

Reviewing in Video Tutorials:
Can it foster Procedural Knowledge Acquisition?

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Faculty of Behavioral Sciences, Department of Instructional Technology (IST)

First Supervisor: Dr. Hans van der Meij

Second Supervisor: Dr. Jan van der Meij

University of Twente, Enschede

Abstract

This study examines the influence of the inclusion of a review in a video instruction for software training. The underlying rationale is that video may induce passivity and may strain the students' working memory. In an experiment two groups are compared with one another. The control group receives the regular video instructions. These instructions are segmented into a set of meaningful tasks. The experimental group receives the same video, complemented with reviews after each task instruction. 55 Participants from two classrooms from middle schools were randomly assigned to condition. The findings favored the experimental group with significant effects on flow and confidence after training. In addition, there were trends favoring the review group on positive moods during training and post-test scores. The discussion draws attention to the issue of schema acquisition and change that is affected by time and by the presence of the review.

Introduction

Recent progress in technological development and in the domain of information infrastructure has led to new opportunities and options for educators and researchers. Since a couple of years, it has become incredible easy, fast and low-priced to watch, record videos and to share them on the internet. This development has not just raised the market and the amount of videos for entertainment purposes, but also that for education and self-instruction.

Due to free or affordable video capture programs such as Camtasia, Screencast or QuickTime, the creation of video tutorials has become very convenient for the private internet user, but also for institutions or education projects. In addition, a lot of websites like YouTube, Howcast, Vimeo, monkeysee or Videojug are offering a publication platform for a large population of potential viewers at low or no costs. As a result, the prominence of "How to" videos as an instruction mean for software usage has also increased.

The most common type of "How to" videos for software is the *recorded demonstration* which essentially consists of a screen capture animation with narration (Plaisant & Shneiderman, 2005). Such a recorded demonstration, or *tutorial* as we will call it from now on, presents a step-by-step demonstration of the correct method for achieving a procedural or contextual learning objective. However, in this study the focus was put exclusively on the acquisition of procedural knowledge.

Research has shown that students can benefit from video supported e-learning in several ways. One, the video fosters self-directed and self-paced learning. The video offers

the student more flexibility, as he is temporally independent from teachers or educational institutions. Two, the video allows practically unlimited access to learning material with the benefit of updated versions (Zhang, Zhou, Briggs, & Nunamaker Jr., 2006).

Along with these developments there has been a tremendous surge of multimedia research and design guidelines in the last two decades. These efforts have resulted in a more fundamental understanding of multimedia learning especially thanks to insights from the fields of instructional design and cognitive psychology. Even so, many issues remain unclear. This study examines the question whether the inclusion of a rehearsal part (i.e., a review) at the end of a video increases its effectiveness. We begin with a summary of relevant theoretical and empirical research on video tutorials and multimedia learning.

Theoretical basis

Most of the recent findings and concrete guidelines in the field of multimedia learning and instructional design are based on two fundamental theories of cognition, namely, the Cognitive Load Theory (CLT) and the Cognitive Theory of Multimedia Learning (CTML).

The former one, CLT, is a widely known and accepted instructional theory with the underlying idea that human working memory is limited and not capable of the processing of large amounts of information. That does not imply that working memory has only a minor part in the process of information acquisition – the opposite is the case. The CLT “assumes that working memory plays an essential role in skill learning, because it serves as a device for transforming instructional information into useful *cognitive schemata*” (Van Gerven, Paas, Van Merriënboer, Hendriks, & Schmidt, 2004). A schema serves as a tool for the long-term memory for retrieval of existing information and for saving working memory capacity. This is done through a (re)organization of new and existing information/knowledge by chunking information elements together. If this process fails or is performed in an ineffective fashion, the working memory faces the risk of cognitive (over)load which will affect learning performance negatively (Moreno, 2005; Sweller, 1994).

The implication of CLT is that learners should be encouraged and supported in using their working memory efficiently and that instruction materials should be designed with the purpose of minimizing cognitive load on the working memory in mind (Moreno, 2007; Van Gerven u. a., 2004).

