Original article

doi: 10.1111/jcal.12082

Journal of Computer Assisted Learning

A test of the design of a video tutorial for software training

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Abstract The effectiveness of a video tutorial versus a paper-based tutorial for software training has yet to be established. Mixed outcomes from the empirical studies to date suggest that for a video tutorial to outperform its paper-based counterpart, the former should be crafted so that it addresses the strengths of both designs. This was attempted in the present study. Two consecutive experiments were conducted to examine the effect of tutorial type (video vs. paper based) on task relevance, self-efficacy, mood, flow and task performance. Participants were students from junior high school. Both studies reported significant, positive contributions of the tutorials to task relevance, self-efficacy, mood and flow. Both studies also found significant and substantial effects on task performance. A learning gain of about 30% was achieved in both studies. A retention task, completed only in Study 2, further revealed that the learning effect was stable. More importantly, performance on this task also indicated a significant interaction with tutorial type, favouring the video. The success of the video tutorial is ascribed to its design, which attended to and even incorporated key qualities of paper-based tutorials, while also capitalizing on the strengths of video.

Keywords design guidelines, procedural knowledge development, software training, tutorial, video.

Introduction

Since video production and distribution have become relatively easy, its use for educational purposes has rapidly increased (Fernandez, Simo, & Sallan, 2009; Jenkins, Browne, Walker, & Hewitt, 2011; Lin, Zimmer, & Lee, 2013). The best known showcase for the popularity of video is YouTube. This video-upload website became an instant hit when it was launched in 2005. A recent estimate is that YouTube now has 1 billion unique viewers each month.

Accepted: 05 July 2014

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Video tutorials for software training are an interesting niche market within the expanding field of educational video, with both makers and users of software operating as active players. Companies such as Adobe, Apple, HP, Microsoft and TechSmith have been replacing their paper-based tutorials with video tutorials. Software users have also been producing video tutorials, sharing them on websites with an instructional focus such as eHow, Howcast and Vimeo. Educational publishers as well are transforming their paper-based materials to digital materials, including video. In addition, an increasing number of teachers are ‘flipping’ their classrooms by recording their own instructional videos and asking their students to watch them at home so that class time can be used for discussion and going deeper. The question is whether video tutorials can be at least as effective as the paper-based tutorials they are replacing.

Empirical research contrasting paper and video tutorials

The effectiveness of a video versus a paper tutorial for conceptual knowledge development has now been examined in a fairly large set of empirical studies (Höffler & Leutner, 2007). Far fewer studies have compared the effectiveness of video and paper for procedural knowledge development about software, and the outcomes of these studies have been mixed. A study by Payne, Chesworth, and Hill (1992) compared four conditions (paper-based tutorial, video tutorial, paper plus video and no instructions) on procedural knowledge development for McDraw and found a time advantage for the paper-based tutorial. A study by Alexander (2013) compared the use of a paper-based tutorial or video tutorial for the creation of a table of contents and the use of mail merge in Microsoft Word and showed no specific benefits of either tutorial. Research by Palmiter, Elkerton, and Baggett (1991) and Palmiter and Elkerton (1993) showed better results during training for video instructions, but better test results for written instructions. The main explanation the authors give is that the video invited mimicking behaviour, with users copying the modeled actions without giving much thought to the underlying mental model. Comparison studies by Spannagel, Girwidz, Löthe, Zendler, and Schroeder (2008) and Lloyd and Robertson (2012) yielded better results for video, but a noteworthy aspect of both of these studies is that the users faced the complex task of learning about both the software and the domain. In two experiments by Spannagel *et al*. (2008), the participants learned to use spreadsheets in order to learn also about physics and mathematics. In the study by Lloyd and Robertson (2012), the participants learned to work with the SPSS statistics program while also acquiring knowledge about the domain of statistics.

Why has the 'anticipated ground-breaking success (for screencasts) not yet been verified, while research results have been both limited and inconsistent?' (Palaigeorgiou & Despotakis, 2010, p. 81). One reason for the mixed outcomes could be that the video tutorials in the reviewed studies may have occasionally underused the possibilities of this medium. A case in point is the use of a silent video by Payne *et al*. (1992) and Palmiter *et al*. (1991). This video could instead have been designed to reduce the demands on the user's working memory by using a dual channel approach that calls on the user's auditory and visual processing capacities.

Another reason could be that a paper-based tutorial has certain advantages over a video tutorial that were not heeded in the design of the latter. For instance, the mimicking effect for video observed by Palmiter *et al*. (1991) and Palmiter and Elkerton (1993) could be due to the user's perceptions of that medium as easy to process. The finding calls to mind a classic study by Salomon (1984) in which he found that people perceived television as 'easy', leading to lower mental effort expenditure than for print, which was seen as 'tough'. This word of warning should be taken to heart in designing a video. The following section examines these issues in detail by looking at the strengths of each medium.

Qualities of a paper-based tutorial that are hard to match in video

A salient and advantageous feature of a paper-based versus a video tutorial lies in the accessibility of its contents.[1] The user of a paper-based tutorial can quickly obtain an overview of its contents by looking at the table of contents. In addition, it is easy to leaf through the pages and scan the information that is presented. In short, the paper-based tutorial is equipped with structural overviews that enhance the accessibility of its content. For video, the accessibility of content can form an important obstacle (e.g., Alexander, 2013; Palaigeorgiou & Despotakis, 2010).

Another aspect in which the paper-based tutorial has an advantage over a video tutorial concerns pacing. In a paper-based tutorial, the speed of processing is user controlled. Pacing of the actions is in the hands of the user. The paper-based tutorial does not impose a limit on the time the user should take to figure out the location of a screen object. Likewise, the user may find it desirable to pause between actions to study the interface. Because the user largely determines the speed with which the tutorial is processed, the user can also set the pace to best suit his or her developing understanding. In a video tutorial, the pacing is preset. It is determined by the designer and it is the same for all users regardless of their needs and desires. Common pace controls such as stop, pause and fast forward buttons on the video interface can only partially correct this situation.

A third feature that gives the paper-based tutorial a potential advantage over the video tutorial concerns the user's spontaneous active processing. In a paper-based tutorial, the user must act to evoke a reaction from the software. In addition to the physical activity of pressing a key or making a mouse movement, the paper-based tutorial stimulates the user to think about the instructions and make decisions about what actions are needed for goal achievement. The user can largely refrain from these activities in a video tutorial because the user can simply wait and see how the video unfolds. In other words, video holds the risk that the user can be 'underwhelmed' and a relatively passive viewer (e.g., Lowe, 2004, 2008; Salomon, 1984).

