with DIY of participants ranged between 1.5 and 10 years, with an average of 5.625 years of activity.

Experience with substitutions

An overview of participant responses related to their experience with substitutions, the frequency, approaches, and reasons behind substituting, can be seen in Table 3.2. When

ID	Age	Occupation	DIY Frequency	DIY Experience
1	23	Student	Almost never	4 years
2	23	Student	Almost never	7 years
3	23	Student	Once a year	10 years
4	22	Student	Once a month	10 years
5	26	Student	Almost never	3 years
6	21	Entrepreneur	Every couple of months	10 years
7	24	Student Worker	Every couple of months	1.5 years
8	22	Student	Almost never	2 years
9	22	Student	Almost never	7 years
10	24	Student	Almost never	4 years
11	21	Student	Almost never	5 years
12	22	Student	Almost never	4 years

Table 3.1: Participant demographic and DIY experience

asked how often they find themselves having to substitute tools or materials in a project, the participants' responses varied, as some explained they had to make a substitution in almost every project, while others rarely had this necessity. 91.7% of participants improvise when faced with the need for a substitution and 25% stated they would buy the missing materials or tools, depending on the project. Only one of the 12 participants stated they would rather postpone the project until all resources are available. Out of the 12 participants 5 (41.7%) said, they decide on the substitution during the idea-finding stage, 50% during the project-building stage, and 2 participants (16%) explained they substitute right before building the project. The reasons for substituting are in accordance with the findings in previous work, which we discussed in chapter2. 75% of the participants named availability of materials as the main reason for substituting and 25% stated that their motivation behind substituting is their wish to improve the project or use materials of better quality. 3 of the 12 participants (25%) explained they substitute in order to stay within a certain budget and 2 participants (16.7%) to save time. One participant explained they often cannot find a tutorial for precisely what they wish to build, so they often adapt the tutorial to their own needs.

ID	Frequency	Approach	Occurrence Stage	Reason
1	Rarely	Postpone project	Project building	Improvement, Difference in needs
2	Often	Improvise	Idea finding	Resource availability, Improvement
3	Often	Improvise	Idea finding	Resource availability
4	Rarely	Improvise	Project building	Resource availability, Quality of materials
5	Almost never	Improvise	Project building	Resource availability
6	Occasionally	Improvise	Project building	Resource availability
7	Almost every time	Improvise, Buy missing materials	Project building, Idea finding	Staying within budget
8	Almost every time	Improvise	Idea finding	Resource availability, Staying within budget
9	Often	Improvise, Buy missing materials	Before project building	Time saving, Resource availability
10	Very often	Improvise	Project building	Resource availability
11	Very often	Improvise	Before project building	Resource availability, Time saving, Staying within budget
12	Very often	Improvise, Buy missing materials	Idea finding	Resource availability

Table 3.2: Participant experience with tool and material substitutions

3.4 Documentation

In this section, we will discuss the documentation part of the study. The participants were given a tutorial and were asked to build the product shown in the tutorial, however, they were provided with different materials than the ones shown in the tutorial. They were then asked to document the changes that arose in their process due to the differences in resources. They were given complete freedom regarding the way they wish to report their process and they could use a digital tool of their choosing. As previously mentioned, the participants built and documented one of three possible projects, a desk lamp, a laptop stand, or a wallet, each of these projects representing a different complexity level of the substitution. We will discuss the resulting tutorials according to each project and then we will present an overview of the results.

3.4.1 Results

Desk Lamp Project

Description of the project and the complexity of the substitution

For this project the participants were asked to build a desk lamp. A link to the original tutorial can be found in Appendix B and the bibliography [Instructables [b]]. The project required the use of dowels, a 3D printer for connecting the legs and building a lampshade, a drill, screws, and wiring of the light bulb fixture. The participants were provided with the dowels for building the legs and the 3D printed part for connecting the legs as shown in the tutorial. The drill and the screws were replaced with wood glue. The wiring was avoided by using a pre-wired light socket, which was then connected to the wood dowels. Another substitution the participants had to include was the use of polypropylene sheets for building their own lampshade, as opposed to 3D printing it as shown in the tutorial. An overview of the materials and tools used can be found in Appendix B. In Figure3.4 pictures of the finished product built by participants can be seen.

Figure 3.4: Examples of desk lamps built by participants during the study

Choice of digital tool for the documentation

This DIY project was assigned to 3 out of the 12 participants. 2 out of them chose to use Microsoft Word (Microsoft [2023a]) for their documentation, while the other participant used Pages (Inc. [2023]) for text editing. Their reasoning behind using these tools was the availability, as they already had the tools installed, and their familiarity with them. Participants stated the importance of having a tool that is *"easy to use"* and accessible. One participant explained: *"It is easy to add pictures to the document while using it"*.

Comparison of participant documentation and provided tutorial

When comparing the tutorial to the process of the participants, we noticed that 5 out of the 14 steps remained unchanged. The 6 steps related to wiring and creating a model for 3D printing, were skipped. For the prepping of the 3D printed parts and the assembly, 3 steps were changed. The building of the lampshade added 2 steps to the process.

Are participants editing or rewriting the tutorial?

The resulting tutorials, written by the participants kept the format of the provided tutorial. All three participants kept the parts of the tutorial that were relevant to their project and added or deleted the rest. One participant chose to edit the original tutorial in order to achieve this. The other two participants started with a blank document where they added steps from the original tutorial and also wrote their

own steps. The main reason for participants choosing to start over and rewrite the tutorial was how time-consuming it was for them to edit and delete whole steps. One participant stated, *"[...]there were too many parts I had to take out or change and the easiest way to do that was to start from scratch. The first thought was that it would be easier to edit it, but once I noticed how long it would take, I chose to make my own."* Another participant explained, *"I did actually keep some parts from the previous tutorial[...]. But after that, I felt like it was easier for me to rewrite it."* Another motivation for rewriting the documentation, given by a participant, was the feeling of involvement.

Structure of the tutorial

All participants kept a step-by-step structure similar to the structure of the example tutorial. All of them added their own pictures of the process and final product. 2 out of the 3 participants also kept pictures of the process from the original tutorial. The remaining participant replaced all the photos with their own. The participants added more pictures than text to their tutorials, underlining the importance of visualizing the process. During discussions, they explained the significance of adding pictures, as they enjoy consuming visual tutorials more than text-based ones.

