# Does the use of cueing in videotutorials facilitate learning of complex software applications? An experimental study with experienced ICT learners

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## Abstract

The present study investigates whether embedding cueing in videotutorials for software training influences task performance. It also considers the indirect effects of cueing on cognitive load, self-efficacy, motivation, and flow. One hundred eighteen undergraduate students from a Greek Computer Science Department participated in the study which employed a mixed factorial between-subjects design. All study participants viewed three videotutorials on how to use a video editing application. Contrary to expectations, cueing affected neither task performance nor cognitive load. However, cueing boosted the participants' motivation (d=0.46). In the last section we discuss the idea that in the context off complex software training cueing may be not beneficial for users with high ICT experience. The paper is concluded with recommendations for the design of videotutorials and directions for future studies.

Keywords: software training, cueing, multimedia learning, motivation

## Introduction

Videotutorials are a popular means of software training application procedures (van der Meij, 2018). Many big software companies like Adobe, IBM, Microsoft, and others continuously offer videotutorials via their official channels. Professional training in software applications is also provided by many educational companies such as Udemy and Skillshare. Software training is also offered by individual tutors who are typically certified trainers and are considered masters of each respective tool. Finally, thousands of users create videotutorials on how to use software applications of all types and make them available on YouTube free of charge. Videotutorials use a combination of on-screen action capturing and synchronized narration. Compared to print manuals, videotutorials are widely used for presenting software operations (van der Meij & van der Meij, 2014). They are commonly referred to as videotutorials for software training (van der Meij & van der Meij, 2016a; 2016b).

The primary focus of software training is to improve task performance. In other words, videotutorials give instructions on how to perform specific software tasks. Practitioners often need solid principles upon which their designs can be based. Fundamental design principles can be derived from the Cognitive Theory of Multimedia Learning (CTML) (Mayer, 2014) which provides theoretical grounding for designing dynamic multimedia instructional materials (e.g. the multimedia principle, signalling principle). This theory considers the features of a novice user's working memory and interprets how mental processes foster learning. Another source is the Demonstration Based Training model which originates in Bandura's theory of observational learning (1986). This model incorporates a set of eight guidelines for the construction of videotutorials for software training (van der Meij & van der Meij, 2013) alongside with user characteristics and situational variables. Even though design principles derived from the CTML and the DBT have been applied to learners with low levels of expertise, their instructional effectiveness has not been explored systematically with experienced learners.

The present study focuses on the effectiveness of videotutorials on software training. In particular, we look at a specific design feature, cueing, and consider its effect on learning (task performance, cognitive load) in the case of experienced learners. As the empirical literature in CTML indicates, cueing is beneficial for learning. Still, in the case of videotutorials, cueing has often been co-examined in conjunction with other design features. Thus, its unique contribution to learning from videotutorials has not been ascertained. Also, this study investigates not only how cueing affects learning but also considers its indirect effects on self-efficacy, flow, and motivation. The remainder of the study reports the findings from a larger experiment in which the effectiveness of videotutorials enriched with cueing principles is compared with plain videotutorials.

## Literature review

### *Cueing*

The cueing principle, also known as signalling principle, (Mayer, 2014) theorizes that people learn better when cues guide user attention to the critical points of the material or emphasize the organization of the material (Mayer & Fiorella, 2014). Cueing is implemented in many codes, i.e. colour cues (red, green), geometric cues (shapes), zoom, etc. How does cueing enhance task performance and, facilitate learning? A recent meta-analysis of 29 experimental studies (Alpizar, Adesope & Wong, 2020). Secondly, the use of cueing allows learners to organize relevant information and integrate it with prior knowledge (a thorough overview is also provided in van Gog, 2014). Third, learning with cues can diminish the cognitive processing demands on working memory, thus avoiding cognitive load (Lowe & Bouheix, 2011).

Several multimedia learning studies have indicated that cueing can lead to improved task performance (Amadieu, Mariné & Laimay, 2011; Jin, 2013; van der Meij & van der Meij 2014; 2016a; 2016b) while others have reported no significant learning gains (de Koning, Tabbers, Rikers & Paas, 2010; Jamet & Fernandez, 2016; Kriz & Hegarty, 2007; Skuballa, Schwonke & Renkl, 2012). Overall, the literature on cueing has two main limitations. First, the studies mentioned above have focused on animation or videos with static images rather than on videos with a constant flow. Second, the videotutorials targeted software with relatively simple interfaces (e.g. word processors, internet applications) and not more complex ones (e.g. video editing, image editing). In this study, we focus on complex software applications which demand more mental effort from learners to accomplish complex workflows. An overview of the training studies that have focused on cueing is provided in Table 1.

As the Table 1 shows, there is only study that had explicitly explored how cueing affects learning from videotutorials in software training (Jamet & Fernandez, 2016). More specifically, the researchers used a self-paced interactive multimedia tutorial with static slides on how to fill a web-based form. Results indicated that cueing improved participants' attention. The CTML justifies this as the choice of the appropriate information through the incorporation of the two sensory channels and the connection to previous knowledge help mitigate working memory overload (Clark & Mayer, 2016). However, the authors found no significant differences concerning the acquisition of procedural knowledge. One potential explanation for this finding is that the tasks were not particularly challenging (filling out a simple web form). A previous pilot study by Ragazou and Karasavvidis (2016) also found that the use of cueing in videotutorials for software learning played no significant role as far as task performance is concerned.