Qualities of a video tutorial that are hard to match on paper

An advantage of a video tutorial that is hard to match in a paper-based tutorial concerns its affordance for multimedia representations. In such a representation, the user's visual and auditory system can be activated simultaneously. According to dual coding theory, the synergy of the two channels of information can partially overcome the processing demands presented by a single modality (Clark & Paivio, 1991; Paivio, 1986). In a video tutorial, the visual component of the instructions mainly consists of a recorded interface demonstration. The verbal component is a voice-over that conveys the conceptual and procedural information alongside the demonstration. A paper-based tutorial can only approximate these qualities by presenting the user with an abundant set of screenshots, along with the pertinent verbal information that the user needs in order to act on and understand the interface (van der Meij & Gellevij, 2004).

Another advantage of a video over a paper-based tutorial is that it can give a more authentic representation of task execution. The authenticity derives from two qualities of video. One, only video presents the interface through the same medium that the user will be facing while working with the software. Two, only video can give a dynamic representation that captures the moment-by-moment changes produced by actions within the program. In other words, there is congruence between a recorded demonstration and real task execution that can be beneficial for learning (see Catrambone & Seay, 2002; Shippey *et al.*, 2011). As the video dynamically visualizes screen changes, it can further assist the user with perceiving temporal changes or movements in a software system. In a paper-based tutorial, this quality of video can be matched somewhat by presenting a carefully selected set of screenshots that mimic the segmentations that users are inclined to make as they process dynamic representations (Tversky, Bauer-Morrison, & Bétrancourt, 2002). In addition, the paper-based tutorial should include signals to call the user's attention to important interface objects or features.

A third advantage of a video tutorial is that it models task execution. In a paper-based tutorial, the successful completion of training tasks is not guaranteed, as task execution lies in the hands of the user. User actions may contain slips, hesitations and omissions, with the ultimate consequence that the user may not even achieve task completion during training. In a video demonstration there is no such risk. A video tutorial can model perfect task execution. In this sense, the video tutorial is perhaps best characterized as a worked example, the effectiveness of which has repeatedly been proven in instructional design research (e.g., Atkinson, Derry, Renkl, & Wortham, 2000; Wittwer & Renkl, 2010).

Utilizing the strengths of paper-based tutorials to improve video tutorials

The video tutorials used in the studies presented here were optimized to address what we described earlier as weaknesses vis-à-vis paper-based tutorials. Their design was based on the guidelines for the design of instructional videos for software training suggested by van der Meij and van der Meij (2013). Further details on their design are provided in the *Method* section.

To establish the effectiveness of the video tutorials compared to a paper-based tutorial, we measured task performance before, during and after instruction, and complemented these measures with data on learners' task relevance, self-efficacy, flow and mood experienced before, during and/or after learning.

Task relevance and self-efficacy are the two key constructs from expectancy-value theory (Eccles & Wigfield, 2002). *Task relevance* refers to the present and future utility of an activity. It indicates the importance of a task to the user's goals or concerns (van der Meij, 2007). A higher perception of task relevance stimulates the user to invest more effort in task execution. The users' perceptions of task relevance were measured before, during and after training. *Self-efficacy* refers to the user's expectancy for success in novel tasks (Bandura, 1997). A high self-efficacy belief is a desirable outcome of a training tutorial, because this belief can affect persistence during training and future task involvement.

According to the cognitive-motivational process model (Vollmeyer & Rheinberg, 1999, 2006), motivational state is an important mediator for the effect of initial motivation on learning. A motivational state indicates the feeling that the student experiences during training (e.g., fun, fear or frustration). In this study, we ask about the learners' *mood* during training as our measure of motivational state (see Clore & Palmer, 2009).

We measure *flow* as a signal of perceived cognitive effort during training. When a user experiences flow, there is an optimal balance between his or her skills and the challenges posed by the task. As such, flow is a good indicator of perceived cognitive load (see Vollmeyer & Rheinberg, 2006).

Study 1

Experiment and research questions

Study 1 was set up as a comparison between a paper-based tutorial and a video tutorial. For the video tutorial, we tried to optimize its design by considering its weaknesses vis-à-vis paper-based tutorials and also heeding its special qualities. In addition, we kept in mind that there should be near equivalence in the content of the two tutorials. The following research questions were addressed.

Research question 1: does tutorial type have an effect on task relevance and self-efficacy?
We expected the video tutorial to have a positive effect on task relevance and self-efficacy. First, the human voice in the voice-over narrative introduces a human element into an otherwise cold technological context (e.g., De Leng, Dolmans, Van de Wiel, Muijtjens, & Van der Vleuten, 2007; DeVaney, 2009; Mayer, Sobko, & Mautone, 2003; Rieber, 1991). Second, its higher authenticity is likely to make video more meaningful and valuable to the user's personal goals (Chan *et al.*, 2010; Despotakis, Palaigeorgiou, & Tsoukalas, 2007; Spannagel *et al.*, 2008).

Research question 2: does tutorial type have an effect on flow and mood?
Compared to paper, video is likely to make users feel less taxed, more at ease and more relaxed (e.g., De Souza & Dyson, 2008; Govaere, De Kruif, & Valcke, 2012; Kim, Yoon, Whang, Tversky, & Morrison, 2007; Lowe, 2004; Mykityshyn, Fisk, & Rogers, 2002). This was expected to result in higher perceived flow and positive mood.

Research question 3: does tutorial type have an effect on task performance?
Because the video tutorial was optimized to address its weaknesses compared to paper-based tutorials and the special qualities of this medium were exploited, we expected the video tutorial to yield better performance compared to the paper-based tutorial.

Method

Participants

The sample consisted of 30 student volunteers from the sixth, seventh and eighth grades at a junior high school. Their mean age was 13.2 years (range 11.8–14.7). The participants were randomly assigned to tutorial type. There were eight male and seven female participants in the paper-based condition, and seven male and eight female participants in the video condition. Some participants did not complete both sessions in the experiment due to illness. The use of the English version of Word is common practice at the school. Basic Word knowledge and skill are therefore assumed. However, the students are expected not to have much experience in using the more advanced functions of Word that are the focus of the training.