The other central theory, the Cognitive Theory of Multimedia Learning (CTML), was introduced by Richard E. Mayer. It is the second major theoretical basis for instructional multimedia design and can be seen as a combination of dual coding theory, CLT and

constructivist learning approaches. The basic assumptions of CTML are the following: (a) visual and verbal information-stimuli are processed in two different systems (dual coding theory), (b) processing capacity of working memory is limited (CLT) and (c) “meaningful learning occurs when learners actively select relevant information, organize it into coherent representations, and integrate it with prior knowledge” (Mayer & Moreno, 2002).

Thus, comparable to the concept of schemata, the CTML uses the concept of - visual or auditory – mental representations, which means that the instructional designer should foster the creation of mental representations. And since the creation of representations is seen as a result of active cognitive processes (i.e. selection of relevant words and images; organization and integration into coherent and meaningful representations), the design of learning material should provide optimal support for the learners’ ability to discriminate relevant from irrelevant information (Mayer & Moreno, 2002).

Many multimedia studies have used CTML as a starting point for the creation of novel and effective design guidelines. In addition, over the course of time, CTML received a lot of empirical support and, thus the validation of its design principles (Mayer, 2008):

Table 1.
Selection of Principles for Reducing Extraneous Processing, Managing Essential Processing and Fostering Generative Processing

Principle	Definition
<i>Coherence</i>	Reduce extraneous material.
<i>Signaling</i>	Highlight essential material.
<i>Redundancy</i>	Do not add on-screen text to narrated animation.
<i>Temporal contiguity</i>	Present corresponding narration and animation at the same time.
<i>Segmenting</i>	Present animation in learner-paced segments.
<i>Pretraining</i>	Provide pretraining in the name, location, and characteristics of key components.
<i>Modality</i>	Present words as spoken text rather than printed text.
<i>Multimedia</i>	Present words and pictures rather than words alone.
<i>Personalization</i>	Present words in conversational style rather than formal style.

These multimedia principles - see also method section - allow the instructional researcher to design more effective multimedia interfaces. However, these are not the only widely accepted design guidelines. The minimalist approach, introduced by van der Meij and Carroll, serves as another relevant source for concrete multimedia design guidelines (van der Meij & Carrol, 1995; van der Meij & van der Meij, 2013).

In summary, there are various theoretical and empirical approaches in the field of multimedia learning and instruction. Most of these have received a substantial amount of empirical evidence, and even if they may differ in elaboration and in setting of priorities, they

all have in common that they strive for a minimization of extraneous load on working memory, ideal support of learners' own ability to distinguish between relevant and irrelevant pieces of information, and thus, the fostering of schema (representation) acquisition and retrieval. Research suggests that this will lead to higher efficiency of learning material and therefore better learning outcomes (Mayer & Moreno, 2002; Moreno, 2007; van der Meij & Carrol, 1995).

The connection of the present study to the literature

The literature offers well supported broad theoretical approaches, but also an increasing amount of concrete principles and guidelines, as seen above. However, little to no research has been done on the effect of reviews in multimedia designs. For this reason, the underlying idea behind this study can be seen as intuitive and derived from conclusions (and design implications) from mentioned approaches like CLT, CTML and minimalism.

While there is a lack of research on the role of reviews in digital multimedia learning, there is no absolute dearth of research on reviews. Various studies have been done on the effect of summaries and rehearsal in analog learning environments.

A study on the effect of visual and verbal summaries in science textbooks showed that these summaries fostered the organization and integration of new information. The reviews helped to create a cognitive structure (akin a schema or mental model) that facilitated recall and comprehension (Mayer, Bove, Bryman, Mars, & Tapangco, 1996). An important caveat is that this study used the active process of summary writing as independent factor and not the presentation of predefined summaries.

A recent study that compared the effect of predefined versus self-generated summaries found "that studying predefined summaries in a pictorial representation mode facilitated deep understanding (Leopold, Sumfleth, & Leutner, 2013). Even so, some critics argue that self-execution of an instructed action (e.g., writing a summary) is a more effective learning strategy than solely processing the outcome (e.g., reading the summary) (Yang, Gathercole, & Allen, 2013). Nevertheless, the use of summaries as a learning tool is an accepted practice, since it facilitates the learner to focus on the important learning objectives and to neglect irrelevant information.