### *Cognitive load in videotutorials for software training*

Two theories provide empirical evidence on how people learn and how instructional design guidelines affect learning. The CTML (Mayer, 2014) postulates that many novice users face learning difficulties for three reasons: a) there are two information processing sensory channels, b) the working memory capacity is limited and c) better learning occurs when users actively engage in selecting, organizing

**Table 1. Software training studies that explored cueing in combination with other design features**

| Authors (Year) | Sample | Independent Variables | Dependent Variables | Software | Cueing | Results | Indirect Effects |
|---|---|---|---|---|---|---|---|
| van der Meij (2014) | N=65 | 8 design guidelines (van der Meij & van der Meij, 2013) | Procedural knowledge Motivation | MS-Word | Not reported | Enhance procedural knowledge | Enhance motivation |
| van der Meij & van der Meij (2014, Study 1) | N=30 | 8 design guidelines (van der Meij & van der Meij, 2013) | Task relevance Self-efficacy Flow Mood Procedural knowledge | MS-Word | Zoom Arrows | Enhance procedural knowledge | Enhance task relevance mood, flow |
| van der Meij & van der Meij (2014, Study 2) | N=62 | 8 design guidelines (van der Meij & van der Meij, 2013) | Self-efficacy Flow Mood Procedural knowledge | MS-Word | Zoom Arrows | Enhance procedural knowledge | Enhance self-efficacy, task relevance, mood, flow |
| van der Meij & van der Meij (2016a) | N=55 | Review | Procedural knowledge Motivation | MS-Word | Not reported | Enhance learning | Enhance motivation |
| van der Meij & van der Meij (2016b) | N=55 | Review | Motivation Learning | MS-Word | Color Shapes Highlights Zoom | Enhance task performance | Enhance self-efficacy |
| Jamet & Fernandez (2016) | N=57 | Cueing | Retention Procedural knowledge Cognitive load | University form | Green arrows | No effect on procedural knowledge Effect on attention | No effect on cognitive load |

and integrating the new information with prior knowledge. The Cognitive Load Theory (CLT; Sweller, 2012) also theorizes how instructional guidelines affect learning. The CLT incorporates three types of cognitive load: intrinsic, extraneous, and germane. Intrinsic cognitive load depends on the complexity of the material in conjunction with the learner's expertise. Extraneous cognitive load stems from the poor instructional design of multimedia presentations. Germane cognitive load refers to the mental effort learners put in constructing knowledge schemas for bridging new information with long-term memory. Empirical research shows that cueing reduces cognitive load (Schneider, Beege, Nebel & Rey, 2018), but the results are not consistent (Alpizar et al., 2020). On the one hand, some studies lend support to the use of cueing for the reduction of extraneous cognitive load (de Koning, Tabbers, Rikers & Paas, 2009) whereas other studies find no significant difference (Kriz & Hegarty, 2007).

In the case of software training, many factors can affect cognitive load, such as the learner's expertise, the complexity of the software application and their interaction with the software. When learners need to learn how to use complex software applications and have low levels of expertise, intrinsic cognitive load might rise. Complex software applications demand more mental effort for novices who need support when completing tasks (van Merrienboer & Kirschner, 2017). On the one hand, research on multimedia learning shows that cueing may be beneficial for novices as it can serve as an aid to support cognitive processes. On the other hand, cueing may be damaging for expert users who have already constructed their mental representations (Kalyuga, 2007). As the empirical evidence seems inconsistent, more research is required to determine how cueing influences cognitive load when the learners have different expertise levels.

### *Self-efficacy in videotutorials for software training*

As a concept, self-efficacy refers to the learners' belief in their ability to complete a given task (Bandura, 1997; Keller, 2010). It could be a subjective self-assessment of learners' ability to perform tasks in the future. High self-efficacy is usually associated with successful task performance and can be a predictor of learning ability (van der Meij & van der Meij, 2016a).

Videotutorials as learning tools seem to affect self-efficacy; users seem to be keener to learn and, therefore, complete tasks. Cueing can also motivate users to actively interact with the information and improve their self-efficacy. A handful of studies that investigated self-efficacy in software learning have reported positive results (van der Meij, 2018; van der Meij & van der Meij, 2014; 2016a). However, since cueing was mixed with other factors in these treatments, it remains unclear whether cueing leads to higher levels of self-efficacy.

Self-efficacy can be distinguished into (a) General Self-Efficacy (GSE) and (b) Specific Self Efficacy (SSE). The former refers to people's belief in their ability to cope with a wide range of stressful situations (Schwarzer & Jerusalem, 1995) while the latter denotes the ability people must complete specific tasks (Luszczynska, Scholz & Schwarzer, 2005).