Instruments

Tutorials
The domain and tasks in the two tutorials were identical and revolved around six Microsoft Word formatting options that are important for school reports. Both tutorials organized the tasks into 'chapters' with subsections. The first chapter dealt with adjusting the left and

right margins for a whole document. The second concentrated on formatting paragraphs, citations and lists. The third chapter dealt with automatically generating a table of contents.

Only the video tutorial was designed especially for this study. The paper-based tutorial had been developed over several years of experimental research on design features of such tutorials (van der Meij, 2008, 2013). The best tested version was used in the present study. The paper-based tutorial was therefore considered to be a good competitor for the video tutorial. The paper-based tutorial was printed in colour on 39 A4 pages and included the during-training questionnaires (see the section on *Questionnaires and tasks*). In the video condition, the participants received these questionnaires on separate A4 pages.

We followed eight design guidelines in the construction of the video tutorial (van der Meij & van der Meij, 2013). The guideline to provide easy access (1) was fulfilled by presenting a table of contents as the main point of entry for the video sections. By presenting a recorded demonstration in synch with a voice-over, we satisfied guideline 2 that calls for the use of animation with narration. The guideline to enable functional interactivity (3) led to the inclusion of a user control panel, and prompted pilot testing of the pacing of the video. Guideline 4 calls for the inclusion of task previews. The video included previews before it presented detailed, step-by-step instructions. According to guideline 5, the tutorial should concentrate on giving procedural rather than conceptual information. This was accomplished by giving the tutorial an action- and task-oriented approach, with only the bare minimum of conceptual information. Guideline 6 calls on the designer to make tasks clear and simple. This guideline received special attention in view of the risk of an underwhelming effect for video. Among other things, this led to a breakdown of complex tasks into meaningful segments or subtasks, the inclusion of deliberate pauses of 2–5 s and attention-drawing signals (see Ertelt, 2007; Moreno, 2007; Rebetez, Bétrancourt, Sangin, & Dillenbourg, 2010; Schwan & Riempp, 2004; Tabbers & De Koeijer, 2010). The guideline to keep videos short (7) was satisfied, with an average duration of 3.07 min. The limited video length also contributed to the accessibility of video content. Guideline 8, which calls for a strengthening of demonstration with practice, was also followed in that users were asked to engage in hands-on practice immediately at the end of a video section. The users were told to use specifically prepared training tasks for this practice.

In the following paragraphs, we briefly describe and illustrate three important features of the tutorials: the table of contents, the preview and the procedural sections.

Both tutorials give an overview of their chapters in a table of contents. In the video tutorial, this table is presented on a website. The video can be activated by clicking on the chapter or section titles from this table (see Figure 1).

In both the paper-based and video tutorials, a distinction is made between preview sections and procedural sections. *Preview sections* define a concept and then present a before-and-after display that highlights task relevance. Finally, the user's attention is directed to the screen object(s) involved in the procedure. Previews always precede (related) procedural sections, and the user is expected to merely read or view the previews. The preview sections in the paper-based tutorial are always presented on a single page (see Figure 2). In the video tutorial, their average length is 3.20 min (range 1.40–4.41).

Procedural sections describe and illustrate the actions for accomplishing a formatting task. The paper-based tutorial captures the interaction between user and software in a two column set-up (see Figure 3). The left column presents action instructions while the right column displays the screen states. The design facilitates user actions by juxtaposing (extended) action * object instructions with corresponding screenshots that help the user in identifying and locating screen objects and that show the changing interfaces. Signals are used to direct the user's attention to important interface features. The procedural sections in the paper-based tutorial take up between two and four pages.

Procedural sections in the video tutorial are recorded demonstrations that dynamically show all the visible actions on the screen during task execution. Their average length is 3.03 min (range 1.52–4.21). A voice-over gives the instructions and directs the user's attention to important features of the interface (see Figure 4). In addition, user attention is drawn with arrows. An occasional zoom-in is used to improve legibility.

Figure 1 Screenshot of the Video Tutorial With the (Translated) Table of Contents on the Left and the Video Area on the Right

Questionnaires and tasks

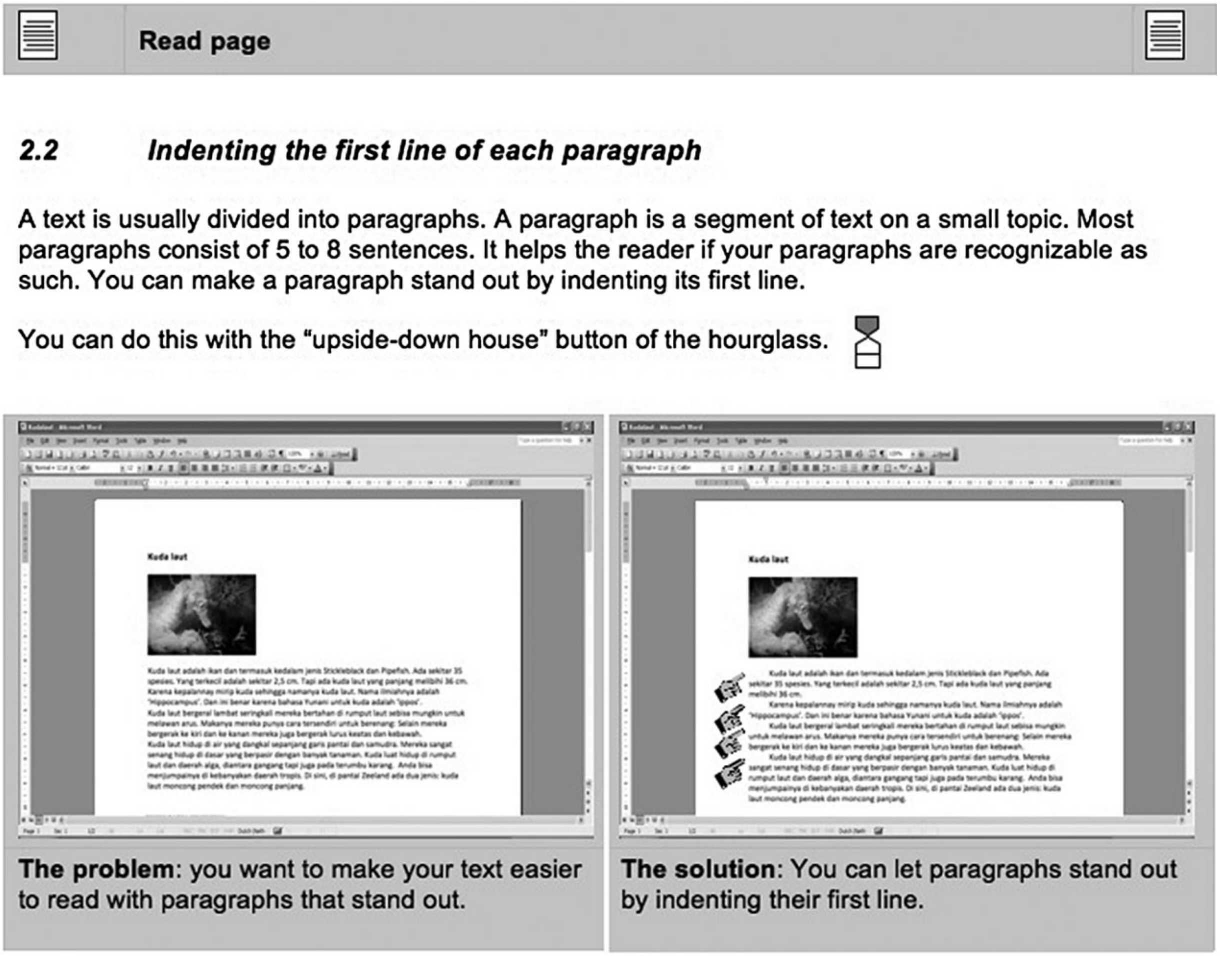
The questionnaires were provided on paper sheets. Responses to task relevance, flow and self-efficacy belief statements were given on a 7-point Likert scale with the response anchors ‘not true’ – ‘very true’.

