Contextual Interference: The Role of Practice in Learning from a Video

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Abstract

The contextual interference effect has been largely studied in the area of motor skill learning however, little to no research has investigated the effect in software training where the focus lies on problem solving and conceptual knowledge development. Therefore, the current study investigates the effect of practice schedules in learning from short instructional videos about software training. Additionally, it is investigated whether self-efficacy and self-regulation mediate this relationship. Forty students, randomly selected into two conditions, took part in the study. The results indicated that contrary to initial expectations, the blocked practice condition did significantly better in both practice and retention than the mixed practice condition. Furthermore, self-efficacy together with practice showed to significantly predict the learning outcomes in both conditions. Self-regulation had no influence on the relationship. The discussion addresses the effect of the complexity and nature of the software training tasks, and gives practical implications and suggestions for future research.

Contextual Interference: The Role of Practice in Learning from a Video

Videos have become widely used instructional means in educational institutions and universities (Shao, Dong, Ma, & Sun, 2019). They are often used as a part of the flipped classroom method in which the instructional content is delivered or watched before the actual lesson, after which it is applied during the lesson (Leatherman, & Cleveland, 2019). The goal of these instructional videos is that students acquire knowledge that they can use to solve similar and related tasks later, after watching the videos and practicing, and complete them without any external help (van der Meij, Karreman, & Steehouder, 2009). The flipped classroom method gives students the opportunity to be in charge of their own learning process and outcome (Zuinudding, & Perera, 2019).

An important facet in learning from an instructional video is the practice or application of the viewed content. Research has indicated that simply watching information without applying it, will not lead to meaningful learning but that the activities performed in addition to watching instructional videos make a crucial contribution to the learning outcome (Karppinen, 2005). Deliberate practice has shown to be necessary in order to achieve high performance levels (Campitelli & Gobet, 2011).

Psychological research has shown that different practice schedules yield different learning outcomes (Brady, 2004; Goode & Magill, 1986; Merbah & Meulemans, 2011). According to the contextual interference effect, practicing multiple related skills in a randomized order impedes performance during knowledge acquiring but increases learning afterwards (Brady, 2004). Generally, two practice modes are compared. In a mixed practice schedule, participants first view all instructional videos on a set of related tasks, and then practice (e.g., ABC-abc, the capital letters refer to the videos and the lower letters refer to the practice). In a blocked practice schedule an instructional video on a task precedes the immediate opportunity to practice that task (e.g., AaBbCc). The blocked schedule is said to yield better performance in knowledge acquisition but lower performance in retention tests, whereas the opposite holds for the mixed practice schedule (Brady, 1998; Merbah, & Meulemans, 2011).

The contextual interference effect has been largely studied within the context of motor skills where the aim of learning is the automatization or speeding up of a certain skill (Brady, 1998; Lee & Magill, 1983; Magill & Hall, 1990). It has shown to be effective in areas such as sports, health care and music. However, to our knowledge little to no research has investigated the contextual interference effect in the area of software training where the focus lies on problem solving and conceptual knowledge instead of the automatization of a task. The fact that contextual interference has been found effective in learning motor skills, raises the question whether it could be effective in other areas also. Accordingly, the current study aims to find out whether there is a contextual interference effect in software training. Therefore, the first research question is: *What is the effect of practice schedules on learning from a video for software training?* The tested assumption is that students in the mixed practice condition will do better in retention than students in the blocked practice condition. However, students in the blocked practice schedule will do better than students in the mixed practice schedule during the practice itself.

In addition to practice, regulating one's learning is important for one's academic achievements. Self-regulation refers to the process through which learners alter their current mental abilities into the task-related skills (Zimmerman & Schunk, 2001). This includes the way students control their feelings, actions and thoughts in order achieve academically higher (Zimmerman & Schunk, 2001). Studies have indicated that students

who are able to self-regulate the cognitive, behavioural and motivational aspects of their learning are more effective as learners (Nota, Soresi, & Zimmerman, 2004). Since one's self-regulation skills are an important aspect contributing to the effectiveness of learning a skill, it is important to see to what extent these skills act as a mediator in practice schedules for software training. Therefore, the second research question of the current study is: *To what extent does one's self-regulation act as a mediator between practice schedules and learning?* The hypothesis is that students with better self-regulating skills, will yield better learning scores regardless of what condition they are placed in.

An important aspect of self-regulation is self-efficacy. Self-efficacy is considered to be one of the most important contributors to observational learning (Bandura, 1997) and has shown to be a good predictor of one's learning and motivation (Zimmerman, 2000). Self-efficacy can be defined as the belief in one's own ability to achieve certain outcomes (Bandura, 1997). In the context of learning this means for example a student's belief that he or she is able to learn, do or accomplish something academically. Therefore, it is also more sensitive to change from task to task than self-regulation. Research on self-efficacy has shown that individuals with high self-efficacy are more persistent and put more effort in the present towards the task but also in the future in similar settings (Bandura, 2012; Bandura, & Locke, 2003). Brady (1998) was one of the first to raise the question whether self-efficacy would have an effect also in the area of contextual interference. He speculated that people with a high self-efficacy would yield better outcomes in the mixed practice, and people with a lower self-efficacy would yield better outcomes in the blocked practice condition. However, he concluded that his speculation still needed confirmation. Due to this and the lack of studies within the context of self-efficacy and contextual interference, the third research question is: *To what extent does self-efficacy act as a mediator between the practice schedule and learning?* The hypothesis is that people with a higher self-efficacy will yield better results in learning regardless of what condition they are placed in.