Laptop Stand Project

Description of the project and the complexity of the substitution

Participants that were assigned this project, were asked to build a laptop stand (Instructables [c]). In the provided tutorial the author used wooden dowels, a 3D printer for the parts connecting the dowels, and a fabric strap that allows the stand to be pliable. Participants were provided with the wooden dowels and the fabric strap, as was shown in the tutorial, however, the 3D printed parts were substituted with PVC fittings. These could be used to connect the wooden dowels to each other. An overview of all the tools and materials used for this project can be found in Appendix B. Examples of finished products built by participants can be seen in Figure 3.5. While some participants stayed close to the design presented in the tutorial (Figure 3.2), others chose to stray away and create their own designs. An example of an original design is visible in the

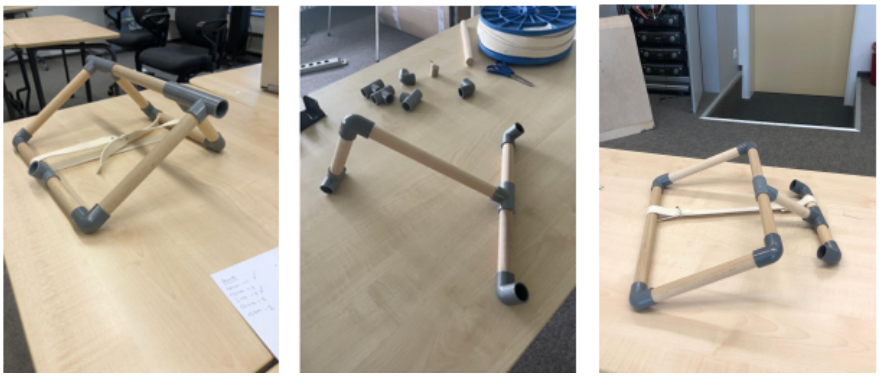


Figure 3.5: Examples of laptop stands built by participants during the study

middle picture of Figure 3.5. The substitution of materials in this project resulted in a substantial difference in the building process. This led to participants straying away from the initial design and adapting the tutorial to their own liking.

Choice of digital tool for the documentation

The laptop stand project was assigned to 5 out of the 12 participants. Out of them, 4 participants (80%) chose Microsoft Word (Microsoft [2023a]) for the documentation, their reason being the ease of use and their familiarity with the software. One participant explained, their choice was based on the online availability of the tool, as they did not have a text editing software on their computer. One out of the 5 participants used Word Pad (Microsoft [2023b]) for their documentation, stating that the accessibility of the tool was their motivation.

Are participants editing or rewriting the tutorial?

As previously mentioned, participants assigned to this project took creative liberty with their designs. As a result, their process differed from the tutorial. All 5 participants chose to write their own tutorial instead of editing the provided documentation. They did not include information or pictures from the given tutorial. They justified their choice by mentioning the dissimilarities between their process and the provided tutorial.

Structure of the tutorial

A result of participants writing their own tutorial is the fact that they wrote it in their preferred format. All 5 participants started with a list of the tools and materials neces-

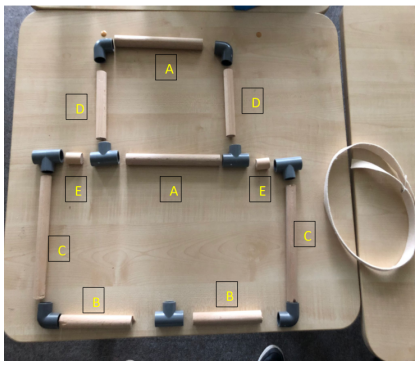


Figure 3.6: Example of an exploded view of the project taken from a tutorial written by a participant during the study

sary and had a step-by-step format. 2 out of the 5 participants added a picture of all the parts necessary for the project, laid out in their correct position. One of them stated, *"[...]the most important part was adding the picture, where all the parts are exploded because it shows exactly where every part goes and how it's positioned"*. An example of such a photo can be seen in Figure 3.6. All participants added pictures to their tutorial and highlighted their importance, however, participants used pictures in different ways. 2 of the 5 participants chose to document their process through pictures and no more than 5 short sentences explaining the steps. When asked about it, a participant reported, *"When building a project, having more text can be confusing or scary. This is why I chose to document mostly through pictures"*. The other 3 participants have written step-by-step explanations in their documentation while adding only pictures of the parts and the final product. Nevertheless, these participants also mentioned their preference for keeping the explanations short, to not confuse the reader.

Wallet Project

Description of the project and the complexity of the substitution

For this project participants were asked to create a wallet (Instructables [d]). In the tutorial they were given, the list of necessary tools and materials included oil cloth, tape, a sewing machine, a ruler, and scissors for the tape and cloth.

Figure 3.7: Examples of wallets made by participants during the study

Participants who were assigned this project were asked to substitute the oilcloth material with upholstering fabric. A detailed overview of all tools and materials used for this project can be found in Appendix B. Examples of the finished product sewn by participants during the study can be seen in Figure 3.7.

Choice of digital tool for the documentation

The wallet project was assigned to 4 out of the 12 participants. Three of them used Microsoft Word (Microsoft [2023a]) for documenting their process, their choice was motivated by the ease with which they could edit text and add pictures. One participant chose PDF/X [2023] as the preferred text editing tool because they could not open Microsoft Word.

Comparison of provided tutorial and making process of participants

For this project the substitution was less complex than in the other tutorials. As only the fabric of the wallet changed, the making process remained unchanged. When comparing the tutorial with the making process of participants, we noticed that no steps were added to their process and none of the steps had to be skipped.

Structure of the resulting tutorials

The resemblance between the given tutorial and the project completed by participants resulted in participants being more likely to edit the provided tutorial, rather than rewrit-

ing their own. 3 out of the 4 participants, who completed this project, chose to edit the tutorial instead of rewriting it. One of these participants only changed the name of the fabric that was used, while the other two added their own pictures to the documentation and kept the written instructions of the original tutorial. When asked about their decision, the participants explained, it was due to the similarity of their process to the original tutorial and their liking of the provided structure. The one participant that decided to rewrite the tutorial, explained their decision was based on their own preference. The participant stated they used some of the instructions and explanations provided in the original tutorial in their own, however, they wished to rearrange the format and make the documentation more concise.

3.5 Semi-Structured Interviews

After completing the project and the documentation, the participants took part in a semi-structured interview. The goal of this interview was to gather information about the participant's experience while documenting the substitutions. The participants were asked about difficulties they encountered, about criteria used to decide on their approach to documenting, and about the digital tools they used. The interview had a semi-structured design, for the purpose of facilitating conversations about specific methods employed by participants in their documentation. The interviews were held in English, recorded, and then transcribed.

Data analysis via evaluation codes

The transcripts contained qualitative data, which was analyzed via coding. Coding of qualitative data is the process of assigning words or short phrases to portions of visual or text-based data, that capture their essence (Saldaña [2013]). For the purpose of analyzing the data gathered in this interview, evaluation codes were chosen. According to Saldaña [2013], evaluation codes assign judgments about the merit, worth, or significance to data sections. The evaluation codes we used fall into two groups, impression codes and recommendation codes. Impression codes cap-

ture participants' evaluations of their experience during the documentation process. These can be positive or negative. The recommendation codes are suggestions made by participants during the interview or recommendations derived from the impression codes.