To assess *task relevance before and during training*, users were asked to evaluate a set of statements about the six formatting tasks. Each task was introduced with a before-after screenshot plus explanation. This was followed with five statements on perceived task relevance: I like this inquiry task; I like learning new things with this task; This task seems useful; I do not need a reward. The task gave me pleasure; I found this task very interesting. To assess *task relevance after training*, users received eight statements about the tasks performed: I found the tasks important; I found the task interesting; I believe the ruler is handy to use; I can use what I learned for making reports; I like to make a report that looks nice; I think it is important to present a list nicely; I find it important to have good margins in a text; I find it important to present a nice table of contents. After removing one question, reliability for the task relevance measure was good, with a Cronbach’s α of 0.95.

To assess *mood during training*, users were asked to respond to a probe after completing a practice task in the video condition or after following the task instructions in the paper-based tutorial condition. Users could signal their mood state by selecting one of five smileys plus description (see Read, 2008). Happy and sure smileys were scored as signs of a positive mood. Unsure and angry were seen as signs of a negative mood.

To assess *flow during training* users received four statements: Thinking went smoothly; The right thoughts came to mind easily; I knew what to do in all steps; I had the feeling I was in control.

To assess *self-efficacy beliefs after training*, users received eight statements about the tasks performed: I can work with the ruler; I can now make a nice list; I



Read page

2.2 Indenting the first line of each paragraph

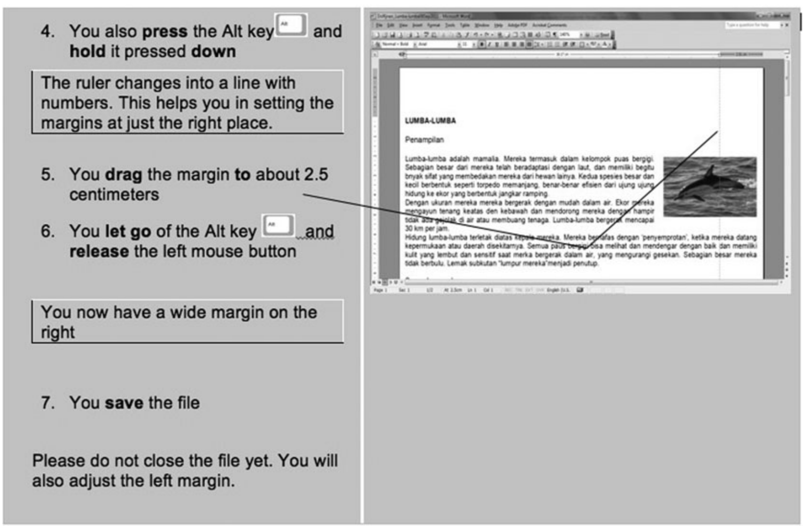
A text is usually divided into paragraphs. A paragraph is a segment of text on a small topic. Most paragraphs consist of 5 to 8 sentences. It helps the reader if your paragraphs are recognizable as such. You can make a paragraph stand out by indenting its first line.

You can do this with the "upside-down house" button of the hourglass.

The problem: you want to make your text easier to read with paragraphs that stand out.

The solution: You can let paragraphs stand out by indenting their first line.

Figure 2 A Preview Section From the (Translated) Paper-Based Tutorial



4. You also **press** the Alt key and **hold** it pressed **down**

The ruler changes into a line with numbers. This helps you in setting the margins at just the right place.

5. You **drag** the margin **to** about 2.5 centimeters
6. You **let go** of the Alt key and **release** the left mouse button

You now have a wide margin on the right

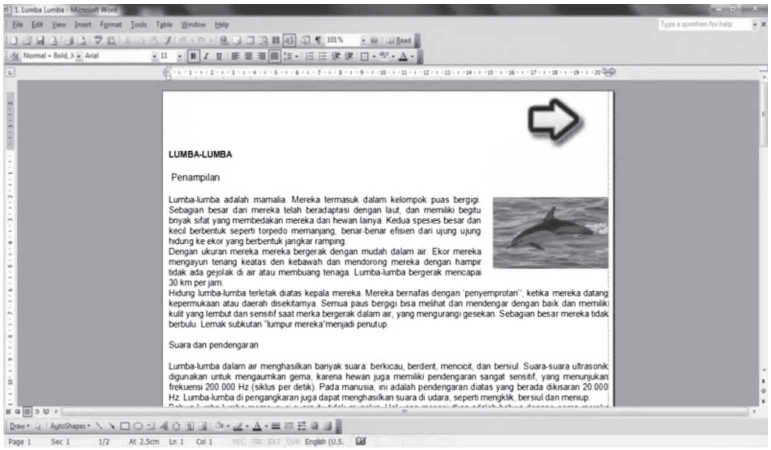
7. You **save** the file

Please do not close the file yet. You will also adjust the left margin.

