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Benefits of illustrations and videos for technical documentations

Cornelia S. Große *, Lisa Jungmann, Rolf Drechsler

Group of Computer Architecture, Institute of Computer Science, University of Bremen, 28359 Bremen, Germany

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ABSTRACT

Technical devices completely surround us and, as they become more and more widespread and important, the need for technical documentation increases as well. While there is a large body of research concerning the question how materials should be designed in order to foster *learning* optimally, there is astonishingly little research on the question how to design a documentation in order to facilitate its application – with respect to time, number of errors, and subjective measures. These issues are addressed in the present work. For this purpose, an experiment was conducted which compared three types of technical documentations – namely, "text only" documentations, documentations with text and illustrations, and video versions – with respect to objective and subjective measures. The results indicate that whether a task is actually solved or not does not mainly depend on the type of documentation; however, working with documentations with text and illustrations significantly shortens solution times. Depending on the concrete problem, "text only" documentations can elicit a considerably larger number of faulty steps. With respect to subjective measures, "text only" documentations reach especially negative scores, whereas documentations with text and illustrations and video documentations reach comparable – and considerably better – subjective ratings. The results also show significant gender differences.

1. Introduction

Technical devices have become an integral part of our world. It is not only the common use of computers or smart phones which radically changes living conditions; even simple washing machines are programmable, and cheap stuffed animals can make sounds when you pet them. Such embedded systems – information processing systems which are embedded into a larger product (Marwedel, 2006) – influence and shape our world. As technical products become more and more widespread and important, the need for technical documentation increases as well. This need for technical documentation is, for example, part of a regulation of the European Parliament and Council of the European Union (2008). Technical documentations have to satisfy the requirements of various norms such as for example the international standard IEC 82079-1 (International Electrotechnical Commission, 2012). These standards aim to ensure sufficient quality of the documentation and give numerous aspects which have to be considered. However, they neither provide detailed information on how to develop a technical documentation, nor do they provide proof that the aspects required are actually helpful in order to create an understandable and usable technical documentation. In recent years, process models for technical documentation of software and hardware in embedded systems were discussed (Muranko & Drechsler, 2006); however, experimental results with respect to the effectivity of different designs are still missing.

In spite of these attempts to set appropriate standards for technical documentations, many documentations do not meet the criteria of being understandable, complete, useful, and up-to-date (e.g., Briand, 2003; Deelstra, Sinnema, & Bosch, 2004; Price & Korman, 1993). It should be admitted that writing a technical documentation consumes a lot of time, and technical developers might prefer the more creative task of actually developing a product rather than writing a documentation for it – albeit there exists astonishingly little research on the question whether developers, technical writers, and users are "satisfied" with the current situation. Overall, it is safe to assume that for each of the parties involved, potential for improvement remains: Developers might wish to invest more time in developing products than in documenting them, technical writers might complain about the large number of standards which have to be considered, and users might wish not to deal with documentations which are either not understandable or not up-to-date with the product.

In order to address these problems, a large number of publications focuses on the question of how to write a technical documentation (e.g., Barker, 2003; Prevezanos, 2013; Price & Korman, 1993; Weiß, 2000). However, many of them just state suggestions, hints,

* Corresponding author. Tel.: +49 421 218 64446.
E-mail address: cornelia.grosse@uni-bremen.de (C.S. Große).

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and advices how to reach understandable documentations. To the best of our knowledge, though, most of them are not backed up empirically. Thus, it still has to be tested experimentally whether different types of technical documentation actually affect their understandability and usability. Until today, it is not clear whether these suggestions really hold in practice.

In the present work, the issue of how to foster the understandability and usability of technical documentations is addressed from the perspective of educational psychology. Following this approach, the lack of experimental evidence in the literature on how to design understandable and usable technical documentations can be overcome. In the following sections it is argued that working with a technical documentation incorporates aspects of learning, thus, a large amount of empirical findings on how to design learning materials is relevant in the context of technical documentation. However, as working with a technical documentation also incorporates aspects which differ from "traditional" learning, it is not possible to transfer empirical results one-to-one. The present experiment addresses the question to what extent specific findings from the field of learning and instruction also apply to the field of technical documentation. The paper is structured as follows: In Section 2.1, related work with respect to learning with written and spoken text, illustrations, and videos is presented. Section 2.2 argues that while these results may be of high relevance also for technical documentations, no one-to-one transfer from the field of learning and instruction to the field of technical documentation is possible. This leads over to the research questions in Section 3. Following the methods section (Section 4), results of the experiment are presented in Section 5, and they are discussed in Section 6.