3.5.1 Results

Notation of codes

In this section we will present the codes assigned to the data resulting from the interview. Codes will be written in typewriter-style text (e.g. `Code`). The category of a code will be visible as a prefix (+) for positive, (-) for negative, and (REC) for recommendations. Additionally, due to the limited character count of the code names, the following abbreviations were used: "&" for and, "pic" for pictures, "doc" for documenting, "sbs" for step-by-step, and "w/" for with.

In order to evaluate the data of the transcripts, a total of 152 segments were coded. Out of them 62 were assigned positive codes, 29 had negative evaluations and 61 were recommendations. We will present the codes according to their evaluation.

Positive Codes

Positive codes were attributed to segments of data in which participants expressed a positive impression. 62 such segments were found in the transcripts and 12 codes were used to sum up these segments. The statistic showing each code and the percentage of positive segments they covered is visible in Figure 3.8. A table with each code, the number and percentage of participants, that expressed impressions related to the codes, can be found in Appendix C, Table C.1.

Occurrences of positive codes in analyzed segments and number of participants expressing each positive impression

In the following section we will discuss the positive codes used for evaluating the data and their occurrences. The most frequent positive code is `+doc not difficult`. This was assigned to 11 data segments. A total of 8 participants (66.7%) mentioned during the interview, that the

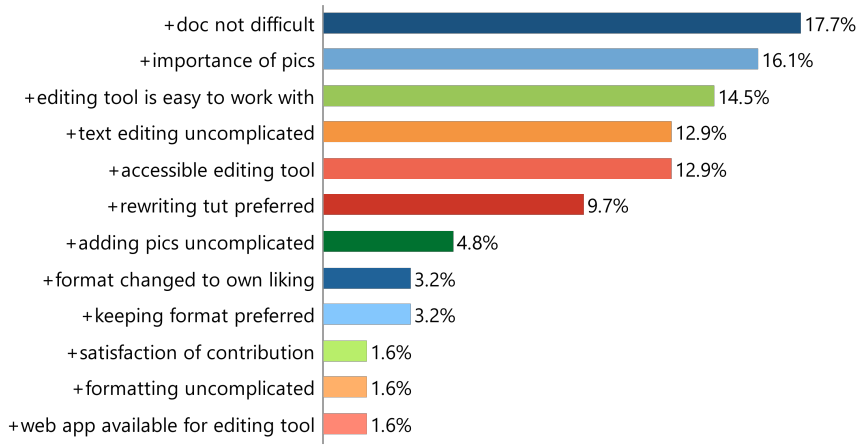


Figure 3.8: Statistic of the occurrence of positive codes in evaluated segments

documentation process was not difficult. 10 segments were coded with `+importance of pics`, as this was a positive attribute mentioned by 58.3% of participants during the interview. `+editing tool easy to work with` was assigned to 9 portions of the data. Positive evaluations regarding the ease of use of the editing tool were expressed by 75% of the participants. The code `+text editing uncomplicated` occurred 8 times, being mentioned by 58.3% of participants. `+accessible editing tool` also covered 8 segments, however, this impression was mentioned by 66.7% of participants. 6 data segments were coded with `+rewriting tut preferred`, with 41.7% of the participants stating positive aspects of rewriting tutorials during the interview. The code `+adding pics uncomplicated` had 3 occurrences, appearing in 25% of the interviews. The code `+format changed to own liking` covered 2 segments of the data, meaning 16.7% of participants expressed positive emotions regarding being able to change the format to their own liking. On the other hand, another 16.7% of participants mentioned liking the ability to keep the given format. The code `+keeping format preferred` had also 2 occurrences. The codes `+satisfaction of contribution`, `+formatting uncomplicated` and `+web app available for editing tool` covered one segment each, each of them being mentioned by one participant (8.3%).

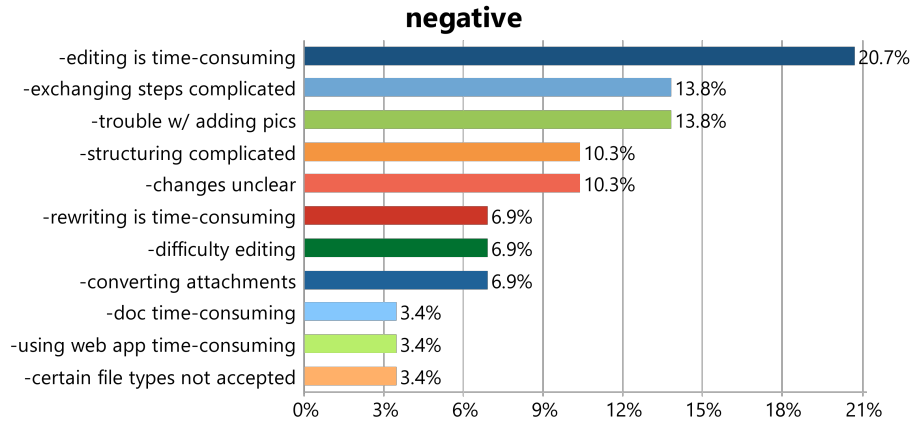


Figure 3.9: Statistic of the occurrence of negative codes in evaluated segments

Negative Codes

Negative codes were assigned to data segments, which contain negative impressions expressed by participants. Out of the 152 coded segments, 29 contained negative evaluations. These were coded with 11 different codes. A visualization of the codes and the percentage of the total negatively evaluated segments they cover can be seen in Figure 3.9. In Appendix C, the Table C.2 containing each code, the number and percentage of participants, that expressed impressions assigned to each code, can be found.

Occurrences of negative codes in analyzed segments and number of participants expressing each negative impression

In this section we will report the negative codes used for the data evaluation, as well as their occurrences. The code with the most occurrences is `-editing is time-consuming` with 6 segments being assigned this code. This sentiment was shared by 41.7% of participants. The code `-exchanging steps complicated` occurred 4 times in the data, as 25% of participants had complaints related to this matter. 33.3% of participants mentioned facing difficulties with importing pictures to their document, for this reason, `-trouble w/ adding pics` covered 4 segments of the data. `-structuring complicated` was assigned to 3 segments, with 16.7% of participants expressing negative emotions related to the difficulty of structuring their documentation during

the interview. 3 data segments were summed up by the code `-changes unclear`. 25% of the participants stated they encountered issues due to the changes they made to the document not being visible. The code `-rewriting is time-consuming` occurred 2 times in the analyzed data, 16.7% of participants considering the process of rewriting the tutorial a lengthy one. 16.7% of participants reported having difficulty editing tutorials, `-difficulty editing` appearing 2 times in the data. `-converting attachments` was assigned to 2 segments of data and was expressed by 8,3% of participants. The codes `-doc time-consuming`, `-using web app time-consuming` and `-certain file types not accepted` occurred one time each. 8.3% of participants described the documentation process as time-consuming. The use of a web application for the documentation was reported to take a long time by one participant (8.3%). One participant (8.3%) reported having issues with certain file types not being accepted by the text editing tool used for the documentation.