### *Motivation in videotutorials for software training*

Motivation is an essential factor in the process of learning (Vollmeyer & Rheinberg, 2006). While a considerable body of multimedia learning studies have explored the effect of cueing on motivation, the results are mixed (Mayer, 2014; van der Meij, 2018; van der Meij & van der Meij, 2014; 2016b). On the other hand, software training studies have investigated motivation levels when learners find themselves in situations where they need to master a new software application or new functions in a somewhat familiar application (van der Meij & Dunkel, 2020; van der Meij & van der Meij, 2016a; 2016b). The research findings suggest that cueing can increase motivation. To the best of our knowledge, however, no former study has examined the unique effect of cueing on motivation in the case of software training.

### *Flow in videotutorials for software training*

Flow is the situation in which learners are completely concentrated and full of positive feelings for whatever it is they are engaged with (Csikszentmihalyi, 1975). Although there is a great connection between self-efficacy and flow in e-learning (Tandon, 2017), the results of empirical studies are unclear. Some studies report that individuals with high levels of flow achieve higher task performance due to high self-efficacy (Zhao, Lu, Wang & Huang, 2011). On the other hand, some studies found no differences in performance in connection to flow (Jackson, Thomas, Marsh & Smethurst, 2001). According to Rheinberg (2008), expertise leads to more flow instead of flow fostering performance.

In the case of software learning, the importance of flow has been recognized. Scholars have started to investigate flow to determine its connection with task performance (van der Meij & van der Meij, 2013; 2016a). Preliminary evidence indicates that videotutorials enhanced user's flow. However, there is little empirical evidence concerning the effect of cueing on flow for complex software training.

### *Rationale of the study and Research Questions*

Overall, while the influence of cueing on learning has been extensively studied in the area of CTML, we were only able to find a single study (Jamet & Fernandez, 2016) which had specifically examined it in the context of learning software applications. Most other studies (van der Meij & van der Meij, 2013; 2014; 2016a; 2016b; van der Meij, van der Meij & Voerman, 2018) tend to examine cueing in conjunction with other factors, such as reviews and practice. Hence, the potential unique contribution of cueing for software training has not been determined yet. On the other hand, cueing might indirectly influence learning software applications through the mitigation of cognitive load (Alpizar et al., 2020; Schneider et al., 2018), and the improvement of motivation, self-efficacy, and flow. Finally, the participants in all former studies were either complete novices or had little experience with the respective software applications used.

The present study focuses on embedding cueing in videotutorials for software training and considers its direct (learning performance), and indirect (cognitive load, motivation, self-efficacy, flow) effects. More specifically, this study addresses the following research questions:

- Does the addition of cues improve learning from videotutorials in learning a complex software application?
- How does cueing impact on cognitive load, self-efficacy, flow, and motivation?

Regarding the first research question, it was hypothesized that, compared to plain videotutorials, cueing in videotutorials will lead to higher levels of task performance. Empirical evidence on multimedia educational environments (Amadieu et al., 2011; Jamet & Fernandez, 2016; Mayer, 2005; van der Meij & van der Meij, 2013) shows that learners perform better as cueing helps them in the phases of selecting, organizing and integrating the relevant information with prior knowledge to mental representations (van Gog, 2014).

Regarding the second research question, it was hypothesized that providing cueing would help users focus on the essential information, thereby reducing the time for visual-spatial search and the related cognitive load (Jamet & Fernandez, 2016). Furthermore, we assumed that cueing would boost the participants' motivation to involve themselves actively with the material and increase their self-esteem in task performance. According to the Expectancy Theory (Eccles & Wigfield, 2002), self-efficacy plays a major role in developing a positive attitude towards task performance (Bandura, 1997; van der Meij et al., 2018). Also, flow can be an important mediator in measuring engagement while learning with videotutorials (Vollmeyer & Rheinberg, 2006).

## Method

### *Research design*

The study involved a quasi-experimental, 2x2 mixed factorial repeated measures design. While the original experiment included two factors, cueing and practice, for the purposes of this paper we limit ourselves to cueing. This factor included two levels: (a) plain version and (b) enriched version.

### *Participants*

A cohort of 118 (mean age 21 years, 28 female, 90 male) students in their fourth year of Applied Computer Science (CS) study participated in the study. Considering their CS background, the participants had high expertise both in ICT knowledge and software skills. All participants had enrolled in a compulsory multimedia course at Computer Science University Department in the mainland of Greece. Participation in the study was voluntary. The subjects signed the consensus form and they were randomly assigned to one of four treatment conditions. The students received a one-course credit point for their participation.

### *Materials*

**Videotutorials:** Three videotutorials were developed for the study. These were made in vitro and covered aspects of video editing with Blender's Video Sequence Editor, a Non-Linear Editor (NLE) bundled with the 3D suit. Table 2 shows the content, the length, and the number of steps each video included. The first video tutorial presented the interface of the VSE in Blender, introducing basic operations (selecting a clip, changing its horizontal (time) and vertical (channel) position)). The second video tutorial presented information on how to carry out a complex action like clip transformation (zoom, rotation). Finally, the third video tutorial presented even more complex topics such as the simultaneous projection of two pictures overlaid against a third one in the background.