Figure 3 A Procedural Section From the (Translated) Paper-Based Tutorial

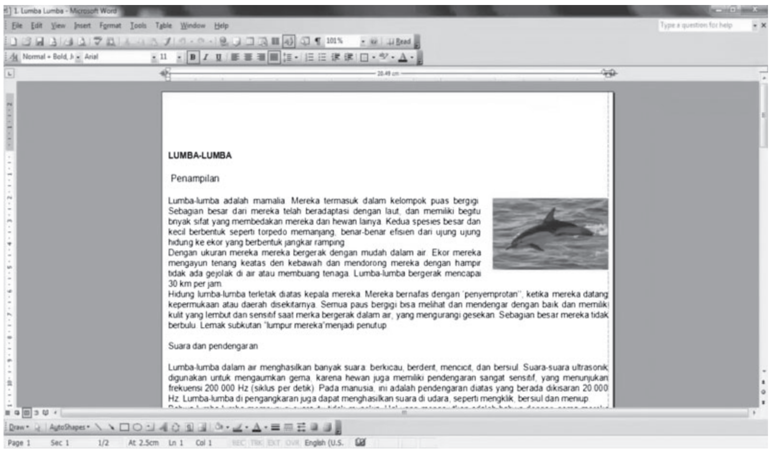
1. Adjusting the right margin

Narrator: Click and hold the mouse button. A dotted line appears. This line will be the right margin.



2. Adjusting the right margin, *cont'd*

Narrator: Press the Alt key and keep it pressed down. The ruler changes into a line with numbers.



3. Adjusting the right margin, *cont'd*

Signaling: Zooming in

Narrator: Drag the margin to the left, about 2.5 centimeters. Release the Alt key and mouse button. The right margin is now adjusted.

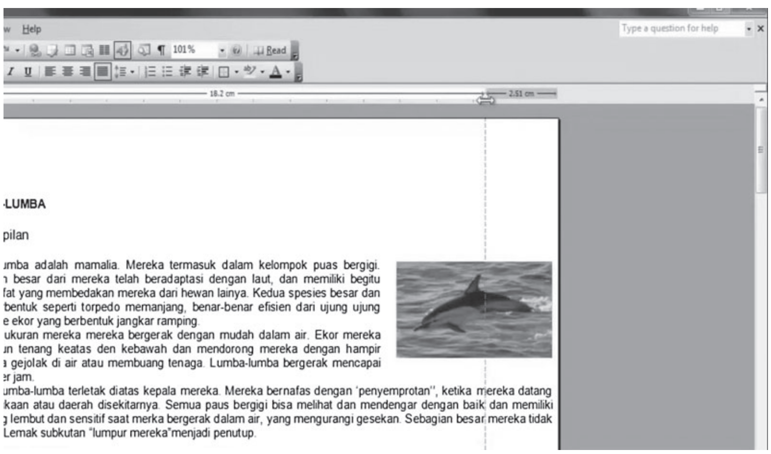


Figure 4 A Procedural Section From the Video Tutorial With (Translated) Voice-Over Narrative

now know how to change the margins of a whole text; I think I will quickly forget what I learned; I found the task easy; I can now make my report attractive; I can now indent the first sentence of a paragraph; I can now tell Word how to make an automatic table of contents. Reliability was good, with a Cronbach's α of 0.95.

To assess *task performance before, during and after training*, users were asked to demonstrate their formatting skills by performing the instructed tasks on the computer. Tasks were scored as correct or incorrect. The scores were expressed as percentage correct.

Procedure

The experiment was conducted in two sessions. In session 1, users received a brief, 5-min introduction in which they were told they would engage in training on Word to assist them in formatting their school reports. Next, they were instructed to complete the task relevance questionnaire and were asked to perform the six formatting tasks, for which a maximum time of 20 min was given. Session 2 followed a day later. Users were first informed about the training procedure in a 10-min introduction. Students in the paper-based condition received an explanation of the distinction between preview and procedural pages and were given instructions about the handling of practice files. Students in the video condition received the same instructions, and were also shown how they could navigate the website. In both conditions, users were then allotted 50 min for training, including answering the questions on task relevance, flow and mood. They were instructed to work independently and to call for assistance only when stuck. After finishing the training and taking a 10-min break, the students were asked to demonstrate their formatting skills and to answer the questions on task relevance and self-efficacy, which they were given a maximum of 20 min to complete.

Analysis

Analyses of variance (ANOVAs) were computed to determine whether tutorial type had an effect on the dependent variables. The training time of 50 min proved to be too short for some participants, which reduced the number of training tasks completed. Tests were two tailed with α set at 0.05. For significant findings, Cohen's (1988) *d*-statistic was computed. This effect size measure tends to be qualified as small for $d = 0.2$, medium for $d = 0.5$ and large for $d = 0.8$.

Results

Effect of tutorial type on task relevance and self-efficacy

The mean task relevance scores before training were 4.66 (SD = 1.50) for participants in the paper-based condition and 5.43 (SD = 1.18) in the video condition. The mean task relevance scores after training were 5.69 (SD = 1.57) for participants in the paper-based condition and 6.14 (SD = 1.31) in the video condition. A repeated measures ANOVA showed that overall task relevance scores after training were significantly higher than task relevance scores before training, $F(1,25) = 15.95$, $p = 0.001$, $d = 0.54$. There was neither a main effect for condition, $F(1,25) = 1.75$, $p = 0.20$, nor an interaction ($F < 1$).

The mean self-efficacy scores after training were 5.06 (SD = 1.22) for participants in the paper-based condition and 5.90 (SD = 0.92) in the video condition. An ANOVA revealed no difference between conditions, $F(1,27) = 4.23$, $p = 0.054$.

Effect of tutorial type on flow and mood

The average scores for flow were 4.83 (SD = 1.40) for participants in the paper-based condition and 6.04 (SD = 0.75) in the video condition. An ANOVA showed that the score for flow was significantly higher for participants in the video condition compared to the paper-based condition, $F(1,27) = 8.07$, $p = 0.009$, $d = 1.08$.