Method

Design

A factorial design with two conditions was employed. The independent variable (schedule of practice) had two levels (blocked schedule and mixed schedule). The three key dependent variables were success on practice and retention tasks, and on a conceptual knowledge test. Additionally, there were two variables (self-efficacy and self-regulation) that were expected to mediate the relationship between the independent and dependent variable. Logging of the videos was used to assess video play.

Participants

Forty university students (28 females, 12 males) with a mean age of 23.2 (*SD* = 6.06 years) participated in the experiment. Participants were from different majors (Psychology 57.5%, IBA 10%, Educational Science and Technology, 5%, Mechanical Engineering 5%, Other 22.5%) and were recruited through SONA, an online study recruitment system for social sciences, and through convenience sampling. Participants were compensated with a 6€ gift card. Students recruited through SONA were also given two credits. Participants were randomly assigned to one of the two conditions (BP: *N*= 20, *Mage* = 24.3, *SD* = 8.42; MP: *N*= 20, *Mage* = 22.2, *SD* = 1.46).

Materials

Instructional Videos. Instructional videos were used to educate participants about APA formatting in Word. There were 11 short videos, organized in four chapters, about formatting one's research paper according to the standards of APA (6th edition). According

to Guo, Kim and Rubin (2014), an instructional video should stay below six minutes. All videos used, stayed well below three minutes in length. The videos were located on the internet on a webpage called Graaps.eu.

Each video focused on a different aspect of APA formatting. The first three videos focused on setting up the document (i.e., how to set margins, font and line spacing in Microsoft Office Word). The next three videos focused on setting up the front page (i.e., how to set up title and header). The next two videos dealt with the abstract and the last three videos focused on setting up different level of headings.

Instructional Booklets. Booklets were used for instructing the participants when to watch a video, and when to practice. They were organized in the same four chapters as the videos. Practice tasks were consistently organized in three steps to make it easier for the participants to follow. The first step always told the participants which file to use (e.g., "Open file Prep13"). The second step consisted of the actual task (e.g., "Set the margins to the standards of APA"), and the third step instructed the participants how to save the modified file (e.g., "Save the file as Prep13c").

Each condition had its own instructional booklet. The booklet for the blocked practice condition, instructed participants to watch a video and then immediately follow by engaging in the corresponding practice task. In the booklet for the mixed practice condition, participants were instructed to first watch all videos in one chapter, and then to make the practice tasks (see Figure 1).

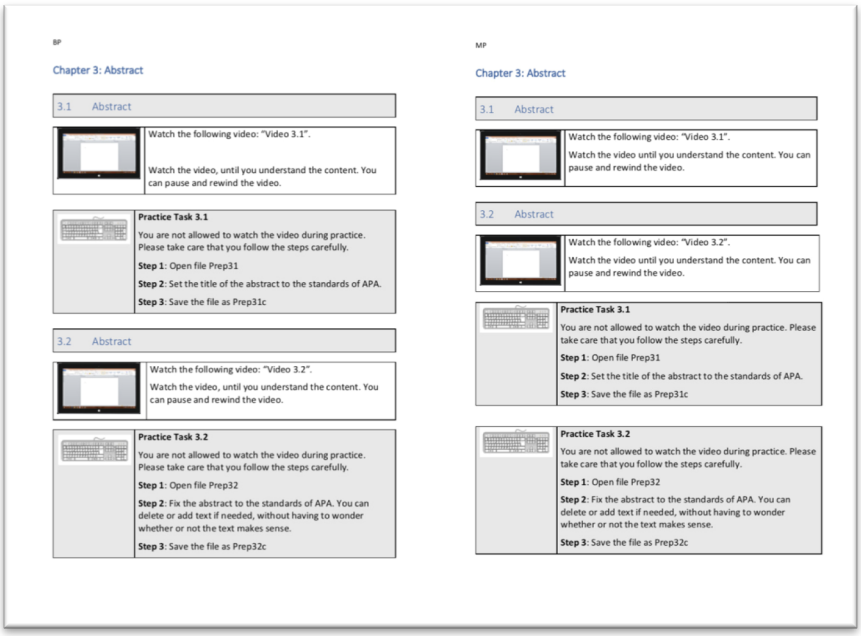


Figure 1. Example page of chapter three from both booklets.