**Implementation:** Cueing was implemented using three main devices: animation (animated arrows), geometric shapes (rectangles), and brightness (dim the screen area that is not the focus of the current operation). These cueing methods pointed the viewers' eye to look at the pertinent on-screen information such as menu items, icons, and popup windows (see Figure 1).

## *Measures*

**Task performance:** To measure task performance, we developed three tasks. Every task comprised five questions: two declarative knowledge questions, two procedural knowledge questions, and one transfer knowledge question. The declarative knowledge test (see Appendix A) was delivered in the form of a printed document on which the participants answered two short multiple choice or True/False questions. The procedural knowledge and transfer knowledge tests were administered online using Blender files. The students were asked to complete tasks like those presented on the videotutorials, such as adding a transformation effect or adjusting scale for a clip (see Appendix B).

**Table 2. Outline the video tutorial contents**

| id | Title & Duration | Steps | Pauses | Topics | Description of videos |
|---|---|---|---|---|---|
| 1 | Introduction<br>3:26' | 9 | 4 | Introduce the video editing GUI<br>Place a strip on different channels | Presentation of the interface (menus, panels, etc.), clip placement, and manipulation. |
| 2 | Main manipulations<br>3:28' | 15 | 6 | Add transform strip (effect)<br>Transform Strip Manipulation | Setup transform effects and apply them on clips. |
| 3 | Juxtapose 2 pictures<br>4:00' | 21 | 15 | Picture in picture (PiP) effect | Set up and apply a complex video effect. |

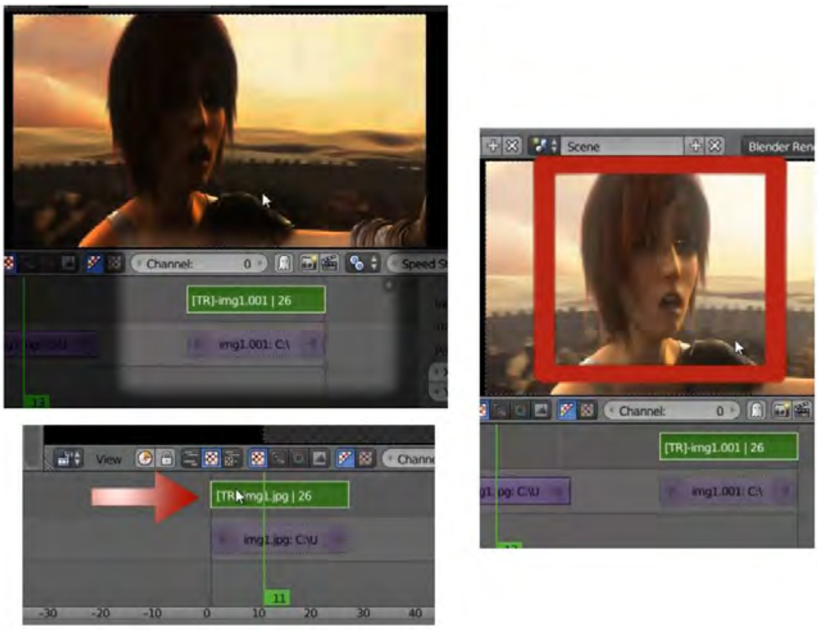


**Figure 1. Examples of cueing used in videotutorials**

Finally, the transfer knowledge question (see Appendix C) required students to apply the knowledge gained from the first two videotutorials to complete the task. A blend file was administered in which the students performed the appropriate operations and then submitted it online. Binary coding was used to score the tasks, with each correct answer receiving 1 point and each wrong answer receiving 0 points. The Cronbach's alpha values for all 3 tasks were high ($\alpha = 0.80$, $\alpha = 0.81$, and $\alpha = 0.81$ respectively).

**ICT Knowledge:** To measure previous ICT experience, the students completed a 22 item questionnaire regarding their previous experience in operating systems ($M = 4.35$, $SD = 0.55$), office applications ($M = 3.73$, $SD = 0.09$), multimedia applications ($M = 2.79$, $SD = 1.11$), social networks ($M = 3.42$, $SD = 1.18$), internet use ($M = 4.75$, $SD = 0.51$), and computer use ($M = 4.98$, $SD = 0.13$). The answers were given on a 5-point Likert scale ranging from very little (1) to very much (5) (Example: How familiar you are with Microsoft Windows? - similar questions were used for word processors, spreadsheets, databases, web browsers, image editing applications, video editing software, social media applications, etc.). The total value of Cronbach's α for the whole scale was 0.7, which is deemed acceptable.

**Cognitive load:** To assess the cognitive load of each video tutorial we used the one item for mental effort (Example: Learning from the tutorial took a great deal of mental effort) (Paas, 1992). As a single item was used, no reliability analysis was possible for each video tutorial. Still, we computed the overall for all three videotutorials, which was acceptable (0.64). While this item has been used in dozens of studies, in our case the total reliability for cognitive load was lower than expected.

