

# Smartorials – A Smart-Glass-Based Infrastructure for Knowledge Transfer in the Health Sector

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**Abstract.** Knowledge transfer plays an important role but is still a challenge in the healthcare sector. In the past, the use of video tutorials has been explored to support knowledge transfer. However, the question of how to efficiently record video tutorials remains. With *smartorials*, we describe a smart-glass-based video-recording-system which represents a low-threshold way to integrate knowledge transfer into existing infrastructures. In this paper, we describe the system and present results of an exploratory study that focused on the preparation process of video tutorials. An interactive design process was utilized to develop the so-called *preparation form*, which incorporates best practices from the literature and aims to better prepare caregivers for video recording. An exploratory study involving caregivers was conducted to evaluate the efficiency and effectiveness of the *preparation form*. The study measures the time required to create video tutorials and analyzes their content quality. Results show that using the *preparation form* reduces the time required to create video tutorials, ensures sufficient content quality, and is a simple method that can be easily integrated into the daily work of caregivers. These findings suggest that *smartorials* including the *preparation form* can be an effective tool for improving knowledge transfer in daily work environments.

## Introduction

Knowledge transfer has become increasingly important in various areas due to an ongoing change and restructuring in many workplaces (Dalkir 2017). When looking at the healthcare sector, knowledge transfer plays an important role to provide the best possible care to patients. Due to technological limitations in care

work infrastructures, accessing knowledge about good work practices is not always easy (Rolls et al. 2020). Consequently, it is important to offer knowledge transfer tools that can be integrated into the daily work routine. In the past, video tutorials have been proposed as a solution to support knowledge transfer in healthcare (Forbes et al. 2016). However, new challenges become apparent with creating video tutorials: It can be stressful for the caregivers to authentically reflect their knowledge and skills in a video. Work activities are usually performed routinely, so presenting the work verbally and visually might be a challenge for the caregivers. Here we present the *smartorials*<sup>1</sup> system that provides support for this knowledge transfer and its challenges: It provides a smart-glass-based infrastructure for creating, exchanging, and viewing video tutorials efficiently during the daily work routine as well as a short *preparation form* that allows caregivers to prepare for the video shoot in a short time. In the following, we present an exploratory study on supporting caregivers to plan and create video tutorials in a short time using *smartorials* including its *preparation form*.

## Related Work

The importance of knowledge transfer in healthcare is increasing, but there are several obstacles that hinder effective knowledge sharing (Almansoori et al. 2021). One of these obstacles is the time factor. Due to the lack of time among healthcare employees, knowledge transfer and its practical methods are often considered too time-consuming (Karamitri et al. 2017). In addition to time factor, non-existent or insufficient technology is often a reason for inadequate knowledge transfer (Dalkir 2017), also in the healthcare sector (Sheng et al. 2013). One reason for a failed technological solution is often the lack of user involvement. The technological solutions are often developed around everyday work instead of integrating them into the everyday work (Karamitri et al. 2017; Morr und Subercaze 2010).

Numerous studies have demonstrated that video tutorials can be an efficient tool for knowledge transfer in various domains (van der Meij und van der Meij 2014; Worlitz et al. 2018), including healthcare (Forbes et al. 2016; Sharma et al. 2021). However, there are fundamental challenges in the use of video tutorials in healthcare: First, the creation of video tutorials is very time-consuming, and second, it results in a natural selection of work processes: Activities that can be well reflected by video tutorials are not yet represented due to the production effort and costs (Forbes et al. 2016). This results in a trade-off between the effort required to create a video tutorial and its potential benefits. In the following section, we will provide an overview of the findings from previous work on producing video tutorials efficiently and highlight the criteria that can be used to evaluate the accuracy and comprehensiveness of their content.

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<sup>1</sup> Abbreviation for “smart-glasses tutorials”

One of the main challenges of creating a video tutorial is the preparation required before filming. While professionals are familiar with the tasks that should be explained in the video tutorial, they often lack experience in structured verbalizing the work activities in video tutorials. To address this challenge, Weeks and Davis conducted a literature review to identify best practices for planning and creating successful video tutorials (Weeks und Davis 2017). One important requirement is the creation of a script, which should contain both instructions and the content of the video tutorial (Weeks und Davis 2017). Norman mentioned that a detailed script can be quite time-saving of the overall process; however, creating a script is still very time-consuming (Norman 2017). Weeks and Davis found that defining the goal, narrowing the target audience, and creating a script were particularly helpful in creating a successful video tutorial (Weeks und Davis 2017). The authors emphasize that the script should only include essential content. Regarding length of videos, Weeks and Davis recommend to divide video tutorials over two minutes into segments (Weeks und Davis 2017).