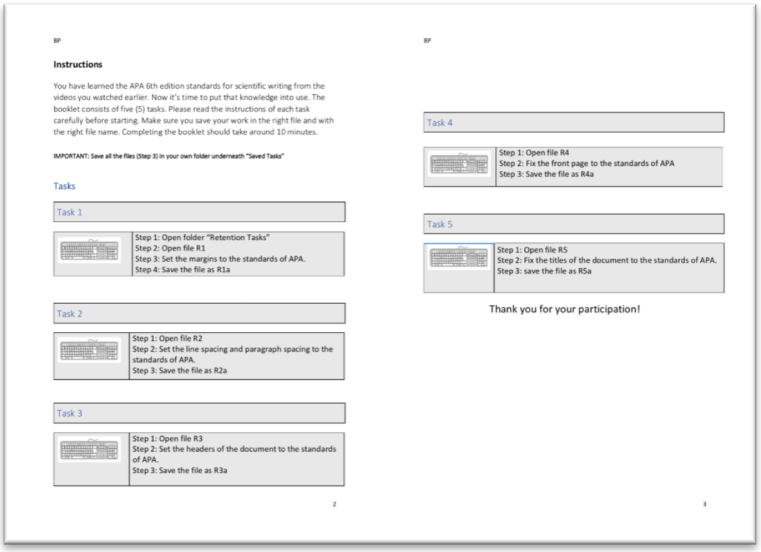
Participant Folders. Each participant was assigned a folder on the desktop of a laptop. This folder included three sub-folders, namely, "practice tasks", "retention tasks", and "saved tasks". The practice tasks folder included 11 practice documents needed for practicing. Each practice document was connected to an exercise mentioned in the booklet. The documents entailed parts of a research article which participants had to modify to meet the standards of APA. For example, in the first document, participants had to change the margins from "moderate" to "normal". In the consecutive documents, the mistakes of the

previous documents were fixed, so that participants were able to continue, even if they had failed on a previous task.

The documents in the retention tasks file were used for measuring the retention of knowledge. The idea was the same as in the practice folders. The retention folder included five documents that participants were to fix according to the standards of APA. A different research article was used than for the practice tasks. As with the documents in the practice folder, the mistakes of the previous document were fixed in the consecutive documents.

The last folder "Saved Tasks" was the repository where participants were to save all completed tasks.

Final Assessment Booklet. A short booklet was used as an instructional aid for the final assessment. The final assessment focused on retention. The booklet consisted of five tasks about the previously practiced content. The difference between the retention and instructional booklet was that in the former participants were not given the chance to watch the videos. As in the practice booklet, the tasks were organized in three steps. Step 1 was used to instruct which file to open "Open file R2", step 2 had the actual task "Set the line spacing and paragraph spacing to the standards of APA" and step 3 was used to guide the participants on saving the file correctly "Save the file as R1a" (see Figure 2).


BP

Instructions

You have learned the APA 6th edition standards for scientific writing from the videos you watched earlier. Now it's time to put that knowledge into use. The booklet consists of five (5) tasks. Please read the instructions of each task carefully before starting. Make sure you save your work in the right file and with the right file name. Completing the booklet should take around 10 minutes.

IMPORTANT: Save all the files (Step 3) in your own folder underneath "Saved Tasks"

Tasks

Task 1

Step 1: Open folder "Retention Tasks"
Step 2: Open file R1
Step 3: Set the margins to the standards of APA.
Step 4: Save the file as R1a

Task 2

Step 1: Open file R2
Step 2: Set the line spacing and paragraph spacing to the standards of APA.
Step 3: Save the file as R2a

Task 3

Step 1: Open file R3
Step 2: Set the headers of the document to the standards of APA.
Step 3: Save the file as R3a

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BP

Task 4

Step 1: Open file R4
Step 2: Fix the front page to the standards of APA
Step 3: Save the file as R4a

Task 5

Step 1: Open file R5
Step 2: Fix the titles of the document to the standards of APA.
Step 3: save the file as R5a

Thank you for your participation!

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Figure 2. Final assessment booklet.

Logging. Video-play was logged. The logs automatically recorded the overall play-time of the videos and the unique play of each participant. Unique play refers to the amount of time in seconds that a video is played. This measure is a proxy for viewing and indicates how much of a video each participant may have watched. A unique play score of 100 % indicates that each second of the video was played at least once. The videos on the website were organized in the order that participants were prompted to watch them. A separate environment was made for each condition in order to see whether there was a difference in the video viewing behavior between the two conditions.

Questionnaires. A paper demographic questionnaire consisted of five questions, aimed at getting demographic information about the participants (age, gender, nationality, field of study, year of study).

A paper questionnaire consisting of eight statements was used for assessing the participants prior knowledge regarding APA and the use of Microsoft Office Word. To

illustrate, items such as “Prepare a Word file so that it is ready for writing in APA- style” (see Appendix A) were used. The statements could be answered in a seven-point Likert scale that varied from 1 (Cannot do at all) to 7 (Can do very well). A higher number indicated greater prior knowledge. The questionnaire yielded a good reliability with a Cronbach’s alpha of α= .83.