**Self-efficacy:** The GSE scale that was used comprised ten items (Schwarzer & Jerusalem, 1995). The answers were given on a 7-point Likert scale ranging from never (1) to always (7) (Examples: I always manage to solve difficult problems if I try hard enough; If someone disagrees with me I can always find ways to do what I want; It is easy for me to stay steady in my goals and accomplish my plans). The scale was reliable both before ($\alpha = 0.85$) and after the procedure ($\alpha = 0.89$). For each scale, the mean score of the questions was calculated. To assess SSE (Bandura, 2006) the participants were asked to answer a questionnaire estimating their ability to complete the tasks demonstrated in the videotutorials (0% - 100%) (Examples: Image strip selection; Moving image strip to horizontal axis x frames; Moving image strip to vertical y-axis channel); Image strip selection). The scales were highly reliable for each questionnaire: first video (three questions) $\alpha = 0.97$, second video (five questions,) $\alpha = 0.95$ and third video (six questions) $\alpha = 0.96$.

**Motivation:** The motivation instrument was adapted from the Reduced Instructional Materials Motivation Survey (Keller, 2010; Loorbach, Peters, Karreman & Steehouder, 2015) and it assessed attention, relevance, self-confidence, and contentment during training. The participants responded to twelve questions on a 5-point Likert scale ranging from never (1) to always (5). (Example: I liked watching this video; The quality of the presentation helped me stay focused; It is clear to me that the content of the video is relevant to what I already know). The total value of Cronbach's alpha value was high for all videotutorials (video 1: $\alpha = 0.95$, video 2: $\alpha = 0.95$ and video 3: $\alpha = 0.96$). An average value resulted from the mean score of the twelve questions for each scale.

**Flow:** To assess flow during training, the users received thirteen items of a 7-point Likert type scale with the response anchors strongly disagree (1) – strongly agree (7) (Rheinberg & Vollmeyer, 2003; Csikszentmihalyi & Larson, 2004). (Examples: I feel just the right level of challenge; My thoughts/actions evolve fluidly and smoothly). The score of each flow scale is based on the mean score of the items. The total value of Cronbach's alpha for each video tutorial was $\alpha = 0.92$, $\alpha = 0.65$ and $\alpha = 0.88$, respectively.

**Procedure:** The whole experimental intervention lasted about 2 hours. In the beginning, the students were briefed about the study (5 min). Next, they logged in the course LMS, and, depending on the condition to which they had been randomly assigned, they accessed a specific learning path. Furthermore, the students completed the demographic data and previous ICT knowledge surveys. After that, they were asked to complete the GSE survey. Then, the participants watched the videotutorials using headsets the whole time. It is worth noting that the students watched each video tutorial only once. After watching the first videotutorial, the students: (a) assessed of the overall cognitive load, (b) assessed their SSE, (c) completed the motivation survey, (d) filled in the flow survey and (e) performed the learning tasks (declarative, procedural and transfer knowledge). The exact same procedure was followed for the videotutorials 2 and 3. Upon completing all three videotutorials, the participants completed the GSE survey, anew.

All materials (videotutorials) and instruments used in the study were in Greek. Apart from task performance (developed ad hoc) and ICT survey, all other scales had been adapted to the Greek language in a former study (Ragazou & Karasavvidis, 2016). Using the standard procedures, each original scale was translated to Greek, and was then back translated to English. The reliability of all adapted scales was comparable to the reliability of the original scales.

### Analysis

The data were analysed with the use of the SPSS Statistical Package version 23. A mixed factorial ANOVA was used with the cueing as the between-subjects factor and the time after the video tutorial as a within-subjects factor.

An alpha value of 0.05 was used throughout the analysis. Each time multiple tests were conducted, the Bonferroni correction (Field, 2013) was applied, thereby reducing the probability level as needed. Finally, because the assumption of sphericity was violated in some cases (i.e. Mauchly's test of sphericity was statistically significant), the corresponding Greenhouse-Geisser F value and degrees of freedom were used (Field, 2013). Cohen's (1988) d-statistic was used to determine the corresponding effect sizes, using the typical classification as small for d = 0.20, medium for d = 0.50, and large for d = 0.80.

### Results

Table 3 presents the task performance scores in the two factor levels. Task performance scores are converted to a percentage of possible points. The repeated measures ANOVA analysis indicated no statistically significant differences in task performance in connection with the videotutorials factor (plain vs. cueing) $F(1,114) = 0.57$, $p = 0.450$, $\eta^2 = 0.005$, $d=0.12$, nor any significant time by cueing interaction ($F(2,228) = 0.137$, $p = 0.872$, $\eta^2 = 0.001$). As the inspection of the mean scores shows, the average performance across the two levels was relatively high, ranging from 70% to 80%. Therefore, our initial hypothesis that the addition of cueing would improve performance was not supported by the data.

Furthermore, the assumption that cognitive load would be reduced in the videotutorials enriched through cueing is not supported by the findings, $F(1,114) = 0.31$, $p = 0.578$, $\eta^2 = 0.003$ (see Table 4).