In addition, research on rehearsal learning shows that rehearsal serves the dual purpose of maintaining an item in short term memory and transferring information about the rehearsed item to the long term memory (Rundus & Atkinson, 1970). As it comes to the process of reminding, it is suggested that the 'reminding material' should differ from the original

instruction in so far that the similarity should neither be too small for risk of failing to elicit reminding, nor should it be too much for risk of producing sheer remembrance with little mnemonic benefit. In other words, it is suggested that it is “the quality of the original encoding that is particularly important for successful acquisition” (Benjamin & Tullis, 2010).

These findings can be seen as consistent with the intuitive deductive idea (based on CLT, CTML etc.) that a review at the end of a video tutorial may: (a) enhance the learners’ ability to focus on important information, (b) facilitate a proper encoding of instruction information, and (c) serve as a blueprint for the creation of schemata. As a consequence, we hypothesize that a review may have a positive effect on recall and performance.

Cognitive learning theories (i.e. CLT, CTML) have been especially criticized for their neglect of the role of social, motivational and emotional factors in multimedia learning. Research has shown that these factors should be considered when testing hypotheses about multimedia learning, since motivational and emotional factors can play an important role during the whole learning process (Graesser, McNamara, & VanLehn, 2005).

In addition, it appears that flow experiences may also play a crucial role in multimedia learning. Flow is also called ‘optimal experience’. It can be described as a state of mind in which the experience of an activity itself is so enjoyable for the learner that he or she is doing it for its own sake, and that everything besides the activity becomes irrelevant and dissolves. Research have found that flow experiences and positive affect go hand in hand and that both are associated with better learning performance (Csikszentmihalyi, 1997; Schüler, 2007). The direction of influence, however, is not clear. Engeser & Rheinberg (2008) indicate that the strong relationship between flow and performance is primarily a consequence of the effect of performance on flow and not vice versa. In contrast, another study concluded that flow experience actually may lead to better performance, since flow seems to correlate positively with higher motivation to perform and also with the intention to yield good performance (Snyder & Lopez, 2009).

The present study was designed to investigate the learning effect of reviews in videos for software training. Two conditions were compared. A control and an experimental condition. The only difference between the two lies in the (added) presence of a review. We looked at performance in an immediate post-test and in a one-week delayed retention test. A second purpose was to look at the relationship between the factors of flow experience, mood and motivation. Three hypotheses are formulated:

- H1: The learning effect (i.e. immediate and post-test score) in the experimental condition will be higher than in the control group.
- H2: Participants in the experimental condition will report higher flow experiences than those in the control condition.
- H3: Participants in the experimental condition will report positive moods more often during training, and more highly appraise their motivation after training than those in the control condition.

Method

Participants and design

The participants were 57 seventh graders from two classrooms of two middle schools in Germany. Two students were excluded in the analysis due to absence during the training and pretest session and due to invalid data, resulting in a total number of 55 participants (33 males and 22 females). The mean age of participants was 12.95 years ($SD = 0.48$; range 12.0 – 14.4).

Each classroom was split into two groups and the students were randomly assigned to either control or experimental condition. The experimental design was a simple 1 x 2 between-subjects factorial design, with the only independent factor being whether students were assigned to the experimental or control group.

Materials

Video tutorials

The design and content of the video tutorials was based on a study by van der Meij & van der Meij (in review) that compared paper-based tutorials with video tutorials for software learning (Microsoft Word). Their approach to design video tutorials was also derived from earlier mentioned cognitive and instructional theories, as well as from their own Eight Guidelines for the Design of Instructional Videos for Software Training (van der Meij & van der Meij, 2013). Therefore, the decision was made to adopt these video tutorials to the present study and to design additional video material coherent with the existing material. The videos were recreated for the German version of Microsoft Word 2007. Likewise, the narration was voiced in German.