A paper questionnaire was used to measure self-regulation. Self-regulation can be defined as the process of controlling and modifying one’s current mental abilities and behavior to fit the skills and competencies needed in a certain task (Bandura, 1991; Zimmerman, & Schunk, 2001). The questionnaire was based on an adapted version of Paul Pintrich’s Motivated Strategies for Learning Questionnaire (MSQL)(Duncan, & McKeachie, 2005). It consisted of nine statements about one’s self-regulation skills related to studying and time management. The questionnaire included statements such as “Finish assignments by deadlines” and “Use effective study strategies” (see Appendix A). Participants were to indicate their level of confidence regarding a statement on a seven-point Likert Scale varying between 1 (Cannot do at all) and 7 (Can do very well). A higher score indicated a higher ability to self-regulate oneself. A Cronbach’s alpha of α= .90 was found.

A paper questionnaire was used for measuring self-efficacy. Self-efficacy can be defined as one’s belief in their own ability to succeed in a task (Bandura, 1997). The questionnaire was a modified version of Bandura’s self-efficacy scale (Bandura, 1997 as cited in Pajares, & Urdan, 2006). It consisted of ten statements. Four of the ten statements focused on the participants self-efficacy regarding Word and included statements such as “Use Word’s basic file management functions (e.g., open, save, print)”. The remaining six statements focused on the participants self-efficacy regarding APA formatting and included statements such as “Create an abstract in APA-style in Word” (see Appendix A). Responses were given on a seven-point Likert Scale varying from 1 (Cannot do at all) to 7 (Can do very well). A higher score indicated a higher self-efficacy. The same self-efficacy questionnaire was administered twice; once before and once after the training. Reliability analyses showed good results for both measurement times, respectively, α= .87 and α= .94

Practice tasks. Hands-on practice tasks were completed to put the newly acquired knowledge from the videos to use. There were 11 tasks where participants had to modify the format of Word files according to the standards of APA. The tasks could be found in the instructional booklets and the documents for modification could be found in the folder “practice tasks”.

Conceptual knowledge test. A conceptual knowledge test was administered after training to assess APA knowledge. The test consisted of six open questions behind which the amount of points one could get for the answer was indicated in brackets (see Appendix B). For instance, one questions was “Which Word features should be arranged in preparation for an APA document? (3 points)”. Below the questions a table with translated Word concepts (English-Dutch, English-German) was presented in order to avoid language barriers, and to help the researcher with the coding of the test. The test was coded according to a predetermined coding scheme.

Retention test. A retention test was administered in the form of the final hands-on assessment. The test consisted of five tasks where participants had to modify the format of Word files according to the standards of APA. The tasks could be found in the final assessment booklet and the folders for modification could be found in the “retention tasks” file. The test was coded according to a predetermined coding scheme.

Scoring

Three coding schemes were developed to analyze the participants practice, knowledge development and retention. Firstly, a coding scheme was developed to analyze the participants answers in the practice files (see Appendix C). Depending on the task, participants could obtain between one and four points for a correct modification of the file. To illustrate, if the participants were asked to "add page numbers and a running head to the document to the standards of APA" (chapter 2, task 2.2) and the participant did both correctly, thus the page number being in the upper right corner and the running head being on the left with "Running Head: SHORTENED TITLE OF THE PAPER", they got two points. If a participant did one of the two correctly, they were awarded one point. If neither the page number nor running head was done correctly, or if they were missing, the participant got zero points. The sum and maximum amount of points obtainable was 22.

Another coding scheme was developed in order to analyze the participants answers on the conceptual knowledge test (see Appendix C). Depending on the question, one could earn two to five points for a correct answer. If the answer was incorrect or left blank, one would get zero points. To illustrate, for the first question "Which Word features should be arranged in preparation for an APA document? (3 points)" one got three points for answering margins (1 point), font (1 point) and line spacing (1 point). If a participant would answer only margins and font, they would get two points, and if they would only answer one of the three e.g. font, participants would gain one point. The points gotten from all answers were added together and the maximum amount of points one could get was 22.

A third coding scheme was developed to analyze the retention test (see Appendix C). The coding of the retention test followed the same coding pattern as the practice files. For each question, one could obtain between one and five points. The sum and maximum amount of points one could obtain was 13.

Procedure

Before the actual experiment, the researcher prepared the laptops for the participants. A personal file for each participant was loaded on the laptop and the internet browser was opened on the website of the logging environment.

The experiment was conducted in a quiet room to avoid distractions. The rooms could accommodate four participants at a time, however the number of participants varied from one to four depending on the time-slot. Each participant was seated by a table where they had their participant number, an informed consent, a laptop, pen and headphones. The experimenter instructed participants with a written-out protocol (2 minutes). Participants were told how the procedure would go, when and how they had to sign in on the webpage, and where the needed files were placed. Furthermore, they were told about their rights to withdraw from the experiment and how the data will be treated with confidentiality. After this, participants were asked to read the informed instructions and fill in the informed consent. The actual research began after the participants had given their consent.

The participants began by answering four questionnaires; the demographic questionnaire, the prior knowledge questionnaire, the self-regulation questionnaire and the self-efficacy questionnaire (5 minutes). After this, participants logged in to the web environment with their participant number, and they were given an instructional booklet which told them what to do. All participants in one time-slot were assigned to the same condition and therefore each participant got the same type of booklet. A maximum of 55 minutes was used for watching the instructional videos and practicing their content on the Word files. After completing the last practice task, participants were given a self-efficacy

questionnaire and a conceptual knowledge test. The participants had ten minutes to complete these.