**Table 3. Mean scores and standard deviations for task performance by condition**

| Condition | Task0 | Task1 | Task2 |
|---|---|---|---|
| | M (SD) | M (SD) | M (SD) |
| Plain (n=60) | 73.67 (31.57) | 72.33 (34.36) | 71.67 (34.80) |
| Cueing (n=58) | 78.62 (30.86) | 76.90 (29.45) | 74.48 (31.96) |

**Table 4. Mean scores and standard deviations for cognitive load by condition**

| Condition | Task0 | Task1 | Task2 |
|---|---|---|---|
| | M (SD) | M (SD) | M (SD) |
| Plain (n=60) | 2.90 (0.74) | 3.82 (0.81) | 5.23 (1.13) |
| Cueing (n=58) | 2.93 (0.92) | 3.79 (0.88) | 5.02 (1.21) |

**Table 5. Mean scores and standard deviations for SSE by condition**

| Condition | Task0 | Task1 | Task2 |
|---|---|---|---|
| | M (SD) | M (SD) | M (SD) |
| Plain (n=60) | 74.00 (23.78) | 78.70 (20.16) | 80.76 (15.45) |
| Cueing (n=58) | 74.77 (25.46) | 79.97 (19.48) | 83.68 (17.16) |

**Table 6. Mean scores and standard deviations for flow by condition**

| Condition | Task0 | Task1 | Task2 |
|---|---|---|---|
| | M (SD) | M (SD) | M (SD) |
| Plain (n=60) | 4.14 (0.69) | 4.09 (0.52) | 4.42 (0.66) |
| Cueing (n=58) | 4.05 (0.63) | 4.26 (0.54) | 4.12 (0.71) |

**Table 7. Mean scores and standard deviations for motivation by condition**

| Condition | Task0 | Task1 | Task2 |
|---|---|---|---|
| | M (SD) | M (SD) | M (SD) |
| Plain (n=60) | 3.82 (0.69) | 3.81 (0.73) | 3.87 (0.68) |
| Cueing (n=58) | 3.83 (0.63) | 4.13 (0.62) | 4.08 (0.70) |

Next, it was predicted that cueing would have a positive influence on SSE. The main statistics are presented in Table 5. As the analysis indicated, the prediction that SSE would be higher in the cueing level, was not confirmed, $F(1,114) = 0.23$, $p = 0.631$, $\eta^2 = 0.002$.

According to theory-based predictions, cueing was expected to improve flow. The main descriptive statistics for the flow scale across the three tasks are given in Table 6. Contrary to expectations, the flow assumption was not confirmed, $F(1,114) = 0.69$, $p = 0.407$, $\eta^2 = 0.006$.

A mixed repeated measures ANOVA indicated no main effect for cueing, $F(1.84, 209.86) = 3.73$, $p = 0.029$, $\eta^2 = 0.032$. The aggregation of mean scores per condition led to a medium effect size (d = 0.46) (see Table 7). Further comparative examination showed that, compared to the plain condition, motivation was considerably higher after watching the second and the third videotutorials when cueing was used. An examination of the differences between the levels of the two factors indicated a significant difference for motivation in the second videotutorial, where the mean motivation for cueing (M = 4.13, SD = 0.62) was significantly higher than the corresponding motivation mean for the plain condition (M = 3.81, SD = 0.73), $t(116) = -2.518$, $p = 0.013$. The same pattern was observed for the mean motivation differences between plain (M = 3.87, SD = 0.68) and cueing (M = 4.07, SD = 0.70) for the third videotutorial. Overall, the findings indicate that the addition of cueing to videotutorials significantly contributed to higher motivation levels in the last two videos, which incidentally were also the most difficult ones.

## Discussion

The present study investigated the effect of adding cues to videotutorials on the learning of complex software training in the case of experienced learners. Moreover, the current study also sought to determine possible indirect effects of cueing on a host of other measures such as self-efficacy, flow, and motivation.

Regarding the first research question, while it was hypothesized that cueing would lead to better task performance, the findings indicated no significant difference between the plain and cueing conditions. While the DBT model is widely accepted and used, not all its design principles have been empirically confirmed. Thus far, it is determined that cueing results in higher performance scores in transfer knowledge tasks rather than procedural knowledge tasks (Jamet & Fernadez, 2016; Lin & Atkinson, 2011; Lowe & Boucheix, 2011). The findings of the present study are in line with the outcomes of a meta-analysis on signalling (Richter, Scheiter & Eitel, 2016), which indicated that cueing leads to higher performance for novice users. Also, the inclusion of cues in the video tutorial for learners with high expertise may interrupt the learning process or may even have negative consequences on learning outcomes, i.e. the expertise reversal effect (Kalyuga, 2007).