## *Smartorials* as Infrastructure for Knowledge Transfer

Here we present the *smartorials* system, which we consider as a prototype of a smart glasses-based infrastructure for knowledge transfer.

### Concept

With *smartorials* users can wear smart glasses during their work and record videos to document knowledge or watch videos to retrieve knowledge. *Smartorials* hereby refers not to a single pair of glasses but rather to the complete knowledge infrastructure which contains also cloud-service to exchange videos and a web application that can be used to modify the content of videos. Each video is recorded in multiple user-defined segments. The segmentation is used for editing videos later on or for playing only a subset of segments of a video.

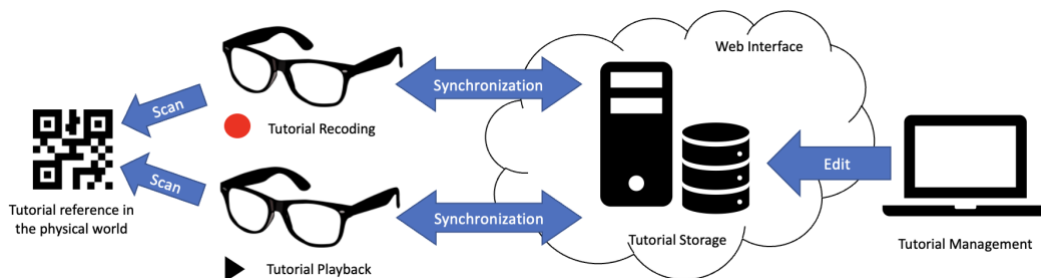


Figure 1 – Concept of the *smartorials* infrastructure

The concept of the infrastructure is shown in Figure 1. Video tutorials are stored on a server and automatically synchronized with all connected smart glasses. In the

real world, a reference to video tutorials is created by printing quick response (QR) codes that contain an identifier (ID). This ID represents hereby a particular task at a specific location. When scanning a QR code, users can either record a new video or watch a video, if a video for the specific ID was already created. In a web-based tutorial management application, videos can be modified in a way that videos can be cut, segments can be created or changed and the sequence of segments within a video can be changed. Furthermore, the assignment of videos to QR codes be changed and new QR codes can be generated.

## Implementation

Our current prototype implementation contains the smart-glass-based application as well as the tutorial management software, as first step into the web-based infrastructure. However, videos are not yet automatically synchronized with the server. For implementing the smart-glass application we used the smart glasses “Vuzix Blade Upgraded Version” („Vuzix Blade® Upgraded Version“ o. J.) that runs Android as operating system, so the mobile application for the glasses was natively developed in Android. The server software as well the web application follows a microservice architecture, using Docker („Docker“ o. J.) with Kubernetes („Kubernetes“ o. J.) for the orchestration of the microservices.

## User Interaction with the *Smartorials* Glasses

Users can interact with the *smartorials* glasses using the head gestures that have been presented earlier by Prilla et al. (2019). The gestures are shown in Figure 2.




|             |   |  |   |
|-------------|---|--|---|
| Gesture     |  |  |  |
| Description | Nodding   | Tilting to the side  | Shaking head  |
| Usage       | Selecting,<br>Approving   | Navigation:<br>Switching active<br>button to left/right                              | Opening menu,<br>pausing video<br>(create segment)                                    |

Figure 2 – Head gestures for the interaction with the *smartorials* glasses. Image is an edited version of the image presented in (Prilla et al. 2019).

While the gestures are used to navigate through the application, scanning a QR code is the initial user interaction: when starting the application, a QR code reader is shown and a QR code with a specific tutorial ID has to be scanned.

If the ID has no video assigned, the user can select to record a video by nodding. During recording, users can shake their head to pause the video, which also automatically creates a new segment. The system determines the start of the head gesture so that the time span of the gesture itself is cut from the video recording. The user then can decide whether to continue recording the video (which creates a new segment), to re-record the last segment, or to finish and save the video.

If a specific ID contains already a link to a video, users are asked if they want to record a new video or if they want to play the existing video. In the playback mode users can play, pause and stop the video or navigate through segments. The user interface follows the common interaction patterns of media players here.