After completing the questionnaire and test, participants got the retention test booklet. Completing the booklet took a maximum of ten minutes. After completion, participants were thanked for their participation and debriefed. During the debriefing, the participants were told that they were randomly assigned to one of the two conditions and that everything they did in the video server was logged. After this, participants received a 6€ gift card for their participation and had to sign a form to confirm they had gotten it. The experiment took all-in-all between 60 and 120 minutes per participant.

Data Analyses

An overall check was done for the data to see whether the data were normally distributed within the two conditions. The computations showed that both age and prior knowledge were equally distributed throughout the conditions. Age was also overall normally distributed despite including three outliers. The outliers were not excluded from the data since their age was regarded as not having a significant effect on the outcomes of the research. ANOVA's were computed to see the difference between the conditions. When normality and homogeneity of variance assumptions were violated nonparametric tests were conducted. Regression analyses were computed to see whether the independent variable predicted the dependent variables, and whether there was a third mediating variable.

Results

Logged data

The activities of the participants on the video were logged to check whether there had been sufficient video engagement to affect practice and learning. Also, the logged data afforded a comparison across conditions. Table 1 shows the mean scores for total play, unique play and replays. The data for unique play show that the participants viewed nearly all videos for their maximum duration. The small variances further indicate that this was true for nearly all participants. The replay data were at a modest level of about 8%, meaning that less than ten percent of all videos were potentially seen twice.

Because the data were skewed to the right (not normally distributed), differences between conditions were assessed with non-parametric statistics (Mann-Whitney U test). For all three play measures the results were non-significant, with respectively total play, $U(40) = 164$, $z = 0.97$, $p = 0.341$; unique play $U(40) = 210$, $z = 0.28$, $p = 0.783$, and replay $U(40) = 174$, $z = 0.71$, $p = 0.481$. In short, the logged video data showed that video viewing did not differ across conditions.

Table 1. Means in Percentages (Standard Deviation) of Video Play Data per Condition.

	Total play		**Unique play**		**Replay**	
	M	SD	M	SD	M	SD
Blocked Practice (*n* = 20)	111.5	(10.3)	97.3	(2.3)	7.7	(7.5)
Mixed Practice (*n* = 20)	107.1	(15.4)	94.6	(9.6)	8.0	(11.0)
Total (*n* = 40)	109.2	(13.1)	96.0	(7.0)	7.8	(9.3)

Self-regulation and self-efficacy

Self-regulation of participants was measured in order to compare the self-regulative levels between the two conditions. Table 2 shows mean scores and standard deviations of self-

regulation. A t-test was computed for comparison and showed no significant differences between the two conditions, respectively, *t(38) = 1.28, p = .23*.

Table 2.
Means and standard deviation of self-regulation per condition.

	Self-regulation	
	M	*SD*
Blocked practice (*n* = 20)	5.26	(1.00)
Mixed Practice (*n* = 20)	4.90	(.81)
Total (*n* = 40)	5.08	(.92)

Self-efficacy of each participant was measured to determine whether it differed depending on the time administered (before and after practice), and to compare the self-efficacy levels of the two conditions. Table 3 shows the mean scores and standard deviations of self-efficacy both before and after practice. A t-test revealed no significant difference in self-efficacy between the two conditions, *t(38) = 1,51; p = .141.* However, the results indicate that self-efficacy in both conditions was significantly higher after practice, *t(38) = 1,51; p = .021*. In short, the results indicate that neither self-regulation nor self-efficacy differed across the conditions.

Table 3.
Means and standard deviations of self-efficacy per condition and time.

	Self-Efficacy			
	Before		**After**	
	M	*SD*	*M*	*SD*
Blocked practice (*n* = 20)	4.53	(1.16)	6.30	(.55)
Mixed practice (*n* = 20)	4.21	(1.30)	5.90	(1.06)
Total (*n* = 40)	4.37	(1.22)	6.10	(.86)

Practice and learning

In order to examine the effect of practice in learning from a video (RQ1), practice files, retention test files and conceptual knowledge test files were analyzed. The practice files were examined to see whether there was a difference in practice between the two conditions. Means and standard deviations of practice can be seen in table 4. A nonparametric test revealed a significant difference in practice between the two conditions, *U*(40) = 105, *z* = -2.59, *p* = .009. In short, the results indicate that the blocked practice condition succeeded better in the practice tasks than the mixed practice condition.

Table 4.
Means and standard deviations of the practice tasks per condition.

	Practice	
	M	(*SD*)
Blocked practice (*n* = 20)	17.45	(2.14)
Mixed practice (*n* = 20)	14.96	(3.17)
Total (*n* = 40)	16.20	(2.95)

The means and standard deviations of the conceptual knowledge test can be seen in table 5. The results of an ANOVA indicated that there were no significant differences regarding the knowledge test between the two conditions, [F (1,38) = 1,028, p = .32]. In short, the data showed that there were no differences in learning regarding the conceptual knowledge test between the conditions.

Table 5.
Means and standard deviations of conceptual knowledge test per condition.