From the perspective of CTLM, experienced users, who already possess adequate knowledge to browse the instructional material, may be distracted by what is highlighted by cueing as relevant (Alpizar et al., 2020). Additionally, users at that level of expertise have already formed proper memory patterns (Van Gog, 2014) as compared to novices who struggle to go through all phases of information processing (Paas & Sweller, 2014). Based on our findings, we propose that in the case of software training the impact of cueing may be dependent on the different levels of expertise of the participants (e.g. novices, intermediates, experts). Moreover, it could also be the case that learners with different levels of expertise might respond differently to different forms of cueing. Considering that cueing has not been extensively investigated in the context of learning complex software applications, the present study makes a small contribution to this area.

Contrary to expectations, the results of the present study indicated that cueing failed to mitigate cognitive load. There may be two possible explanations. First, a single item was used for measuring the cognitive load. This item may have failed to distinguish between different forms of cognitive load: intrinsic cognitive load (the nature of the material), extraneous cognitive load (how the material is presented), and germane cognitive load (the effort to create schemas) (Sweller, 2012). It is possible that instruments that assess all types of cognitive load (Leppink et al., 2013) might have afforded a more fine-grained evaluation, potentially leading to different outcomes. Future studies will need to explore how cueing impacts on cognitive load when the latter is measured with more sophisticated instruments. Second, empirical studies in multimedia learning have shown the positive effect of cueing on learning when the materials were static rather than dynamic (Van Gog & Paas, 2008). The findings of this study comply with the ones reported by Xie’s et al., (2016) cueing meta-analysis, according to which cueing does not promote learning when the materials are dynamic visualizations (e.g. videos). Therefore, in the case of software training, the dynamic nature of materials may have shaded the effect of cueing on cognitive load.

With respect to the second research question, two main patterns emerged. First, the results indicated that cueing did not influence self-efficacy and flow. This is not in accordance with the findings of other studies in software training (van der Meij & van der Meij, 2016). According to Bandura (1997), controllability is a key principle over the outcomes of one’s actions. In this study, the students in all conditions were not allowed to consult the videotutorials for as long as they wanted. It could be the case that this lack of control might have hindered the influence of cueing on self-efficacy. More research is needed to account for this discrepancy.

Second, while there were no learning gains from adding cueing to videotutorials, the findings indicated that cueing enhanced the participant’s motivation. The effect size suggested a moderate difference ($d=0.46$) in favour of the cueing condition. This finding is in accord with findings from other studies in multimedia learning (Mayer, 2014) and software training (van der Meij & van der Meij, 2014; 2016), which report that enriched videotutorials motivate users to boost their self-confidence for future reference.

On a more practical level, the present study provides the two substantial insights for the design of videotutorials. First, in the case of experienced users, adding cueing to software screencasts is unlikely to improve the learning of complex software. As the CTML literature suggests (Mayer, 2005; Moreno, 2004), the signalling principle holds mainly for learners with no prior knowledge or users whose expertise level is medium. Therefore, for this specific learner demographic cueing may serve mostly decorative purposes. Cueing does not seem to be an appropriate design principle for software training when users are experts or very knowledgeable in the field but novices as far as the specific software application is concerned. Our findings have indicated no regression, namely cueing does not result in lower performance. Still, adding cues to videotutorials when the recipients are knowledgeable users should not be expected to lead to any considerable learning gain. If the videotutorial designers know in advance the viewer demographic, cueing might be completely optional for domain experts who are novices in the specific software application that the training targets.

Second, our findings indicated that cueing could improve motivation even when the participants are experts or knowledgeable in the field. Consequently, if the users are expected to have low levels of motivation, cueing is highly recommended, as it is likely to increase their motivation and engagement in task execution. Motivation is an important dimension of learning and it turns out that embedding cues in the videotutorials might make the videotutorials more appealing for this specific learner demographic. Therefore, while cueing might not be expected to contribute to learning directly, our recommendation is to employ it as it may facilitate learning indirectly.

Future studies will need to investigate cueing further. On the one hand, empirical research would need to determine the specific learner demographics for which cueing leads to improved performance. Our findings indicated that, while cueing has been proven to be effective, for leaners with relatively high domain knowledge it serves mostly decorative purposes. From a learning perspective, the interest is more in how to facilitate learning rather than how to enhance a dynamic presentation in cosmetic terms. Striking a balance between the two requires more systematic research. On the other hand, future studies will need to examine whether specific forms of cueing are more effective for different learner demographics. For instance, it might be worth considering if verbal cues (Alpizar et al., 2020) might facilitate learning from videotutorials in the case of software training. Finally, maximizing learning from videotutorials will require examining the interaction of cueing with other design factors such as practice with feedback or pacing.

This study has two main limitations. First, the sample was not balanced in terms of gender. Since the research was conducted in a Computer Science department, the proportion of male students is higher. It is not known how a more balanced sample might have influenced the study findings. Replication of the findings with a more balanced sample is advisable. Second, we were unable to include any delayed transfer measures, so the potential long-term effects of cueing could not be determined. Addressing this limitation is an important requirement for future studies as differences often emerged between immediate and delayed transfer tests.