## The Preparation Form — How to Support People to Plan the Tutorial Recording?

The preparation form was motivated and informed by the results of a prior evaluation. This section summarizes this previous evaluation, describes how the form was developed based on the results and presents the preparation form.

### Experiences from the Evaluation without Preparation Form

In the first iteration of the project, the prototype of *smartorials* was evaluated in the field of nursing within three realistic use cases: placing medications according to a medication schedule, patient transport with the help of a lift from a bed to a wheelchair, and tracheal cannula exchange.

In this evaluation, several video tutorials for each use case were recorded by caregivers. From the video tutorials of a use case, a "best case" was then cut together manually with the help of an editing program. This procedure took several hours for recording a single video tutorial. The recorded video tutorials in the field of nursing were on average 9:48 minutes long. The videos were divided into segments. Afterward, the tutorials were tested with untrained employees followed by interviewing the participants about their experience.

Overall, the feedback from the participants about *smartorials* was mostly positive. Learning unfamiliar work activities was very helpful through the video tutorials. Additionally, the hands-free aspect of the smart glasses was noted as a particularly beneficial feature. However, there were several issues regarding the recording of the videos. First, the experts had no experience creating and recording video tutorials. Therefore, the participants who created video tutorials mostly lacked a clear structure of which aspects should be shown in each use case and which should be excluded. As a result, the recording of the video tutorials was quite time-consuming, with an average of almost a whole working day required for each video. In one of the evaluations for a use case, the preparation alone took more than three hours until the first recording. Feedback from some caregivers indicated that preparing for a video recording was challenging: *"We had also needed a lot of time in preparation, too."* On the one hand, the lack of structure in the preparation asked for a lot of creative space, but on the other hand, this also led to a high time consumption: *"I would have thought it would go faster after all."* During the video recording, the caregivers sometimes forgot the structure or the content they had thought about in the preparation. Some recordings had to be stopped and started

several times. As a result, stressful situations were sometimes observed by the researchers during the recordings.

Moreover, the video tutorials typically required post-production editing, a skill that was not readily available within the healthcare company in question and thus had to be performed by a researcher.

## Development of the Preparation Form

Based on the previous findings, we identified the need to enhance the efficiency of the video recording process for the next iteration. The long time for creating video tutorials, and in particular the long preparation phase, conflicts with the goal of integrating video recording into everyday work. Consequently, the focus was on more efficient preparation. A workshop was conducted to elicit the requirements for a type of script to increase the efficiency of the video recording process. From the workshop, it was concluded that a cognitive preparation for the corresponding work activity is necessary to possibly reduce the time needed for preparation. An iterative process was started to create a “tool” for supporting cognitive preparation. In the first phase, a team of three researchers discussed initial ideas, during which the "form" medium was selected for cognitive preparation. Choosing written documentation or forms had a significant advantage in that caregivers are already familiar with them from their daily work. This idea was presented to the stakeholders from the healthcare sector, who agreed to use the form.

In the following a first version of the preparation form was created and tested with a caregiver. The caregiver was asked to use the preparation form to prepare for the video shoot and was interviewed afterwards. The input was used to revise the form resulting in the form which is presented in the following.

## The Preparation Form

Figure 3 shows the final developed and evaluated preparation form. The best practices of goal definition, target audience, script, and dividing longer video tutorials into segmentations as described in related work for proper preparation were adopted in the form. The form was divided into three sections: *Objective* (goal definition), *Target Group*, and *Segmentation*. On the left of Figure 2, the two sections *Objective* and *Target Group* are shown. The first section contains the *Objective* description, which is use case depended and summarizes in a short sentence the goal of the video. The second section contained the best practice target audience, represented based on the persona concept. The caregiver should select one from these personas that they think is appropriate in the context. In the evaluation of the form, the real situation was represented by a previously given scenario description. In the future, the persona should be selected based on the real situation. This section was designed to make the caregiver aware of who would be

using the video tutorial later, and therefore increase awareness of what content is relevant to explain the activity through the video tutorial.





**Formular zur Videovorbereitung**

**Ziel des Videotutorials**

In dem Video sollen alle wichtigen Arbeitsschritte gezeigt und erklärt werden, die für die Tätigkeit „Transfer einer Patientin/eines Patienten mit Lifter und Tragetuch in einen Rollstuhl“ und für die Zielgruppe wichtig sind.