	Conceptual Knowledge test	
	M	(*SD*)
Blocked practice (*n* = 20)	14.40	(2.87)
Mixed practice (*n* = 20)	13.45	(3.05)
Total (*n* = 40)	13.95	(2.69)

Table 6 shows the means and standard deviations of retention per condition. An ANOVA was computed for the comparison and the results showed a significant difference between the two conditions, respectively, *F(1,38) = 5.320, p = .027*. In short, the results indicate that the blocked practice condition succeeded significantly better in retention than the mixed practice condition.

Table 6.
Means and standard deviations of retention per condition.

	Retention	
	M	(*SD*)
Blocked practice (*n* = 20)	9.50	(2.21)
Mixed practice (*n* = 20)	7.75	(2.57)
Total (*n* = 40)	8.63	(2.53)

Two multiple regression analyses were conducted to see whether practice predicted learning. They were also used to see whether self-efficacy and self-regulation worked as mediators for practice and learning (RQ2 and RQ3). The first regression analysis was computed to see whether practice predicted the outcomes of the conceptual knowledge test. The results of the analysis indicated that 16% of the variance of the knowledge test was explained by the predictors (*R2 = .22, F(3,36) = 3.41, p = .03*). The knowledge gain showed in the test was found to be significantly predicted by self-efficacy (β *= .38, p = .02*). Both practice and self-regulation were not found to significantly predict the knowledge development of participants (β *= .29, p = .06;* β *= -.123, p = .42*).

The second regression analysis was computed to see whether practice predicted retention. The results of the analysis showed that 44% of the variance of retention was explained by self-efficacy, self-regulation and practice (*R2 = .48, F(3,36)=11.22, p= .000*). It was found that practice significantly predicted retention (β *= .58, p= .000*) as well as did self-efficacy (*β = .31, p =.02*). Self-regulation was not found to significantly predict the amount of retention of participants (β *= .22, p = .08*).

Discussion

Looking at the results, it can be concluded that the first hypothesis *students in the mixed practice condition will do better in retention but students in the blocked practice schedule in practice* is rejected. In addition, the second hypothesis *students with better self-regulating*

skills, will yield better learning scores regardless of what condition they are placed in is rejected since the analysis showed self-regulation to have no effect on learning. However, since self-efficacy showed together with practice to predict the outcomes of the test, the third hypothesis *students with higher self-efficacy will do yield better learning scores regardless of the condition* is accepted. In short, it can be said that the first and second hypotheses are rejected, however, third hypothesis is accepted.

The logging data showed that all videos were watched at least once, almost fully. The mean total amount of played video was around 100% in both conditions showing no significant differences in engagement between the two conditions. This also indicates that participants in the mixed practice condition were not more likely to compensate for the longer pause in between practice. This suggests that any effect found in the current research cannot be caused by differences in video engagement.

The aim of the current research was to see whether practice schedules have an effect on learning from a video in software training, and to see whether self-regulation and self-efficacy worked as mediators between the two variables. The results clearly show that practice schedules did have an influence on learning, however contrary to the initial expectation, blocked practice schedule did better in both practice and retention. This is also conflicting with research regarding contextual interference in motor learning which has consistently shown that mixed practice yields better results in retention than blocked practice (Magill & Hall, 1990). Two possible explanations can be given to the lack of the contextual interference effect in the current research; task complexity and task nature. Previous research has shown that contextual interference effect may not be applicable for all types of tasks (Magill & Hall, 1990), and the complexity of the task may have an influence on whether this effect is present or not (Wulf, Hörger, & Shea, 1997).

The contextual interference effect has been widely studied in the area of motor skill acquisition (Magill & Hall, 1990), and the contextual interference has been found beneficial for simple tasks (Frömer, Stürmer, & Sommer, 2016). The effect has also been found in a study about contextual interference in problem solving, where students had to use Boolean logic functions to solve equations (Carlson & Yaure, 1990). However, the study focused on fairly simple tasks where the correct rule could be found easily from a few operators, instead of complex problem solving. Contextual interference's roots lie in cognitive processing (Lee & Magill, 1983) and it has shown to increase the cognitive load of learners (Frömer et al., 2016). In motor skill learning, a different combination of similar movements can solve multiple different problems (Woltz, 1988). In simple tasks, using the mixed practice schedule has proven beneficial due to the increased cognitive demands that have shown to improve one's performance in retention (Wulf & Shea, 2002), and to encourage memory coding and elaborate processing (Frömer et al., 2016). However, due to the increased cognitive load of the contextual interference together with task complexity, and the nature of the working memory, these benefits seem not to be present in complex tasks.

Research on cognitive processing has shown that the increased cognitive load may be useful in simple tasks, however, may impede learning in complex tasks (Wulf & Shea, 2002). This is because in complex tasks one's cognitive load is already increased due to the complexity of the task and therefore by increasing it with a non-fitting practice schedule, it may cause a cognitive overload which in turn disrupts the actual learning process (Wulf & Shea, 2002). The software tasks used in the current research rely more on working memory and cognitive effort instead of skill automatization as in simple motor skill acquisition. Due to the increased cognitive effort and the limitedness of working memory, it seems like the

mixed practice schedule does not work for complex tasks. For complex tasks short duration responses may be better since memory problems are more easily targeted in this type of practice schedule (Smith, 1997). This is in line with the findings of the current research where blocked practice schedule seemed to be more effective than mixed practice schedule in both practicing and retrieving the information from the complex software tasks.