## Conclusion

All in all, the findings of the present study indicate that, contrary to predictions, embedding cueing in videotutorials did not improve task performance in the case of complex software with learners who are domain experts but novices in the particular software application. Interestingly, adding cueing to videotutorials had a positive influence on the motivation of the participants. The picture that emerges from this study is a rather complex one, as e.g. the null hypothesis for learning was not confirmed concerning cueing. Since there is limited empirical evidence on the role of videotutorials for complex software training, the issues of software complexity as much as leaner expertise is concerned require further systematic investigation.

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### *Compliance with ethics*

The authors confirm that this research has received approval from the institutional review board ethics committee.

### *Conflict of interest*

There is no conflict of interest whatsoever.

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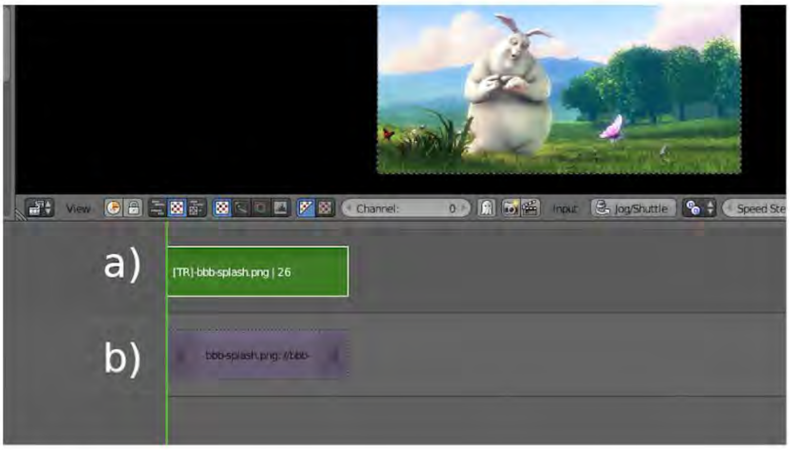
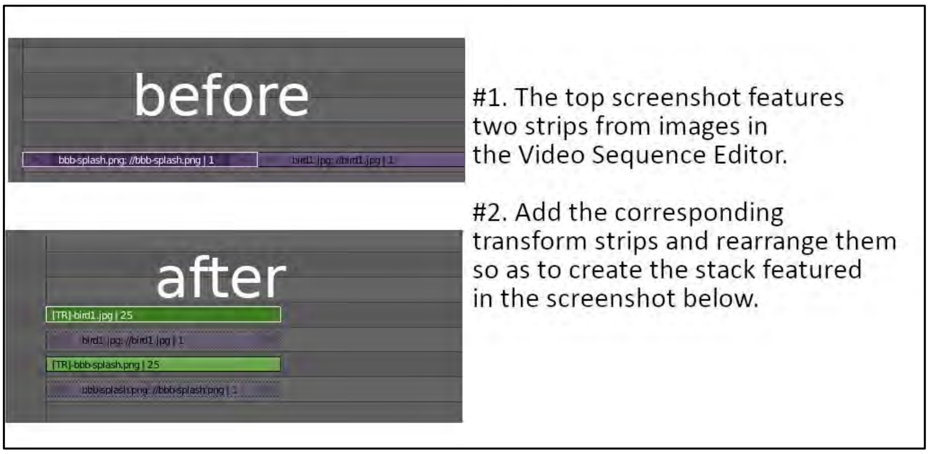
## Appendix A. Screenshot of a declarative knowledge question (translated version)



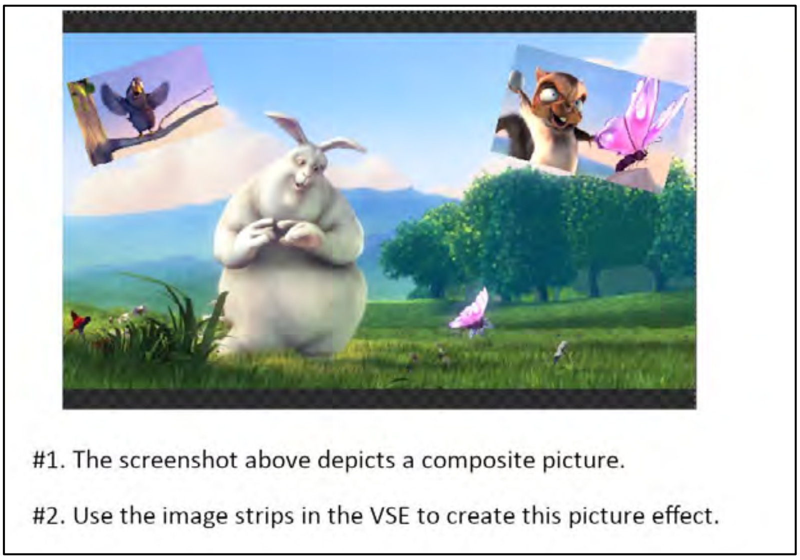

#1. The screenshot to the top features two strips with their corresponding labels (a,b).
#2. In the space provided below, please write down the label corresponding to transform strip.

**Answer**
........................................................

## Appendix B. Screenshot of a procedural knowledge question (translated version)




## Appendix C. Screenshot of a transfer knowledge question (translated version)

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