**Zielgruppe**

Machen Sie sich noch einmal bewusst, für wen Sie das Video aufnehmen sollen. Wählen Sie dafür aus den folgenden vier beschriebenen Personen die Person aus, die der Zielgruppe am ähnlichsten ist.

| Madita  | Daniel  | Tobias   | Ilja  |
|---|---|--|---|
|    |    |   |    |
| Alter: 43   | Alter: 19   | Alter: 32  | Alter: 20   |
| <b>Pflegefachkraft</b>  | <b>Auszubildender</b>   | <b>Pflegehilfskraft</b>  | <b>Auszubildende</b>  |
| <b>Beschreibung:</b><br>Madita ist ausgebildete Pflegefachkraft. Die letzten Jahre war Madita nicht in der Pflege beschäftigt. Ihren letzten aktiven Einsatz hatte Sie vor fünf Jahren. Sie möchte nun wieder mit pflegebedürftigen Patienten arbeiten. | <b>Beschreibung:</b><br>Daniel ist Auszubildender. Er ist in seinem ersten Lehrjahr als Pflegefachkraft. Er durfte schon erste Erfahrungen in der Praxis sammeln. Er beherrscht schon viel theoretisches Wissen. Ihm mangelt es an einen sicheren Umgang in der Praxis. | <b>Beschreibung:</b><br>Tobias ist leidenschaftliche Pflegehilfskraft. Er besitzt eine langjährige Berufserfahrung. Die genannte Tätigkeit führt Tobias gemeinsam mit einer erfahrenen Fachkraft gelegentlich durch. | <b>Beschreibung:</b><br>Ilja ist Auszubildende. Sie ist in ihrem zweiten Lehrjahr als Pflegefachkraft. Ilja hat einen Fluchthintergrund. Ihre Muttersprache ist nicht Deutsch. Sie hat bereits Erfahrungen in der Praxis, aber nicht hier vor Ort. Die Sprachbarriere und die wenige Praxiserfahrung macht ihr zu schaffen. |

Folgende Person kommt meiner Zielgruppe am nächsten:

Bitte Namen eintragen:




Figure 3. The Preparation Form. On the top left is the goal description with the heading "objective of the video tutorial". Below is the persona concept to create awareness of target audience to reach. The selection of the target group depends on the context. In our evaluation, the target group should be "students". On the right is the third section, with the segmentation of the video tutorial. Here already filled in and chronologically sorted by a participant during the evaluation.

The *Segmentation* section of the form is meant for dividing the planned video into shorter segments (see Figure 3, right). Caregivers are asked to break down the activity into smaller steps and write down the content of each step while ensuring that breaks can be taken between these steps without risking themselves or the patient. Each card represents one segment, and caregivers can choose whether to write down key points or sentences about the content of the segment on the card. The cards can be kept nearby during video recording and can be sorted e.g., according to their chronological order. In addition, while recording the segments, they can be used as a reference guide or a reminder. This approach creates a script with the essential content aspects which is split into segments.

## Evaluation with the Preparation Form

### Evaluation Method

To evaluate the use of *smartorials* including the preparation form, we run a study under conditions close to the field. We used the use case of transferring a patient,

which was setup as follows: in the center of the room was a patient bed, as used in nursing. To the right of it was an electronic patient lift, and a chair represented the wheelchair. The patient to be transferred was played by students. Figure 4 shows the test bed during a video tutorial recording.



*Figure 4. A caregiver uses data glasses to record a video tutorial in the test environment.*

The participants, all caregivers, were introduced to the background and purpose of the study and consent was obtained for data collection. Next, the participants were given time to familiarize themselves with the electronic lift, followed by instructions on how to operate the smart glasses through a tutorial and practice with a short video recording. The scenario was then described to the participants, including the reason for the video recording, the use case, described above, and the target group (in this case, first-year students). The form was given to the participants to prepare for the recording. The participants could choose to take their previously completed segmentation cards with them or leave them on the table. After the video recording was completed, the participants were asked to come to a separate room for a brief post-session interview. The researchers thanked the participants for their participation.

A total of eight participants were scheduled to record one video tutorial each. The participants all have practical and long-term experience in the chosen activity. Eight recording sessions were planned, but due to illness and a technical malfunction, only seven participants were able to participate and a total of six videos were created.

To assess the effectiveness of the video tutorials produced using the preparation form, time taken during preparation and recording was measured, and feedback on the form was gathered immediately after recording.

Moreover, the quality of the videos was evaluated by an expert, a nurse scientist, who evaluated the videos based on content quality. To do this, she watched all videos from both iterations (without and with preparation form) and rated content in terms of completeness and errors. All videos addressed the basic aspects that are



critical to the safe performance of the work activity. If any aspects of the content were missing, they were minor details that did not pose a threat to the safety of either the caregiver or the patient.