These recorded demonstrations or tutorials showed easy to follow instructions for Word formatting options and covered different domains of learning objectives: (a) adjusting

the left and right margin for the whole document, (b) formatting of paragraphs, lists and citations and, (c) the creation of an automatically generated table of contents.

Van der Meij & van der Meij (in review) used a website to present the videos to the participants. In the present study, the website was also adopted and translated (see Figure 1). On the left side, the participants were able to click on the corresponding heading (i.e. “1.1 Adjusting the right margin”) in order to start the video tutorial, which then appeared automatically on the right side. The total length of the tutorials ranged from 1.08 minutes to 2.08 minutes. In general, each video showed the required series of actions to perform a formatting task in Word.

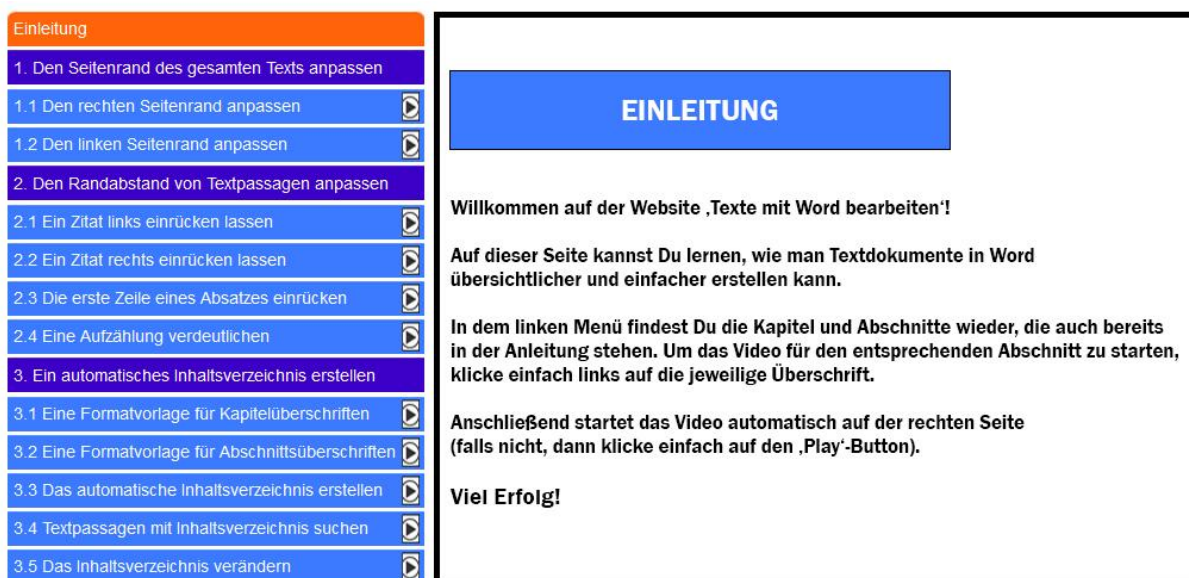


Figure 1. German website with video tutorials which were presented to the participants

Reviewing

The main distinction in the presented stimuli (tutorials) between the mentioned study and the present study, was the inclusion of a rehearsal summary (or review) at the end of every rounded-off video (thus at subtask completion). Just as in the other studies, this preceded the hands-on activities of the participants.

The design of the reviews was – again – based on earlier mentioned guidelines and especially on the multimedia principles in instructional design (Mayer, 2008). Following the signaling and coherence principle by Mayer, the main purpose of these summaries was to reduce extraneous material and to highlight the essential steps in order to perform the task. Thus, each review began with a clear signal for the participant that the ‘normal’ instruction was finished. That is, the narrator introduced the review with the statement “You’re finished

now, but remember...”. It was assumed that the use of the term *remember* could function as a prompt to pay attention. In the review, the “you”-form in the normal instruction changed into an “I”-form during review narration. Both forms of address remain personal, which is in line with research on personalized speech (i.e., the use of ‘I’ and ‘you’) that found positive effects on transfer and retention tests (Kartal, 2010; Moreno & Mayer, 2004). In practice, the narrator used phrases such as “At first, I must click on [...] Then, I should select [...] Finally, I press on the TAB-key”. The underlying idea behind this decision was the assumption (see also Introduction) that a review may foster the organization and integration of cognitive schemata and that a summary of the essential required procedural actions may increase the efficiency of this process and reduce cognitive load. Accordingly, the use of the first-person singular minimizes the process of recoding the ‘You’-statements into ‘I’-statements, which may facilitate the process of encoding relevant information and therefore may reduce cognitive load.