Recommendation Codes

Recommendation codes were used to analyze data segments containing suggestions made by participants. Recommendation codes were also derived from the positive and negative impression codes. Out of the 152 coded segments, 61 of them were assigned a recommendation code. For the evaluation, 15 different codes were used. A visualization of the codes and the percentage of the total recommendations they cover can be seen in Figure 3.10. In Appendix C, the Table C.3 containing each code, the number and percentage of participants, that made recommendations assigned to each code, can be found.

Occurrences of recommendation codes in analyzed segments and number of participants making each recommendation

In this section we will present the recommendation codes used for the evaluation of the data and report the frequency of their appearance during the interviews. The code with the most occurrences is `REC: adding pics should be easy`, which was assigned to 11 segments. 50% of the participants mentioned the significance of adding pictures

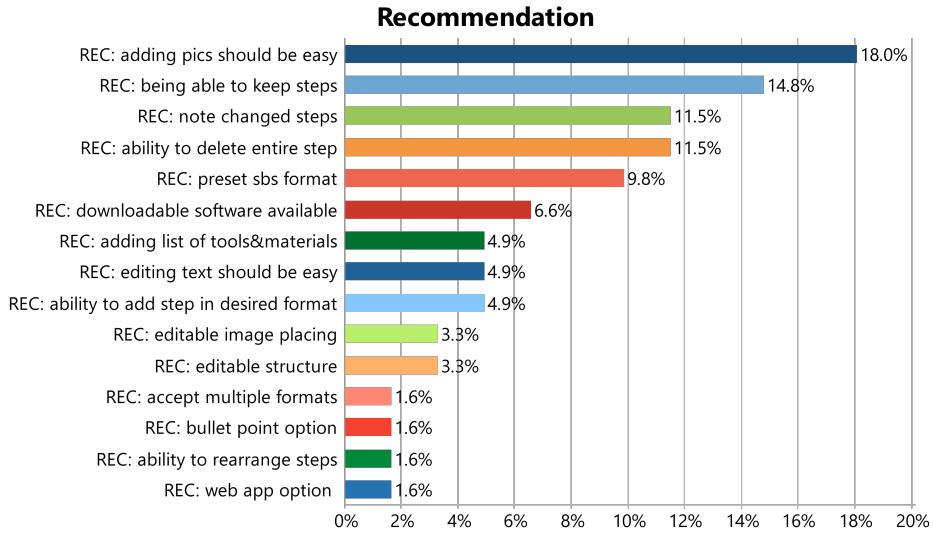


Figure 3.10: Statistic of the occurrence of recommendation codes in evaluated segments

to the documentation with ease. `REC: being able to keep steps` is a recommendation appearing in 9 different segments. The ability to keep steps from the original tutorial while documenting substitutions was suggested by 50% of the participants. The code `REC: note changed steps` was derived from data found in 7 different segments taken from 5 participant interviews (41.7%). The code `REC: ability to delete entire step` had 7 occurrences. 33.3% of the participants suggested the ability to delete entire steps with one button would have eased the documentation process. The next derived recommendation `REC: preset sbs format` covered 6 segments. This code was derived from the answers of 41.7% of participants and refers to having a preset step-by-step format in order to ease the documentation process, as participants found it time-consuming to structure their documentation. The code `REC: downloadable software available` occurred 4 times. This recommendation originated from 33.3% of participants stating it as a preference. `REC: adding list of tools&materials` had 3 occurrences and suggests a way to ease adding tools and materials as a list at the beginning of a tutorial. This recommendation was derived from conversations with 25% of the participants. The recommendation `REC: editing text should be`

`easy` was assigned to 3 data segments, being mentioned by 25% of participants. 16.7% of participants expressed that being able to add a step and have it according to the preset template, would improve the documentation process. For this reason, the code `REC: ability to add step in desired format` was used in 3 different segments. The code `REC: editable image placing` was assigned to 2 segments and was derived from the fact that 16.7% of participants encountered issues with placing images in the desired location of their tutorial. The significance of the ability to edit the structure of the tutorial was suggested by 16.7% of participants and the code `REC: editable structure` appeared 2 times in the transcripts. The code `REC: accept multiple formats` occurred in one of the segments, where a participant (8.3%) suggested its importance by explaining the struggle of having to convert files, in order to add them to the tutorial. The code `REC: bullet point option` was assigned to one segment, in which a participant (8.3%) expressed their preference for having this option. `REC: ability to rearrange steps` was used to code one segment and refers to a functionality suggested by a participant (8,3%). The recommendation `REC: web app option` was assigned to a segment, in which the participant underlined the importance of having the option to use a web application for text editing.

Chapter 4

Evaluation

In this chapter, we will discuss the results reported in Chapter 3. We will evaluate participants' approach to documenting substitutions in DIY tutorials, as well as the use of digital tools for this type of documentation. We will then present our suggestions and guidelines for future tools that could offer support to makers in the documentation of substitutions.

4.1 Documentation of substitutions

In this section, we will discuss the results of our observation and the analysis of the documentation written by participants. We will start by evaluating their approaches to documenting substitutions in DIY tutorials. We will then discuss the codes used to analyze the data gathered in the semi-structured interview, related to their approaches. We will use these results to explore the behavior patterns of participants while documenting and conclude which functionalities they deem important or helpful for the documentation process.

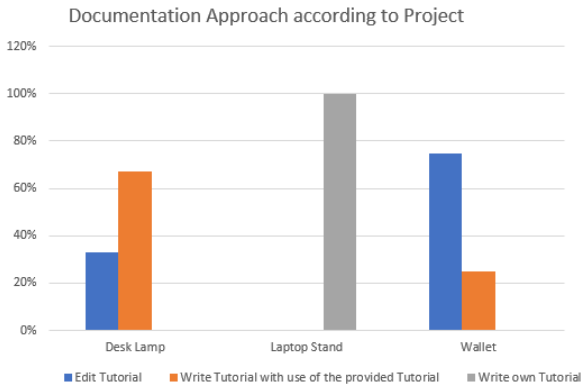


Figure 4.1: Participant approach to documenting substitutions for each project

4.1.1 Approaches to documenting substitutions back into the tutorial

Approaches to documenting substitutions depend on the complexity level of the substitution

Participants had one of three approaches to working their substitution back into the tutorial. A total of 4 participants (33.3%) decided to edit steps of the provided tutorial, where differences arose. 3 participants (25%) decided to rewrite the tutorial in the preferred format, including information and steps from the original tutorial in their documentation. Meanwhile, 5 participants (41.7%) chose to create a new tutorial according to their own liking, without regard to the provided tutorial. While analyzing participants' approaches to documenting, we noticed a correlation between the complexity of the substitutions and the way they were reported. A graph showing participants' approaches to the documentation of substitutions, according to the project they worked on, can be found in Figure 4.1.