In the end, a conclusive statement was reached regarding the critical factors for producing high-quality video tutorials for healthcare work activities, as well as an assessment of the quality and efficiency of the videos created using the preparation form, in comparison to the previous videos created without the form.

## Results and Discussion

The preparation form was generally accepted by the participating caregivers and found to be practical. The form proved to be important for cognitive preparation: *“Very helpful as a tool for mental preparation.”* Participants stated that the form helped them to prepare for the video tutorial in a structured way: *“I was thinking in myself-hm- now also filling out slips of paper beforehand, but this was helpful.”* In particular, the segmentation with the small cards helps the nurses to remember the essential aspects for the explanation of the work activity. In addition, it was emphasized that the little cards could be looked at once again during the recording and offered a structured overview: *“The little cards are mobile and I can also rearrange them flexibly.”*

Table 1 summarizes the results on average in terms of time for preparation, recording, duration, and content quality of the video tutorials. The table contains the data from the first iteration (without preparation form) as a baseline. The average time spent preparing and recording video tutorials using the form resulted in significant time savings compared to those created without the form (a total of 24 minutes and 20 seconds compared to several hours). Furthermore, it was found that the error rate regarding missing aspects was reduced. In videos that have been recorded without previous preparation, an average of 13 errors were identified by the nursing scientist. In the videos with the preparation form, only 5.5 errors were identified on average. This means that the error rate could be reduced by 7.5 missing aspects on average. Additionally, it should be mentioned that none of the recorded video tutorials with the preparation form required any post-editing.

In summary, the results demonstrate that the preparation form achieved the following successes: First, it reduced the time required to record a video tutorial. Second, it simultaneously increased the quality of the video tutorials by reducing the number of missing content aspects with the aid of the form. Third, the form is a method that can be easily integrated into the daily work of caregivers. Our initial research demonstrates that the form can increase the efficiency and content quality of videos. The form is a proven documentation tool within many infrastructures of the healthcare system and is flexible enough to be used in digitization projects. Moreover, the form can be easily implemented digitally, and information can be directly displayed on the glasses.

Table I. Results with time units in mm:ss, content completeness, and number of missing aspects in average

|  | <b>Time for preparation</b> | <b>Time for recording</b> | <b>Video duration</b> | <b>Content complete?</b> | <b>Missing aspects</b> |
|--|-----------------------------|---------------------------|-----------------------|--------------------------|------------------------|
| <b>Video creation without preparation form (n=3)</b> | <i>Several Hours</i>        |                           | <i>10:25</i>          | <i>No</i>                | <i>13</i>              |
| <b>Video creation with preparation form (n=7)</b>    | <i>09:50</i>                | <i>14:30</i>              | <i>10:30</i>          | <i>No</i>                | <i>5.5</i>             |

Of course, the presented results are subject to certain limitations: the study was intentionally designed in an exploratory way to obtain initial insights into whether an improvement can be achieved with the preparation form. For this reason, only a small number of participants were evaluated with this method.

## Summary and Conclusion

Video tutorials have the potential to significantly enhance knowledge transfer in the healthcare sector by making complex and individual activities more comprehensible. However, creating video tutorials efficiently presents some challenges. In initial investigations within the context of this research project, it became clear that video tutorial preparation is a significant time factor that needs to be minimized. There are only a few best practices in the literature that focus on structured preparation. The most common methods for creating successful video tutorials include defining objectives, identifying the target audience, and creating a detailed script. These three methods were considered in the development of a preparation form through an iterative process. The final developed form provides the caregivers with a quick overview of the content-related goal and the target group. In addition, the caregivers are asked to split the activities into individual steps and to write down initial notes on the content. The preparation time for recording a video tutorial was significantly reduced using the preparation form. Our data shows that the preparation time was reduced from several hours to less than one hour. Furthermore, the content completeness of the videos was improved. From an average of 13 missing content aspects, this rate was more than reduced by half with the new preparation method. We assume that with the help of the form, the caregivers are better primed cognitively for the content aspects that are to be shown. Smartorials offer a low-threshold way to integrate into existing infrastructures and daily work routines. Future research should explore other use cases using the preparation form and investigate its potential for other target groups, such as onboarding experienced caregivers after a long career break. In the future, the form could be integrated into existing digital infrastructures and displayed on data glasses used for real-time support during video recording.

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