2. Related work

2.1. Learning with written and spoken text, illustrations, and videos

What is actually done by the person who reads a technical documentation can be considered as a learning process: The goal is usually to understand how the product works and how one has to operate it, and to memorize for example dangerous situations in order to avoid them. Thus, it seems reasonable to take theories and empirical insights from the field of educational psychology into consideration. Here, many aspects have been identified which support the acquisition of knowledge and skills. A large body of research has shown over the last decades that including carefully constructed illustrations in texts enhances learning outcomes (for an overview see Carney & Levin, 2002; see also Mayer, 2003). However, inappropriately designed graphics can interfere with mental model construction and, thus, hinder learning (Schnotz & Bannert, 2003). Kürschner and Schnotz (2007) showed that in order to foster visuo-spatial mental representations, a combination of text and pictures was more effective than text only. This representational format is especially important in the case of technical documentations, as dealing with devices often involves spatial information with respect to the relative position of switches, buttons, or other technical components. Occasionally, technical components are hard to describe verbally (e.g., when neither the location nor the appearance can be described easily), resulting in unclear and ambiguous documentations – needless to say that they do not help much. In this case, including pictures might improve the understandability considerably, as the reference between "description" and "object" is made distinct and precise.

Kürschner and Schnotz (2007) pointed out that presenting learning contents in a spoken form allows for supporting comprehension by varying pace, frequency, intonation, and including breaks; whereas written language can be processed repeatedly by the learner in an individual pace, and learners can be supported by text features such as highlighting or dividing the text into paragraphs. In the study of Kürschner and Schnotz (2007), in order to foster visuo-spatial mental representations, listening was more effective than reading. This effect can be explained by referring to Baddeley's working memory theory, more specifically, by the visuo-spatial sketch pad and the phonological loop (e.g., Baddeley, 1992). In a reading condition, the visuo-spatial sketch pad may be overloaded, whereas in a listening condition, cognitive processes can be distributed evenly (see also Kürschner & Schnotz, 2008). Similarly, in the study of Kühl, Scheiter, Gerjets, and Edelmann (2011) learners presented with spoken text outperformed learners presented with written text with respect to transfer tasks.

As pointed out above, in the case of technical documentations, visuo-spatial mental representations are very important. Thus, it can be concluded that presenting information in a spoken form should be recommended. However, Kürschner and Schnotz (2008) point out that the effectivity of reading versus listening depends on the difficulty of the text: For difficult texts, reading is often more effective, whereas for easy texts, empirical results are heterogeneous. Thus, if a spoken form is chosen, it should be ensured that the text is not too difficult and demanding.

Another possibility of providing information is in form of videos or animations. Höffler and Leutner (2007) conducted a meta-analysis and found a medium-sized overall advantage of instructional animations over static pictures; the study of Kühl et al. (2011) also found that dynamic visualizations were more effective than static visualizations which fits in this picture. Thus, using instructional animations should be recommended. However, providing instruction in form of a video can also limit the "freedom" of the learners: While a video can "lead" the learner through an "optimally" designed learning environment, providing instruction in form of written text enables the user to decide independently whether to read the text rapidly or leisurely, completely or only partially, and whether to repeat parts or not. In this respect, it should be expected that including videos or leaving them out may influence the subjective "feeling" – those who prefer to act independently favoring a written text version, and those who prefer being taken by the hand favoring a video version.

In addition, it should be noted that the total run time of a video sets some kind of "lower bound" for the learning time, at least as long as it is assumed that each learner will watch the video at least one time in complete length – which might be necessary as it is not possible to know in advance in which part of the video relevant information will appear. In contrast, when learning with a text, it might be possible to just scan it superficially very quickly and to grasp the major aspects anyway (possibly depending on the complexity of the task and on the prior knowledge of the learner).

Another disadvantage of videos, at least in the case of more complex learning contents, can be seen in its "fleetingness": A video which presents instructions to be followed in a step-by-step manner requires the user either to memorize all the steps – which may be difficult depending on the number or complexity of the steps –, or to perform the steps simultaneously while watching the video – which may be difficult depending on the pace of the video –, or to watch the video repeatedly – which would take more time.

In short, learning with text and learning with videos both have advantages and disadvantages; and accordingly, Merkt, Weigand, Heier, and Schwan (2011) found no significant differences between "common video" (with start/stop, forward, and rewind button), "enhanced video" (with a number of interactive features), and "illustrated textbook" with respect to a multiple choice knowledge test.

In a recent study, König, Stadler, Klepsch, and Seufert (2012) not only focused on actual learning outcomes (recall and comprehen-