The current research also found that self-efficacy seemed to moderate the relationship between practice and learning. Despite there being no significant difference in self-efficacy between the two practice schedules, a significant difference was found between the two measures of self-efficacy. Research regarding demonstration-based videos in software training have found that these types of videos significantly enhance one's self-efficacy and learning (van der Meij & van der Meij, 2016; van der Meij & van der Meij, 2016; van der Meij, 2017). This was the case also in the current research where self-efficacy was significantly higher after watching the instructional videos. These findings are important since self-efficacy is an important contributor for learning and persistency in future tasks (Bandura & Locke, 2003; Bandura 2012). Self-efficacy was found to contribute significantly in the learning outcomes in the current research, with participants with a higher self-efficacy succeeding better with both the conceptual knowledge test and retention.

The findings of the current research are relevant for two reasons. Firstly, as previously mentioned, to our knowledge it is one of the first researches concentrating on the contextual interference effect and procedural knowledge acquisition instead of motor skills training. Despite not finding a contextual interference effect, possibly due to the complexity and nature of the software training task, the results showed that in such tasks blocked practice schedules may be better. These results could serve to enhance the effectiveness of training in schools, universities and organizations where video training is often used. It is important to acknowledge which type of practice is effective for learning complex procedural knowledge. Additionally, the results contribute to research regarding instructional videos by showing consistently with other researches that these types of videos increase one's self-efficacy which in turn increases learning. Therefore, the results of the current research can help guide future research in the area.

It is important to acknowledge that despite the positive findings of the current research; some improvements could be made for future research. The current research focused mainly on practice and learning in the form of conceptual knowledge development and retention. Therefore, knowledge transfer was missing and it could be useful to research the effect of practice schedules in such complex tasks in knowledge transfer. Mixed practice schedules have in general, found to enhance knowledge transfer however in the current case it could be the opposite due to the results of the retention task. However, more research is needed to find this out.

To conclude, due to the lack of research in contextual interference and complex procedural knowledge acquisition, and the findings of the current research, more research is needed to see whether blocked practice schedule is better for learning complex procedural knowledge. The current study has been one of the first in this field of research but more exploration is needed to make instructional video learning and practice more effective in the future.

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APPENDIX A

QUESTIONNAIRES

Participant number:_____

DEMOGRAPHIC QUESTIONS
Please tick of the answer that fits you, and fill in the blanks.

Gender:
□ Male □ Female □ Other

Nationality:
□ Dutch □ German □ Other, namely_____

Age: ……

Field of study: ……

Year of study (e.g., first, second, etc): ……

PRIOR Experience QUESTIONNAIRE
The following questions help us get an impression of your skills in using Microsoft Word and writing in APA style. Please rate how certain you are that you can do each of the things described below by circling the appropriate number.

Rate your degree of confidence by recording a number from 0 to 7 using the scale below

1 2 3 4 5 6 7
Cannot do at all — Moderately can do — Can do very well

	Cannot do at all			Moderately can do			Can do very well
1. Use Word's basic file management functions (e.g., open, save, print)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
2. Use Word's advanced file management functions (e.g. account, export)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
3. Use Word's basic formatting options (e.g., fonts, replace, bullets)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
4. Use Word's advanced formatting options (e.g. styles, inserts, links)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
5. Prepare a Word file so that it is ready for writing in APA-style	**1**	**2**	**3**	**4**	**5**	**6**	**7**
6. Create an abstract in APA-style in Word	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Participant number:_____

7. Create a running head in APA-style in Word	**1**	**2**	**3**	**4**	**5**	**6**	**7**
8. Create references in APA-style in Word	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Self-regulation Questionnaire

The following questions help us get an impression of your self-regulation skills. Please rate how certain you are that you can do each of the things described below by circling the appropriate number.

Rate your degree of confidence by recording a number from 0 to 7 using the scale below

1 2 3 4 5 6 7

Cannot do at all — Moderately can do — Can do very well

	Cannot do at all			Moderately can do			Can do very well
1. Finish assignments by deadlines	**1**	**2**	**3**	**4**	**5**	**6**	**7**
2. Get yourself to study when there are other interesting things to do	**1**	**2**	**3**	**4**	**5**	**6**	**7**
3. Concentrate during real life lectures	**1**	**2**	**3**	**4**	**5**	**6**	**7**
4. Concentrate during video lectures	**1**	**2**	**3**	**4**	**5**	**6**	**7**
5. Organize your study	**1**	**2**	**3**	**4**	**5**	**6**	**7**
6. Plan your study time	**1**	**2**	**3**	**4**	**5**	**6**	**7**
7. Monitor progress for assignments	**1**	**2**	**3**	**4**	**5**	**6**	**7**
8. Motivate yourself to study	**1**	**2**	**3**	**4**	**5**	**6**	**7**
9. Use effective study strategies	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Participant number:_____

Self-Efficacy Questionnaire

The following questionnaire will help us get an impression of your confidence in using Word and the APA style. Please rate your confidence by circling the appropriate number.