Documentation of the substitution of materials and techniques

The substitution of materials and techniques in the laptop stand project was complex. The building process of participants differed from the one presented in the tutorial they were given. As a result all participants, that were assigned this project, decided to write their documentation themselves, without making use of the information provided in the tutorial they were given. Participants explained the difference between their process and the tutorial was considerable, which led them to create their own tutorial.

Documentation of the addition of a step

The complexity level of the substitution in the desk lamp project was moderate, which is also visible in the resulting documentation approaches of participants. Two-thirds of the participants (66.7%), who built this project, chose to rewrite the tutorial while using steps and information from the tutorial they were given. These participants justified their approach by stating the provided tutorial had useful and relevant information however, editing it was time-consuming. The other 33.3% preferred to edit the tutorial by only changing the steps that differed.

Documentation of a material substitution

The substitution of the fabric in the wallet project did not alter the making process as much as the other substitutions, as a result, more participants working on this project decided to edit the tutorial. The 75% of participants, who edited the tutorial, explained that, given the similarity of their process and the tutorial they were provided with, editing was more efficient. The remaining 25% rewrote the tutorial and included some explanations from the original tutorial, however, they chose this approach because they wished to add a more personal tone and change the structure according to their preferences.

4.1.2 Discussion of codes regarding the documentation

In this section, we will discuss the codes resulting from the interview with regard to the approach participants had for documenting the substitutions. We will start by evaluating the impressions and recommendations concluded from answers about editing tutorials. We will continue with the impressions and recommendations about rewriting the tutorial and, finally, the ones regarding rewriting the tutorial while including information from the original. Some codes coincide, as participants with different approaches encountered similar difficulties.

Impression codes regarding editing the tutorial

When asked about editing the provided tutorial in order to include the substitution, participants had various reactions. While some participants preferred this method, perceiving it as more efficient and describing positive at-

tributes such as the ones covered by `+keeping format preferred`, others had negative experiences with this method. The code `-editing is time-consuming`, which occurred 6 times, and the code `-exchanging steps complicated`, which occurred 4 times, sum up some of the complaints participants had. The code `-changes unclear` was assigned to 3 segments, showing that another issue encountered by participants results from the uncertainty of the changes that occurred in the documentation.

Recommendations regarding editing the tutorial

From the previously mentioned codes together with suggestions made by participants during the interview, we derived the following recommendation codes with the purpose of facilitating the editing of a tutorial. The code `REC: being able to keep steps` is the code with the most occurrences, covering 9 data segments. The recommendation `REC: ability to rearrange steps` also appeared in the interviews. These codes suggest ways in which makers could use the information provided in the tutorial which they are recreating while documenting their substitutions. The ability to rearrange steps would ease the restructuring of the documentation according to the building process resulting from the substitution. The code `REC: note changed steps` was derived from the difficulties encountered by participants, covered by `-changes unclear` and is referencing a way to mark the parts of the tutorial that the maker altered so that they are visible. The recommendation codes `REC: ability to delete entire step` and `REC: ability to add step in desired format` were suggested by participants as a solution for the editing process being time-consuming. Such a feature would shorten the time spent editing the documentation by offering users the possibility to add steps in the format they are using and delete entire steps when necessary.

Impression codes regarding rewriting the tutorial

Participants had both positive and negative impressions with regard to the rewriting of a tutorial, which we will cover here. The code `+rewriting tut preferred` having 6 occurrences, shows the positive experience of some of the participants regarding this approach. Positive attributes of this method of documentation were covered by

codes such as `+satisfaction of contribution` and `+format changed to own liking`. These show that participants enjoyed creating their own tutorial, as their contribution brought them satisfaction and the end result was in accordance with their preferences. Other participants had a negative view of the approach of rewriting the tutorial, as they considered this process required too much time and effort. This sentiment was shared during the interviews and was assigned the code `-rewriting is time-consuming`.

Recommendations regarding rewriting the tutorial

From these experiences and the impressions of participants, we derived recommendation codes with the purpose of facilitating the process of writing a tutorial. The code `REC: preset sbs format` was used 6 times and suggests the ability to use a preset step-by-step format for the tutorial. This would shorten the amount of time spent on structuring the tutorial. This can also be said about the recommendations `REC: ability to add step in desired format` and `REC: ability to rearrange steps`, which we discussed previously in the section regarding the editing of a tutorial. Another recommendation suggested by participants, which also regards the structure of the tutorial, was assigned the code `REC: adding list of tools&materials`. This refers to a set template for the tutorial, which includes a list of the tools and materials necessary for the project at the beginning. This list should be easily editable.

Rewriting tutorial including information from the original

As previously mentioned, participants had one of three approaches to documenting their substitutions. We covered the codes regarding editing the tutorial and the codes regarding writing a new tutorial. However, some participants chose to rewrite the documentation while also including information from the provided tutorial. The codes assigned to segments of data related to this approach, were covered in the previous sections, as this approach requires functionalities that facilitate both editing and rewriting the tutorial.

Impressions codes regarding rewriting the tutorial while including information from the original

The impression codes used for coding data related to this approach coincide with the codes used for data about editing and rewriting tutorials. The positive codes

+rewriting tut preferred and +satisfaction of contribution imply the desire to write the documentation according to preference. On the other hand, some participants considered this approach time-consuming, as the code -rewriting time-consuming also occurred. Participants had various impressions regarding formatting the documentation as both the code +format changed to own liking and the code -structuring complicated were assigned to the data. We asked participants why they chose this method of documentation. The codes -exchanging steps complicated and -editing is time-consuming were assigned to their responses.

Recommendation codes regarding rewriting the tutorial while including information from the original

From the previously mentioned issues encountered by participants and from solutions suggested by them, we derived the following recommendation codes. The recommendations REC: editable structure and REC: preset sbs format suggest functionalities that would facilitate the structuring of the documentation by having a preset step-by-step format while also providing the possibility to edit it if desired. The recommendation REC: ability to add step in desired format also supports the structuring of the documentation when adding steps. As this approach implies the use of information from the original tutorial, the recommendation REC: being able to keep steps was suggested.

4.2 Use of digital tools for the documentation

In this section, we will provide an overview of the choices of digital tools used for the documentation of substitutions in all projects. We will then discuss the codes related to the digital tools used. Analyzing participants' choices and opinions on these tools helped us get a better understanding of the motivations behind their decisions and the functionalities of these tools which they deemed important for this type of documentation.