Participants predominantly indicated having experienced a favourable mood during training. That is, 75% of all mood states were evaluated as positive (see Table 1). An ANOVA showed no difference in positive moods between the conditions, $F(1,27) = 2.65$, $p = 0.12$. Likewise, no difference was found for neutral moods, $F(1,27) < 1$. Participants in the paper-based

Table 1. Mean Scores for Mood States During Training (Study 1)

	Positive mood		Neutral mood		Negative mood	
Condition	*M* (%)	*SD*	*M* (%)	*SD*	*M* (%)	*SD*
Paper-based tutorial ($n = 15$)	66.9	(24.6)	15.0	(16.8)	18.1	(21.9)
Video tutorial ($n = 15$)	83.3	(28.5)	11.9	(24.1)	4.8	(8.4)
Total	75.1	(27.5)	13.4	(20.4)	11.4	(17.6)

Table 2. Mean Scores for Task Performance Before and After Training (Study 1)

Condition	Task performance before training		Task performance after training		Cohen's *d*
	M (%)	*SD*	*M* (%)	*SD*	
Paper-based tutorial ($n = 15$)	24.0	(21.3)	56.7	(31.7)	1.21
Video tutorial ($n = 15$)	35.6	(31.8)	66.4	(25.7)	1.06
Total	29.8	(27.2)	61.5	(28.7)	1.13

condition more often signalled the presence of a negative mood, $F(1,27) = 4.54$, $p = 0.04$, $d = 0.80$.

Effect of tutorial type on task performance

The mean task performance scores during training were 58.4% (SD = 28.9) for participants in the paper-based condition and 83.8% (SD = 24.0) in the video condition. An analysis of covariance (ANCOVA) with task performance before training as covariate showed that task performance scores during training for participants in the video condition were significantly higher than the scores in the paper-based condition, $F(1,27) = 4.50$, $p = 0.044$, $d = 0.95$.

Table 2 shows the mean scores for task performance before and after training. A repeated measures ANOVA showed that overall task performance scores after training were significantly higher than overall scores before training, $F(2,48) = 35.38$, $p = 0.001$, $d = 1.66$. There was neither a main effect for condition ($F < 1$) nor an interaction ($F < 1$). Participants in both conditions substantially advanced their formatting skills.

Discussion

In this study, we examined the effects of a paper-based tutorial versus a video tutorial on task relevance, self-efficacy, mood, flow and task performance.

For task relevance, a significant overall increase was found for both tutorials. Presumably, this outcome is due to a change in knowledge and corresponding skill, with users knowing more about formatting possibilities (what), as well as becoming more capable of achieving those effects (how). The repeated presence of before-after states brought the software's potential for better text formatting to the users' attention. The ensuing opportunity for practice supported their skills development.

Self-efficacy, measured only after training, tended to be rated higher in the video condition, but the difference was not significant. Self-efficacy belief is an important signal of a person's confidence in himself or herself and a strong predictor of success on similar tasks in the future.

During training, most users experienced a positive mood most of the time. A significant effect of condition was found only for negative mood. Users of the paper-based tutorial more often reported negative moods.

The measures for flow were well above the scale midpoint in both conditions. This finding indicates that users of both the paper-based and video tutorials felt that they could concentrate well on their task and did not feel taxed beyond their capacities. However, users of the video tutorial scored significantly higher. Their absolute scores for flow approached the scale maximum, signalling that users found their training to be an absorbing experience.

The findings for task performance were varied. During training, a strong and positive advantage of the video tutorial for the successful completion of the training tasks was found. In the video tutorial, the users could first watch a video in which the training task was modeled perfectly and without hesitations. In the task that followed, this model may have been recalled by the user or may have been replayed to jog the user's memory of the correct task execution procedure. In short, there could be two reasons for their performance success during training: video is a good model to support the user's own mental model construction and is also a good model to call upon for help when the user does not know exactly what to do in practice. Regardless of the reason, this finding supports the view that when *task completion with support* is the goal, video is substantially more effective than a paper-based tutorial.

The findings for task performance after training revealed that considerable learning gains were achieved. Users of both tutorial types made significant and substantial progress. Even so, there was room for improvement, given the mean score of 61% on the post-test. The superior results obtained by the users of the video during training levelled out during testing, meaning that the advantage gained during training vanished when knowledge was tested by requiring independent performance.

We believe that this performance outcome, and also in part the finding for task performance during training, were affected by training time. Pilot tests of both tutorials on the target audience had suggested that a limit of 50 min of training time would be sufficient for the majority of participants. The findings from the experiment showed that this time frame may have been too short. For this reason, it was decided to run a second study in which the participants were given ample time to complete the training.

Study 2

The most important difference between this study and its predecessor concerned the prolongation of training time. Instead of 50 min, the participants were now given about 2 h to complete their training. In addition, the time for the introductory explanation was extended from 10 to 20 min to ensure that students would be sufficiently equipped with basic navigational skill in handling practice files and, for video, interacting with the website. The number of participants was raised from 15 to 31 per condition to increase power. It was expected that these measures would provide a better foundation for an examination of the effectiveness of the paper-based versus the video tutorial.

There were a few other changes in the design of the study as well. One modification concerned self-efficacy. Just as for the measurement of task relevance, the participants' self-efficacy beliefs about their capacity to handle Word's formatting options were now also measured both before and after the training. Asking about the learners' self-efficacy before and after training yields insight into the development of this belief as a result of the training.

Another design change involved the inclusion of a retention measure. The review of literature revealed the presence of a possible delayed effect for the users of the paper-based tutorial. That is, the empirical studies by Palmiter and Elkerton (1993), Palmiter *et al*. (1991), and Spannagel *et al*. (2008) showed that users of the video tutorial performed better during training than did users of the paper-based tutorial. However, the latter group more or less caught up with the users of the video tutorial in immediate and/or retention testing after training. In addition to immediate task performance, Study 2 therefore also included a retention task administered 1 week after training.

In many respects, Study 2 is the same as Study 1, with the same research questions being asked. In the *Method* section, we will therefore describe only the novel aspects of this study.

Method

Participants

The sample consisted of 62 student volunteers from the eighth grade at a junior high school. Their mean age was 14.9 years (range 13.3–16.3). The participants were randomly assigned to tutorial type. There were 12 male and 19 female participants in the paper-based condition and 14 male and 17 female participants in the video condition. Two participants did not attend the third session due to illness.

Instruments

Tutorials
Minor, cosmetic changes were made in the presentation of the video tutorial website.