The reviews also signaled relevant information (e.g., the mouse cursor, selecting text, specific menu options) visually. The purpose of highlighting or signaling should be that the users’ attention is drawn to important and visually unobtrusive – but still relevant - actions. This can be done by adding visual objects or animations. Nevertheless, it is crucial that the user perceive these signals as clearly imposed, because “the user should not confuse them with the real objects belonging to the interface” (van der Meij & van der Meij, 2013). As a consequence, all used signal objects were colored in bright red (i.e. arrows and circles) and should be clearly perceived as imposed (see Figure 2). In addition to the signals in the ‘normal instruction’, a special object was used in the summaries, namely an animated arrow which represented a moving object. All in all, the reviews lasted between 13 to 26 seconds.

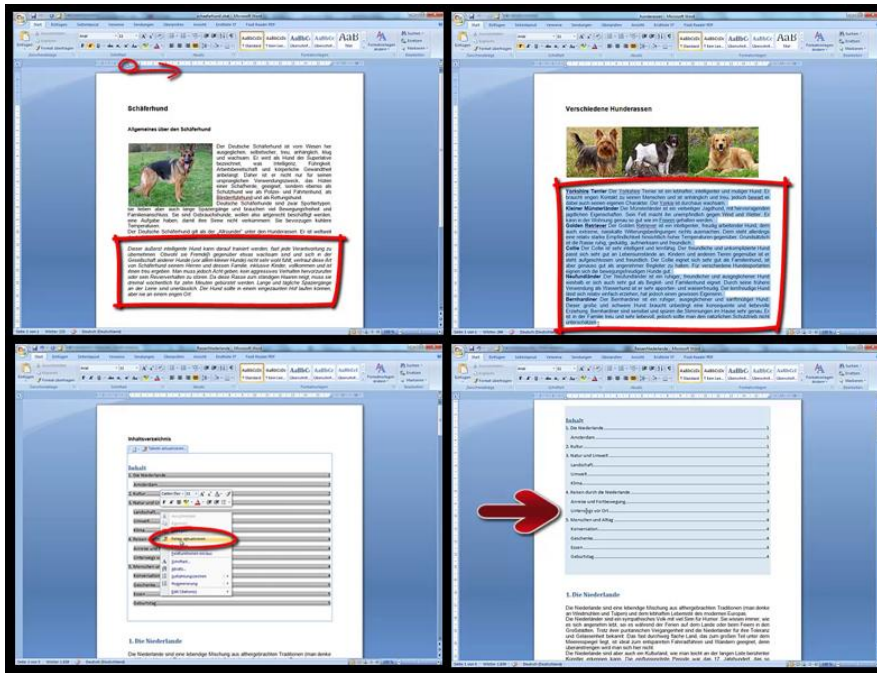


Figure 2. Examples of signaling objects in added summaries

Motivation, Mood and Flow measures

Participants have received a motivational questionnaire in the pretest (prior training) and at post-training. These questionnaires were identical to the ones used by van der Meij & van der Meij (in review). In test tasks were always the same in pretest, training, post-test and retention-test, differing only in the provided Word practice files. During the pretest, participants received a paper manual with before-after screenshots of word formatting tasks. Subsequently, they were asked three questions: (a) “Do you ever have to do this task?” (Experience), (b) “How often do you need to complete this task?” (Task-relevance), and (c) “How well do you think you can complete this task?” (Self-efficacy). Participants have answered these questions on a 7-point Likert scale.