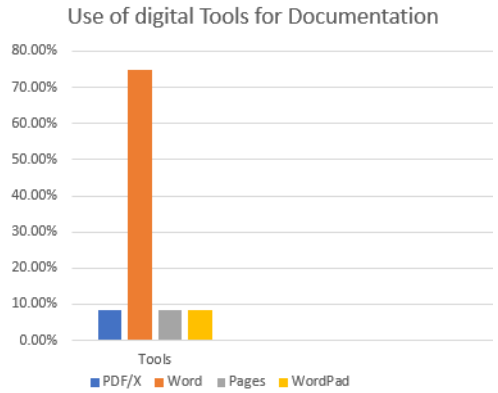


Figure 4.2: Digital tools chosen by participants for the documentation

4.2.1 Choice of digital tools

Participants could use a digital tool of their choosing for the documentation. However, when analyzing their choices, we noticed a trend. Out of the 12 participants, 9 (75%) used Microsoft Word (Microsoft [2023a]). This was an expected choice given the results of the preliminary study, where 63.6% of participants stated, they would use this tool for text-based documentation. Their motivation for using this text editor was the ease with which they could add pictures and edit text. This was mentioned by 5 of the participants (55.5%). Their familiarity with the tool was named by 3 participants (33.3%) as a reason for using Word. Another motivator listed by 2 participants (22.2%) was accessibility, as they already had the software installed or it was easily accessible online. One participant (8.33%) used PDF/X [2023] in order to edit the tutorial, however, they explained it was their second choice, as they were not able to open Word. The participant who chose Pages (Inc. [2023]) stated, their choice was motivated by the availability to Mac users and the ease of use. One participant (8.33%) used WordPad (Microsoft [2023b]) because the tool was easily accessible, as they already had it on their computer. A graph showing the ratio of participants using each digital tool can be found in Figure 4.2.

4.2.2 Discussion of Codes regarding the Use of digital Tools

In this section, we will discuss the positive, negative, and recommendation codes assigned to the data gathered during the semi-structured interview, regarding the digital tool used for the documentation. We will evaluate these according to different aspects that influenced participants' experience during the documentation process.

Accessibility of the tool

The first important factor in participants' choice of a digital tool was accessibility. The positive code `+accessible editing tool` was assigned to 8 data segments retrieved from the interview, making this a frequently mentioned factor. One participant underlined the importance of having a web application available, as they did not have any software for text editing on their computer. The code `+web app available for editing tool` was assigned to this segment. On the other hand, another participant had an issue with the prolonging of the process while using the web application, which led to the use of the code `-using web app time-consuming`. From these segments, we derived the recommendations `REC: web app option`, which occurred one time, and `REC: downloadable software available`, occurring 4 times in the transcripts. The frequent use of the code `+editing tool is easy to work with`, which covered 9 segments, called attention to the significance of accessibility in this sense as well. Participants were influenced by the ease of use and their familiarity with the digital tools they chose.

Importing and placing of images in the document

The importance of pictures in DIY documentation was a recurring topic during the interviews. For this reason, the code `+importance of pics` was assigned to 11 segments of data. This factored in participants' choice and use of digital tools. Participants had various experiences with importing images into their document which led to the code `+adding pics uncomplicated` covering 3 data segments, while the code `-trouble /w adding pics` covered 4. These experiences of participants resulted in the recommendation code `REC: adding pics should be easy` being derived in 11 different segments and `REC:`

editable image placing being suggested 2 times.

Text editing

The participants were given text-based tutorials. For this reason, text editing functionalities were an important factor in their documentation. While describing the documentation process, participants mentioned the significance of using these functionalities with ease. The code +text editing uncomplicated was used 8 times in the evaluation. From this the recommendation REC: editing text should be easy was derived. One participant expressed their preference of using bullet points, in order to keep explanations short. This resulted in the recommendation REC: bullet point option.

Formatting of the document

The text editing capabilities participants required were not limited to only writing and deleting text. Formatting the document in order to achieve the desired tutorial structure was perceived as necessary. Participants had various experiences with formatting as both the codes -structuring complicated and +formatting uncomplicated occurred. Participants encountered various issues with formatting. Having a preset step-by-step format, to shorten the formatting process was suggested in 6 segments, which were covered by the code REC: preset sbs format. Other participants enjoyed being able to edit the structure according to their preferences, REC: editable structure appearing 2 times. The recommendation REC: ability to rearrange steps was suggested by a participant, who wished to rearrange steps from the provided tutorial, in a way they deemed easier to understand.

Acceptance of different file types

The acceptance of file types was discussed with participants, as some of them encountered issues while importing certain file types and converting attachments. This was proven by the use of the negative code -certain file types not accepted being assigned to a data segment and -converting attachments being assigned to 2. From discussions with these participants, we derived the recommendation REC: accept multiple formats.

4.3 Guidelines and Recommendations

Our study brought to light behavior patterns and preferences of makers with different backgrounds. The experiences and impressions of participants, while using digital tools to document substitutions of various complexity levels into a tutorial, helped us better understand their needs. Based on our findings, we concluded a list of guidelines and recommendations for future tools that could support makers in their documentation.

Tool support for both writing and editing tutorials

We discovered during our study, that substitutions can have different impacts on the making process. Depending on the nature of the substitution, which a maker includes in their project, the building process might become considerably different than the one presented in the tutorial. Other substitutions do not cause such notable differences. The nature and complexity of the substitution influence the decision of makers on whether editing the tutorial or rewriting it is more efficient. Currently, DIY platforms offer support for the writing of tutorials, however, these can rarely be linked to another tutorial, which in the case of substitutions would be helpful. We propose the inclusion of functionalities that make the editing of tutorials or the use of information from a tutorial while writing a new one possible. In the following section, we will present some attributes such a tool should have, which resulted from our study.

Text editing capabilities

Any tool used for text-based documentation should offer text editing functionalities. This refers to writing and deleting text. Other such functionalities that are desired are the ability to use bullet points and numbering while documenting.

Keeping information from the original tutorial

A tool that supports the documentation of a substitution by editing a given tutorial, should offer the option of keeping entire steps of the given tutorial, as well as editing them. If the user makes changes in the tutorial, these should be visible, as the uncertainty of changes could lead to confusion.

Formatting and structuring of the tutorial

A tool used for editing and writing tutorials should offer the possibility to structure the document in a step-by-step

format. Such a format should be set beforehand, but the ability to edit it according to preference should also be an option. In order to save time, adding, deleting, and rearranging entire steps should be a functionality of the tool. Another attribute that is recommended is the addition of a tool and material list at the beginning of the tutorial, as part of the preset format.