Questionnaires and tasks
The main change in instruments concerned the questionnaire for assessing *self-efficacy before training*. Just as in Study 1, the instrument introduced each of the six tasks with a before-after screenshot plus explanation, only this time a set of three questions followed the description of each task: How often do you face this problem? (experience); How often would you like to solve this problem? (task relevance); and How well do you think you can solve this problem? (self-efficacy belief). Good reliability scores were found for the six items for task relevance ($\alpha = 0.95$) and for self-efficacy ($\alpha = 0.95$). Analyses again revealed good reliability scores for these measures after training, with an α of 0.89 for task relevance and an α of 0.84 for self-efficacy. The retention task was identical in design to the formatting task after training, but the Word file for which the users were asked to change the formatting

was different. Scoring was the same as for the tasks in Study 1.

Procedure

The experiment was conducted in three sessions. In session 1, users were instructed to complete the before-training questionnaire and were asked to perform the six formatting tasks, for which a maximum time of 20 min was given. Session 2 followed a week later. Users first had a 20-min introduction informing them about the procedure for the training. Students in the paper-based condition received an explanation of the distinction between preview and procedural pages and were given instructions about the handling of practice files. Students in the video condition received the same instructions, and were also shown how they could navigate the website. In both conditions, users were then allotted 120 min for training, including answering the questions on task relevance, flow and mood, and including a 10-min break after 1 h. They were instructed to work independently and to call for assistance only when stuck. After finishing the training, the students were asked to demonstrate their formatting skills and answer the questions on task relevance and self-efficacy, which they were given a maximum of 20 min to complete. Session 3 took place 1 week later. The retention task was administered, again, with a maximum of 20 min allowed.

Analysis

ANOVAs were computed to determine whether tutorial type had an effect on the dependent variables. The level of task experience reported by participants before training showed no difference between conditions (paper-based tutorial $M = 4.40$, SD = 1.33; video tutorial $M = 4.57$, SD = 1.48; $F < 1$). Users of the paper-based tutorial completed their training faster ($M = 74.8$, SD = 4.79) than users in the video condition ($M = 84.3$, SD = 1.27). There were unequal variances between conditions due to a much bigger time range for users of the paper-based tutorial (min-max: 65–80 min) than for users of the video tutorial (min-max: 80–87 min). Tests were two tailed with α set at 0.05. For significant findings, Cohen's (1988) d-statistic was computed.

Results

Effect of tutorial type on task relevance and self-efficacy

The mean task relevance scores before training were 3.56 (SD = 1.29) for participants in the paper-based condition and 4.63 (SD = 1.55) in the video condition. The mean task relevance scores after training were 5.48 (SD = 1.08) for participants in the paper-based condition and 6.15 (SD = 0.38) in the video condition. A repeated measures ANOVA showed that overall task relevance scores after training were significantly higher than task relevance scores before training, $F(1,60) = 85.67$, $p = 0.000$, $d = 1.39$. There was a main effect for condition, $F(1,60) = 14.59$, $p = 0.000$, $d = 0.97$, and no interaction, $F(1,60) = 1.17$, n.s. The main effect of condition was due to a significant difference in starting levels. Even though users were randomly assigned to tutorial types, there was already a significant difference between conditions on task relevance scores before training, $F(1,61) = 8.79$, $p = 0.004$, $d = 0.75$.

The mean self-efficacy scores before training were 3.70 (SD = 1.24) for participants in the paper-based condition and 4.51 (SD = 1.56) in the video condition. The mean self-efficacy scores after training were 5.46 (SD = 0.96) for participants in the paper-based condition and 6.22 (SD = 0.44) in the video condition. A repeated measures ANOVA showed that overall self-efficacy scores after training were significantly higher than self-efficacy scores before training, $F(1,60) = 88.47$, $p = 0.000$, $d = 1.47$. There was a main effect for condition, $F(1,60) = 12.90$, $p = 0.001$, $d = 0.91$, and no interaction ($F < 1$). The main effect of condition was due to a significant difference in starting levels. Even though users were randomly assigned to tutorial types, there was already a significant difference between conditions on self-efficacy scores before training, $F(1,61) = 5.14$, $p = 0.027$, $d = 0.58$.

Effect of tutorial type on flow and mood

The average scores for flow were 5.38 (SD = 0.89) for participants in the paper-based condition and 5.81 (SD = 1.55) in the video condition. An ANOVA revealed no difference between conditions, $F(1,61) = 1.78$, n.s.

Over 70% of the reported moods were evaluated as positive (see Table 3). The two conditions did not differ

Table 3. Mean Scores for Mood States During Training (Study 2)

Condition	Positive mood		Neutral mood		Negative mood	
	M (%)	*SD*	*M* (%)	*SD*	*M* (%)	*SD*
Paper-based tutorial ($n = 31$)	64.8	(30.1)	26.8	(23.6)	9.4	(11.5)
Video tutorial ($n = 31$)	77.7	(30.5)	18.4	(24.2)	3.2	(8.3)
Total	71.3	(30.8)	22.6	(24.1)	6.3	(10.4)

for positive and neutral moods, $F(1,61) = 2.81$, $p = 0.099$; $F(1,61) = 1.91$, n.s. There was a significant difference for negative moods, with participants in the paper-based condition reporting these more often, $F(1,61) = 5.76$, $p = 0.020$, $d = 0.62$.

Effect of tutorial type on task performance

The mean task performance scores during training were 67.3% (SD = 25.7) for participants in the paper-based condition and 82.8% (SD = 25.2) in the video condition. Table 4 shows the mean scores for before training, after training and retention task performance. An ANCOVA with task performance before training as covariate showed that task performance scores during training showed no difference between conditions ($F < 1$).

A repeated measures ANOVA showed that overall task performance scores after training were significantly higher than overall scores before training, $F(1,60) = 78.56$, $p = 0.000$, $d = 1.41$. A significant main effect for condition, $F(1,60) = 6.78$, $p = 0.012$, $d = 1.41$, and no interaction, $F(1,60) = 2.28$, n.s., were found. Task performance before training did not differ significantly between conditions, $F(1,61) = 1.44$, n.s. For task performance after training, the scores for the users of the video tutorial were significantly higher, $F(1,61) = 6.85$, $p = 0.011$, $d = 0.66$.