Mood was measured after subtask completion during the training session. Participants were asked to report their current perceived mood as (a) Happy, (b) Confident, (c) Neutral, (d) Unconfident, or (e) Sad.

The experience of flow was also assessed during training and after subtask completion. Rheinberg, Vollmeyer, & Engeser (2003) have found that specific questions are especially appropriate to measure the concept of flow experience. Four items with the indication of a high internal consistency were derived from their Flow Questionnaire: (a) “At each step, I know what I have to do” ($\alpha = .84$), (b) “The right thoughts/movements are arising automatically” ($\alpha = .81$), (c) “My mind is completely clear” ($\alpha = .75$), and (d) “I have the

feeling that I can control the procedure” ($\alpha = .80$). Again, the participants gave their answers on a 7-point Likert scale, ranging from (1) strongly disagree to (7) strongly agree.

Procedure

The experiment was conducted in two sessions in the computer lab of the schools. In the first session, students participated in the pretest, training and post-test. Every computer was labeled with a number and assembled with the learning and testing material beforehand (half of it with the experimental website version). In the beginning, all students received an introduction (5 minutes) and they were told that they would receive a Word training that may help them to improve their school reports. Furthermore, it was clarified that they should work individually and that they cannot ask for help in completing the tasks and should only put their hands up if they are ready or if they have technical problems. Subsequently, all students were assigned to a specific computer number (dependent on the prior assignment to condition) and were instructed to complete the pretest. The students were given a maximum of 20 minutes to complete the pretest.

Thereafter, a second introduction was presented (10 minutes) which explained the training procedure and the use of the website therein was explained (10 minutes). When everything was properly prepared, the training session started (40 minutes). In order to ensure good audio quality of the narration and to prevent disturbance and talk, every student watched the tutorials with headphones. When a student completes the training session before the expiration of the 40 minutes mark, they were instructed put their hand up. Subsequently, all training material was collected and the student could start with the post-test (20 minutes). During the post-test the students were not allowed to access the videos.

Seven days later, the same students took part in the retention-test (20 minutes). After that, all students got a verbal debriefing about the purpose of this study and the existence of two different website versions. Finally, the students were asked to give feedback about the whole experiment.

Analysis

A check on the random distribution of participants across conditions for the data from the Motivation Questionnaire revealed no significant differences. ANCOVAs were computed to examine procedural knowledge development during and after training, using the pre-test scores as a covariate. The non-parametric Mann-Whitney U-test was computed if a check revealed a violation of the homogeneity assumption. All tests are two-tailed with alpha set at

0.05. Trends are mentioned when they are in the predicted direction. Cohen's (1988) d -statistic is used to report effect size. These tend to be qualified as small for $d = 0.2$, medium for $d = 0.5$ and large for $d = 0.8$. For some measures the degrees of freedom vary slightly, due to missing data.

Results

Participants in the experimental group were expected to learn more from the training than did the control group. This effect was examined for the immediate post-test as well as the retention test taken one week later. Another prediction was that there would be a greater experience of flow in the experimental group. Finally, it was expected that the experimental condition would have yielded more positive moods during training and higher motivation (i.e., task-relevance and confidence) after training.

Training Effect

An analysis of covariance (ANCOVA) on the measured post-test training success, with pre-test scores as covariate, was conducted. Table 2 shows that participants in the experimental group showed higher task completion performances on the post-test, than those in the control group. After controlling for the effect of pretest performance, the effect of condition on the post-test performance showed a trend, $F(1,52) = 2.9, p = .096$ (two-sided). An ANCOVA on the retention-test, with post-test scores as covariate, revealed no significant effect of condition. In this case, the covariate (i.e., post-test score) was significantly related to the scores on the retention-test, $F(1,49) = 8.94, p = .004$. When controlling for this effect, the conditions did not differ on the retention-test, $F(1,49) = .065, p = .426$. [In addition, the Levene test indicated a violation of the homogeneity assumption.] A comparison between the scores on the post- and retention-test yielded the interesting result that both groups performed slightly better on the latter.