Importing files

DIY tutorials often require the use of images and other attachments. Importing such files to the document should be possible with the help of the tool. The list of accepted file types should be as large as possible and should include file types used for images and 3D sketches, as these are often used in DIY projects. Converting files by other means can be cumbersome. The positioning of these attachments in the document should also be editable, in order to offer makers the possibility to achieve their desired layout.

Accessibility of the tool

A tool for the documentation of substitutions should be accessible. It should be offered as a downloadable software as well as a web application to ensure accessibility. The tool should be intuitive, in order for makers to use it with ease for their projects.

Limitations

Our study was conducted in a controlled environment. Participants were assigned a project, and given the tutorial, and the substitutions were chosen for them. In a real-life example, the substitutions and approaches to their documentation might vary from the results we observed. Makers might encounter different types of substitutions, which were not covered in our study and could result in different approaches to the documentation of their process. Furthermore, the projects chosen for this study had a low difficulty level to ensure the duration of the study remained between 60 and 90 minutes for each participant. Different complexity levels of projects might influence the way makers document their work.

Chapter 5

Summary and future work

5.1 Summary and contributions

This thesis explored the way makers use digital tools to document substitutions in tutorials, which they are recreating. In order to achieve this, we conducted a study in which 12 participants were asked to build a DIY project while substituting materials, tools, and techniques. Participants used digital tools to document their substitutions. Furthermore, we conducted semi-structured interviews with the goal of gathering data on their experience. The documentations were then analyzed and the interviews were evaluated via coding. The results helped us get a better understanding of makers' behavior regarding the documentation of substitutions and their preferences regarding digital tools used for this type of documentation. We also concluded a list of recommendations for future tools that can facilitate the documentation process of makers.

This thesis explored the way makers use digital tools to report substitutions in DIY tutorials by conducting a study with 12 participants

Substitutions have different complexity levels and impacts on the making process. The differences that arise due to a substitution influence the way makers document their projects. If the substitution does not cause considerable differences in the building process of a project, makers tend

Correlation between substitution and documentation approach

to document it by editing the specific steps in which differences arise. However, more complex substitutions lead to makers preferring to rewrite the tutorial in a way that matches their project.

Preferences regarding digital tools

The documentation of substitutions requires certain functionalities from digital tools. For text-based tutorials, text editors such as Microsoft Word (Microsoft [2023a]), Pages (Inc. [2023]), PDF/X [2023] and WordPad (Microsoft [2023b]) have been used. Some attributes of these tools that proved to be significant for the documentation of substitutions are their accessibility and text-editing capabilities. The use of images in tutorials is important. As a result, the ability to import and place images in the documentation is a crucial functionality of these tools. Tutorials have a specific step-by-step structure, so makers require functionalities that facilitate the formatting of a document from digital tools.

Recommendations for tool support for the documentation of substitutions

For a digital tool to support makers in their documentation of substitutions, the options of editing a tutorial or rewriting it should be possible with the help of the tool. In addition to the previously mentioned attributes and functionalities preferred by makers, there are ways to improve the documentation process by including functionalities such as having a preset step-by-step format, adding, deleting, rearranging entire steps, and noting changes made in the document.

5.2 Future work

Future research could evaluate the suggested guidelines

Future research could be done, in order to evaluate our recommendations and whether or not they support makers in the documentation of substitutions. Furthermore, research could be done concerning how such a tool should look like.

Future research on the documentation of substitutions in video-based tutorials

In addition to text-based tutorials which we discussed in this thesis, makers use video-based tutorials. Platforms such as TikTok gained popularity in recent years and are now used for sharing DIY tutorials. Future research could focus on the ways makers document their work and report

substitutions in video-based tutorials.

Future research on the impact of AI on DIY

Another technology that is rapidly evolving and might influence the DIY community is artificial intelligence. During our study, a participant mentioned their intention of using ChatGPT (OpenAI)for the documentation of their substitution. This technology might impact the way makers improve projects, substitute, and document. Further work can investigate the influence AI engines have on making and documenting.

Appendix A

5 Minute Interviews

Aim: To get a rough idea about the participant's level of expertise and experience with tool and material substitution in DIY tutorials.

Questions:

- Personal Information: age, occupation
- How often do you carry out DIY projects?
- What are some areas of making that are mainly of interest to you and how long have you engaged in these areas?
- Can you remember the last time you were working on a project and had to substitute a tool or material? How often does this happen to you?
- What is your approach to having to make a substitution?
- At what stage of your project are you usually substituting?
- If you are substituting during your projects can you elaborate why you are usually doing it?

Appendix B

User Study Protocol

User Study Protocol

Context

Makers use DIY tutorial platforms to publish their work and find inspiration for future projects. However, recreating a tutorial can be challenging, as modification is often a necessity arising from differences in resources and goals. Changing the process by means of substituting tools, materials and techniques is a common practice among crafters.

Currently DIY platforms do not offer a tool supporting makers in working their substitutions back into the tutorial in order to share it with the world. If makers wish to document the changes that occurred in their process due to a substitution, they are limited to a comment or are required to publish a new tutorial. This can be problematic since it could lead to insufficient information or platforms being cluttered by many similar projects.

For this reason, we want to study the way makers document the substitution of a tool or material and the differences in process that originate from it.

Research question

How are hobby-crafters (makers) using digital tools to report their substitutions into DIY

tutorials which they are replicating?

Variables

Participants

- Different levels of expertise participants have

Complexity of the substitution

- Changing a material
- Add steps
- Substitution of a material and technique

Documentation

- How are participants working their substitutions back into the tutorial
- How they formulate their instructions
- Which parts of the tutorial they change

Task

The participant is asked to complete one of the projects. The possible projects are a wallet, a laptop stand or a desk lamp. They will be provided with a text-based tutorial for the project and with the tools and materials necessary. However, they will have to incorporate a substitution into their project. For the wallet they will have to substitute the oil-cloth material with an upholstering fabric. For the laptop stand they will use PVC-elbows and wooden dowels, instead of the 3D-printed parts used in the provided tutorial. For the desk lamp they will have to build the lampshade themselves instead of 3D printing it, the way it is shown in the tutorial. The participant will be asked to document these changes by editing or rewriting the tutorial so that it matches their process. For the documentation the participant can use their personal laptop, or they will be provided with one if necessary, and they can use a software of their choosing.