A repeated measures ANOVA showed that overall retention task performance scores were significantly higher than overall scores before training, $F(1,58) = 103.48$, $p = 0.000$, $d = 1.59$. There was a significant main effect for condition, $F(1,58) = 10.86$, $p = 0.002$, $d = 0.85$, and a significant interaction, $F(1,58) = 5.19$, $p = 0.026$. Just as for task performance after training, users of the video tutorial did significantly better on the retention task than users of the paper-based tutorial, $F(1,59) = 15.10$, $p = 0.000$, $d = 1.00$. More importantly, the significant interaction indicates that the learning gains from before-training task performance to retention were higher for the users of the video tutorial than for those who used the paper-based tutorial.

Discussion and conclusions

In both studies, we examined the effects of a paper-based tutorial versus a video tutorial on task relevance, self-efficacy, mood, flow and task performance.

The findings for the two main constructs from expectancy-value theory pointed to positive changes in perception of motivation. An increase over time in *task relevance* was found in both studies. After training, the users valued more highly the formatting tasks that they had worked on. An increase over time in *self-efficacy* was investigated only in Study 2. The significant

Table 4. Mean Scores for Before Training, After Training and Retention Task Performance (Study 2)

Condition	Task performance before training		Task performance after training		Retention task performance[a]	
	M (%)	*SD*	*M* (%)	*SD*	*M* (%)	*SD*
Paper-based tutorial ($n = 31$)	20.4	(18.1)	50.5	(26.3)	49.4	(24.6)
Video tutorial ($n = 31$)	26.9	(23.8)	69.4	(30.2)	72.2	(20.7)
Total	23.7	(21.2)	60.0	(29.6)	60.8	(25.3)

[a]One participant in each condition did not complete the retention task.

change over time indicated that the users had become more confident in their capacity to successfully complete the formatting tasks about which they received instruction. No effects of tutorial type on task relevance and self-efficacy were found. In Study 2, an unexpected difference in initial levels emerged. Although participants had been randomly assigned to condition, the two groups already differed significantly on task relevance and self-efficacy before training. This may have meant that the video tutorial faced a more challenging task in improving its users' appraisals.

In both studies, the users reported high levels of *flow*. The flow scores showed that they did not feel taxed beyond their capacities during training. Users could concentrate well as they processed the instructions and while trying to complete the training tasks successfully on their own. In Study 1, flow was also significantly and positively affected by tutorial type, with users of the video tutorial reported higher levels. Over 70% of the users in both Studies 1 and 2 indicated having been in a positive *mood* during training. In both studies, a significant effect of condition on negative mood was found, with users of the video tutorial reporting these moods less often than users of the paper tutorial.

In both Studies 1 and 2, the users were quite successful in completing their training tasks. The mean score of around 80% correct indicated that the users could complete these tasks very well during training. Because there was no log registration, we do not know whether those scores were achieved independently or with looking back to the instructions in the tutorial. In both Studies 1 and 2, a significant change in the users' task performance scores over time was also seen. Study 1 included only a task performance test immediately after training. Study 2 also included a retention task. The findings for retention were virtually the same as for task performance after training. This indicates that the learning effect was not short lived.

In Study 1, a significant effect of condition on success on the during-training tasks was found, with users of the video tutorial realizing better performance. In Study 2, these scores were also higher for participants using the video tutorial, but there was no significant effect of condition. In Study 1, the users of the video and paper tutorials both significantly improved their scores from task performance before training to task performance after training. No effect of tutorial type was found. In Study 2, significant and substantial learning gains were also found from task performance before training to task performance after training. Again, conditions did not differ. The findings on the retention task indicated that the users had retained their skills well 1 week after training. In addition, a significant interaction with condition signalled that the users of the video tutorial had better retention than users of the paper-based tutorial.

In sum, both studies reported positive contributions of the tutorials to task relevance, self-efficacy, flow and mood. Both studies also found significant and substantial effects on task performance for both the paper-based tutorial and video tutorial. In addition, the video tutorial showed better results for retention task performance. We believe the positive effects for our video tutorial can be ascribed to the measures that were taken to minimize the weaknesses of video vis-à-vis paper-based tutorials and optimization efforts capitalizing on the special qualities of video. Our results suggest that it might indeed be the case that earlier studies that failed to find positive effects of video instruction for procedural knowledge have underused the possibilities of this medium. Although we did not find a 'groundbreaking success' (Palaigeorgiou & Despotakis, 2010, p. 81) for our video tutorial, overall, the video tutorial had a strong positive impact on task relevance, self-efficacy, flow, mood and task performance. We believe that finding better retention scores for the video tutorial is a big plus, especially since the video tutorial was being compared to a strong paper-based contender.

An issue that merits further study concerns the absence of an effect of tutorial type on task relevance and self-efficacy. The random assignment to conditions unfortunately did not safeguard Study 2 from a significant difference before training. This calls for a replication study.

Another issue that should be examined in future research concerns the difference in training time that was found. The users of the video tutorial took longer to process the instructions. Because no log recordings were made of the users' actions on the computer, it is impossible to say whether the video group studied their instructions for a longer time period, or whether they took more time for practice. Recent research on videos for conceptual learning appears to be moving away from the initial question of frequency of use, in favour of an examination of the issue of functionality of video consults (Wouters, Tabbers, & Paas, 2007). This is also a promising area for further research on video tutorials for software training. Log registration of the user's software actions and consulting of the video can reveal whether video usage during practice is desirable, necessary and beneficial, among other things.

Although video is not a new technology, the availability of cheap and easy-to-use software for its production and the availability of the Internet as a publication platform have given it a much more prominent role in (e-)learning today than it had 10 years ago (e.g., Chen, 2012; Hansen *et al*., 2011; Palaigeorgiou & Despotakis, 2010). After a silent period of about 15 years following a few early studies contrasting a paper-based tutorial with a video tutorial (Palmiter & Elkerton, 1993; Palmiter *et al*., 1991; Payne *et al*., 1992), empirical research has only recently been resumed (Alexander, 2013; Lloyd & Robertson, 2012; Spannagel *et al*., 2008; see also Ertelt, 2007; Morain & Swarts, 2012; Pflugfelder, 2013; Swarts, 2012). What these studies and the present one indicate is that video can only be a more effective instructional medium when considerable attention is given to its design, so that it can serve its purpose optimally.

Acknowledgements

We would like to thank Vascolino Pattipeilohy, Suhendri, and Isnaëni Mukhammad for their help in conducting the experiment.

Notes

[1]The term access refers to the process of information seeking within a document (i.e., paper or video). Gaining access to the document itself is another matter.

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