Table 2. *Scores on the pre-test, post-test and retention-test per condition.*

	Pre-test Mean (S.D.)	Post-test Mean (S.D.)	Retention-test Mean (S.D.)
Control	22.1 % (18.1)	77.4 % (19.7)	81.8 % (23.3)
Experimental	23.7 % (14.7)	86.2 % (17.8)	89.3 % (13.5)
Total	23.0 % (16.3)	82.1 % (19.1)	85.8 % (18.9)

Flow

The ANOVA analysis showed a significant effect of condition on the experience of flow, $F(1,53) = 10.61, p = .002$. However, the Levene test indicated a violation of the homogeneity assumption. Therefore, we examined this effect with the non-parametric Mann-Whitney test. This test statistic indicated the presence of a significant effect, favoring the experimental condition, $U(55) = 552.50, p = .003$ (see Table 3).

Table 3. Mean scores of flow experience per condition.

	N	Mean	SD
Control	26	5.56	1.32
Experimental	29	6.43	0.54
Total	55	6.02	1.08

Mood during and Motivation after training

A one-way analysis of variance (ANOVA) on the motivational issues in the pretest yielded no significant difference between the conditions. On subscale frequency, $F(1,53) = 1.36, p = .25$, on subscale relevance, $F(1,53) = 2.22, p = .14$, and on subscale confidence, $F(1,53) = .65, p = .42$.

Participants predominantly reported having experienced a positive mood during training (see Table 4). An ANOVA analysis revealed a trend for condition on positive mood during training, $F(1,53) = 3.51, p = .066$ (two-sided). The effect of condition on neutral mood, $F(1,53) = 1.44, p = .24$, and on negative mood, $F(1,53) = 2.66, p = .11$, is not significant.

For motivation after training we measured relevance and confidence. A one-way ANOVA was conducted with the result of no significant difference between the conditions on subscale relevance, $F(1,53) = .83, p = .37$. The Levene test indicated a violation of the homogeneity assumption for confidence. Therefore, we examined the effect of condition on this measure with the non-parametric Mann-Whitney test. This test statistic indicated the presence of a significant effect, favoring the experimental condition, $U(53) = 475.50, p = .003$.

Table 4. Mean Scores for Mood per condition.

	Positive Mood Mean (S.D.)	Neutral Mood Mean (S.D.)	Negative Mood Mean (S.D.)
Control	79.2 % (24.3)	14.6 % (19.2)	5.4 % (12.1)
Experimental	89.7 % (16.6)	9.0 % (15.7)	1.4 % (5.2)
Total	84.7 % (21.1)	11.6 % (17.5)	3.3 % (9.2)

Discussion

The present study investigated whether reviewing in video tutorials (i.e., through presentation of a predefined summary) have an influence on the efficiency of users' knowledge acquisition. The expectation was that the reviewing group will show a higher learning effect than the not-reviewing group on an immediate and delayed test (Hypothesis 1). The results are in line with this hypothesis. The reviewing group showed a substantial amount of higher learning performance on the immediate post-test. And even if the two groups differed not significantly, it showed a distinct trend of higher training effect for the reviewing-group. The results failed to confirm the assumption that the effect of reviewing is also present in a one week delayed retention-test. Surprisingly, both groups performed better on the retention test when compared to their post-test performance. This was unexpected, since no intermediate training was given, and needs to be discussed.

A second assumption was that the participants in the reviewing-group would report higher flow experiences than those in the not-reviewing group (Hypothesis 2). Again, the results showed – on average – the report of higher flow experiences in the reviewing-group and a further analysis revealed a distinct effect of reviewing.

Finally, it was expected to see more positive mood reports and higher motivation of participants in the reviewing-group (Hypothesis 3). The results indicated a trend for condition on positive mood and, thus, participants in the reviewing-group (90%) showed a higher probability to report a happy or confident state of mind than those in the not-reviewing group (80%). Furthermore, with regard to motivation, both groups differed significantly on confidence after training, but not on relevance.