Experimental Procedure

Before arrival of participant

- Set up the room according to Setup
- Test if audio recording is working
- Prepare drinks and snacks for participants
- Set up consent form
- Have a pen ready

After arrival of participant

- Greet them and thank for participation and time
- Introduce the participant to the purpose of the study
- Request participant to read and sign consent form**.** Explain content if necessary
- Explain that the study will start with a short interview followed by the task and will end with a semi-structured interview about their experience
- Ask participant if they have any questions
- Set up their Laptop at Desktop Station
- Provide the tutorial
- Tell participant that while doing the crafting process they can ask for help if needed or look up anything online
- Ask the participant if they are ready to start
- Start audio recording and make them aware that the recording is starting

- Conduct the 5 minute interview to find out the participant's level of expertise
- Stop audio recording
- Once the interview is ready prepare to start the crafting process
- Let the participant perform the task and provide help if necessary

After the task

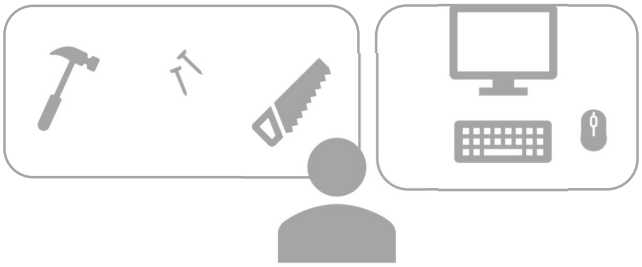
- Ask the participant to send their new tutorial
- Start audio recording for the post-task semi-structured interview and make participant aware that the recording has started
- Gather qualitative data about the participant's experience while documenting the substitution process

End of the study

- Thank the participant again for their time and effort
- Ask the participant if they have any questions or comments

Setup

- All required tools and materials are available on the table (List for each project provided)
- Table with monitor, keyboard, mouse, HDMI cable & USB-C
- Phone for audio recording
- Laptop for additional audio recording
- Sheet of paper with tutorial but also available on computer if preferred



List of required tools and materials

1. Wallet project - https://www.instructables.com/Sew-a-snazzy-oilcloth-wallet
    - Synthetic leather (165x200mm + 155x200mm + 71x94mm)
    - Thread
    - Needle
    - Sewing machine
    - Textile scissors
    - Tape
    - Ruler
    - Pen
    - Paper
2. Laptop stand - https://www.instructables.com/Note-a-Laptop-Stand/
    - Dowels
    - 3-way PVC elbows x2
    - 2-way PVC elbows x6
    - Glue
    - Saw
    - Fabric strap
    - Needle
    - Thread
3. Desk lamp
    - Lightbulb
    - Socket with cable and plug
    - 3-way PVC elbow x3
    - 3D printed lampshade holder
    - Colored polycarbonate sheet
    - Dowel
    - Saw
    - Glue

Participants

The participant group should be heterogeneous since the target maker community is diverse. For this study around 12 participants will be needed. They will be recruited at the university campus.

Experimental Design

- Between-groups design:
    - Three different projects of different complexity levels
    - Each participant will complete one project
    - There will be multiple participants for each of the projects
- One 5 minute interview to collect information about the participant's level of expertise and experience with tool and material substitution in DIY tutorials
- One post-task interview to gather information about the participant's thoughts and approach to documenting the substitution process.
- Participant's documentation of the project
- Estimated duration per participant is 60–90 minutes

Appendix C

Codes

Code	Participants	Percentage
+editing tool easy to work with	9	75.0
+doc not difficult	8	66.7
+accessible editing tool	8	66.7
+text editing uncomplicated	7	58.3
+importance of pics	7	58.3
+rewriting tut preferred	5	41.7
+adding pics uncomplicated	3	25.0
+format changed to own liking	2	16.7
+keeping format preferred	2	16.7
+satisfaction of contribution	1	8.3
+formatting uncomplicated	1	8.3
+web app available for editing tool	1	8.3

Table C.1: Positive codes, number and percentage of participants expressing impressions that were assigned the codes

	Segments	Percentage
+doc not difficult	11	17.7
+importance of pics	10	16.1
+editing tool is easy to work ...	9	14.5
+accessible editing tool	8	12.9
+text editing uncomplicated	8	12.9
+rewriting tut preferred	6	9.7
+adding pics uncomplicated	3	4.8
+keeping format preferred	2	3.2
+format changed to own liking	2	3.2
+formatting uncomplicated	1	1.6
+satisfaction of contribution	1	1.6
+web app available for editi...	1	1.6
TOTAL	62	100.0

Figure C.1: Table showing the positive codes, number and percentage of segments they were assigned to

Code	Participants	Percentage
-editing is time-consuming	5	41.7
-trouble w/ adding pics	4	33.3
-exchanging steps complicated	3	25.0
-changes unclear	3	25.0
-structuring complicated	2	16.7
-rewriting is time-consuming	2	16.7
-difficulty editing	2	16.7
-doc time-consuming	1	8.3
-converting attachments	1	8.3
-using web app time-consuming	1	8.3
-certain file types not accepted	1	8.3

Table C.2: Negative codes, the number and percentage of participants expressing impressions that were assigned the codes

	Segments	Percentage
-editing is time-consuming	6	20.7
-exchanging steps complicated	4	13.8
-trouble w/ adding pics	4	13.8
-changes unclear	3	10.3
-structuring complicated	3	10.3
-difficulty editing	2	6.9
-converting attachments	2	6.9
-rewriting is time-consuming	2	6.9
-using web app time-...	1	3.4
-certain file types not accepted	1	3.4
-doc time-consuming	1	3.4
TOTAL	29	100.0

Figure C.2: Table showing the negative codes, number and percentage of segments they were assigned to

Code	Participants	Percentage
REC:being able to keep steps	6	50.0
REC:adding pics should be easy	6	50.0
REC:note changed steps	5	41.7
REC:preset sbs format	5	41.7
REC:downloadable software available	4	33.3
REC: ability to delete entire step	4	33.3
REC:adding list of tools&materials	3	25.0
REC:editing text should be easy	3	25.0
REC: editable structure	2	16.7
REC:editable image placing	2	16.7
REC: ability to add step in desired format	2	16.7
REC:accept multiple formats	1	8.3
REC:bullet point option	1	8.3
REC:ability to rearrange steps	1	8.3
REC:web app option	1	8.3

Table C.3: Recommendation codes the number and percentage of participants expressing impressions that were assigned the codes

	Segments	Percentage
REC: adding pics should be easy	11	18.0
REC: being able to keep steps	9	14.8
REC: note changed steps	7	11.5
REC: ability to delete entire step	7	11.5
REC: preset sbs format	6	9.8
REC: downloadable software available	4	6.6
REC: adding list of tools&materials	3	4.9
REC: editing text should be easy	3	4.9
REC: ability to add step in desired format	3	4.9
REC: editable image placing	2	3.3
REC: editable structure	2	3.3
REC: accept multiple formats	1	1.6
REC: bullet point option	1	1.6
REC: ability to rearrange steps	1	1.6
REC: web app option	1	1.6
TOTAL	61	100.0

Figure C.3: Table showing the recommendation codes, number and percentage of segments they were assigned to

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