The most important finding that needs to be discussed is that in this study, reviewing in video tutorials actually led to better learning performance on an immediate post-test, but not on an equivalent test seven days later. This indicates a trend of reviewing for better knowledge development on short-term recall (short time interval between the training of procedures and recall of learned procedures). It also raises the question why does reviewing fail on facilitating long-term recall of procedures?

As stated in the introduction, the underlying idea behind this design was the assumption that reviewing fosters the process of schema acquisition (building of mental models). Here, it is important to consider that schema acquisition is not a one-time only process where new information is integrated in a novel schema and subsequently can be stored in long-term memory. Rather similar to digital files which can be saved in an

unchanged or fixed shape on hard drive, cognitive schemata tend to continuously change and adjust themselves on basis of novel and existing knowledge and information (Mayer & Moreno, 2002). Thus, it is likely that the summary as a means to review the instruction during the training session indeed has increased the efficiency of schema organization and integration, but that these schemata were further on adjusted by the participant between the moment of post-test and retention-test (even unconscious). One reason of schema change may be that the acquired schemata tend to dissolve over time and that the recall of information of these schemata becomes increasingly difficult, if the schema is not properly organized and associated and with other schemata, which makes retrieval harder (Sweller, 1994). Another (intuitive) explanation may be that the participants simply had the opportunity and the time (seven days) to engage in similar Word practice on their own, namely between the first (pretest, training, post-test) and second session (retention-test). For the researcher, this factor is difficult to control and tricky to examine. Still, it should be reasonable to say that every type of activity which is associated with the formatting of texts in Word (or even more abstract associations) will have an influence on already existing schemata.

Another finding that needs discussion is the outcome that both groups showed higher performances on the retention-test when compared to the immediate post-test. This is a counter-intuitive result, especially if we accept the explanation that the lack of effect of condition on the retention-test is due to unintentional schema adjustment (with the result of less efficient schemata which leads to reduction of Word performance). However, as the finding of higher retention-performance was encountered in both groups, it should not be a causally related to the manipulated factor (reviewing or not). As a result, it might be accurate to say it is not the performance on retention-test that is too high, but rather that the performance on the post-test (in both groups) was systematically too low. The proposed explanation for this is straightforward: The execution of the experiment in both schools was possible only during two ordinary double lessons (90 minutes) with a 10 minute break in between. This means that all participants have completed the pretest, training and post-test in one single session without big time intervals for refreshment and that participants finished the post-test during their ordinary break between different courses. This can be seen as a limitation of the research design and may have reduced their motivation to perform well on the post-test (see also the finding of no effect of condition on relevance items in the post-training motivation questionnaire).

In summary, it can be concluded that reviewing in video tutorials may indeed foster the acquisition of procedural knowledge, at least in short delayed performance or transfer

tasks. This conclusion is also supported by Kopp & Mandl (2005). They conclude in their article about schemata that “for knowledge acquisition and permanent knowledge representation it is necessary to build adequate schemata within the relevant knowledge domain. As antecedent for comprehension constructing a schema on the one hand proceeds unconsciously, yet on the other hand can be fostered and made conscious by adequate schema induction. This means in particular that experts provide schemata for learners in a certain domain, thus using them as a learning strategy. This can be effected [...] via pre-settings, which are directly implemented into the learning environment and which pre-structure the work processing.”

Finally, the aspect of practical relevance should be addressed. The present study contributes to existing literature about instructional design and multimedia learning in that it showed that all participants in both groups achieved a significant learning effect due to the training with video tutorials. Thus, video tutorials, as long as they are constructed on the basis of the same design guidelines, should be a good means to instruct people about software procedures. In addition, and as stated in the introduction, the amount and relevance of self-generated video tutorials on internet platforms (i.e., YouTube, Howcast etc.) has massively increased in recent years. Likewise, the technological development has not just changed the private education sector, but has also led to new methods of instruction in school education. Many schools have modernized their equipment and teaching methods (e.g., many are now using the interactive whiteboards instead of the old analog blackboard). Thus, the demand for novel and more effective multimedia instruction is likely to increase in the future. Further research is suggested in order to investigate the relationship between reviewing, schema acquisition and learning performance more deeply.

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