Rate your degree of confidence by recording a number from 0 to 7 using the scale below

Cannot do at all			Moderately can do			Can do very well
1	2	3	4	5	6	7

	Cannot do at all			Moderately can do			Can do very well
1. I can manage files in Word	1	2	3	4	5	6	7
2. I can modify styles in Word	1	2	3	4	5	6	7
3. I can adjust margins in Word	1	2	3	4	5	6	7
4. I can create a header in Word	1	2	3	4	5	6	7
5. I can set up a Word file that fits APA-style	1	2	3	4	5	6	7
6. I can write an introduction in APA-style	1	2	3	4	5	6	7
7. I can create section headings in APA-style	1	2	3	4	5	6	7
8. I can write an abstract in APA-style	1	2	3	4	5	6	7
9. I can create a title page in APA-style	1	2	3	4	5	6	7
10. I can adjust a font so that it fits the APA-style	1	2	3	4	5	6	7

APPENDIX B

CONCEPTUAL KNOWLEDGE TEST

Participant number: _____

Conceptual knowledge test

Instructions
Below are questions regarding the information you learned from the videos and practiced. Please answer the questions with **clear handwriting**. Answering the test should take you around 10 minutes.

Test

Question 1: Which Word features should be arranged in preparation for an APA document? (3 points)

Question 2: What are the main formatting requirements for the title of a document? (4 points)

Question 3: What are the formatting requirements for page numbers? (2 points)

Question 4: What are the formatting requirements for the running head on the title page? (5 points)

Question 5: What are the formatting requirements for the section header - second level? (4 points)

Question 6: What are the formatting requirements for paragraphs? (4 points)

Participant number: _____

Key words:

English	**German**
Margins	Ränder
Font	Schriftart
Paragraph	Absatz
Lower case	Kleinbuchstaben
Upper case	Großbuchstaben
Header	Kopfzeile
Footer	Fußzeile
Colon	Doppelpunkt
Words	Wörter
Characters	Zeichen
Bold	Fett (gedrucht)
Italics	Kursivschrift
Align	Ausrichten
Indent	Einzug

English	**Dutch**
Margins	Marges
Font	Lettertype
Paragraph	Paragraaf
Lower case	Kleine letters
Upper case	Hoofdletters
Header	Koptekst
Footer	Boettekst
Colon	Dubbele punt
Words	Woorden
Characters	Tekens
Bold	Vet
Italics	Cursief
Align	Richten
Indent	Inspringen

APPENDIX C

CODING SCHEMES

Coding Scheme for Practice Tasks Booklet

The participants must fix the given documents according to the following guidelines. For each correct modification, the participant gets 1 point. For an incorrect modification, participant gets 0 points. The maximum amount of points per task is written after in brackets the task name in bold. Under each task, the guidelines for giving points to the specific task can be seen. Participant can get between 1 and 4 points per task. The sum of points and the maximum score is 22 points.

Prep 13 **(max 1 point)**
- Margins 1 inch/2,5 cm/" Normal"

Prep 14 **(max 1 point)**
- Times New Roman, 12

Prep15 **(max 1 point)**
- Double line spacing

Prep 21 **(max 4 points)**
- 12 words or less (1 point)
- Center (1 point)
- Not bolded (1 point)
- Double line spacing (1 point)

Prep 22 **(max 2 points)**
- Page number right header (1 point)
- "Running head: CAPS" with a shortened version of the title or "short version of title" (1 point)

Prep 23 **(max 1 point)**
- No "Running head" on second page

Prep 31 **(max 2 points)**
- "Abstract" middle (1 point)
- Not bolded (1 point)

Prep 32 **(max 2 points)**
- Abstract paragraph/ text not indented (1 point)
- 250 words or less

Prep 41 **(max 3 points)**
- Same title as on title page→ no "introduction" (1 point)
- Center (1 point)
- Not bolded (1 point)

Prep 42 **(max 2 points)**
- "Methods" bold (1 point)
- In the middle/center (1 point)

Prep 43 **(max 3 points)**
- Both participants and materials must be modified
- On the left, capital letter (1 point)
- Bold (1 point)
- Without ":" (1 point)

Participant number:_____

Conceptual knowledge test coding Scheme

The maximum amount of points one can get from each question is indicated in brackets after each question. Under each task, the guidelines for giving points to the specific task can be seen. Participant can get between 3 and 5 points per task. The sum and the maximum score is 22 points.

Question 1: Which Word features should be arranged in preparation for an APA document? (3 points)

(1) margins
(1) font
(1) line spacing

Question 2: What are the main formatting requirements for the title of a document? (4 points)

(1) center
(1) 12 words or less
(1) upper case first letter major word
(1) lower case first letter minor word (and, or)

Question 3: What are the formatting requirements for page numbers? (2 points)

(1) in header
(1) top right corner

Question 4: What are the formatting requirements for the running head on the title page? (5 points)

(1) Name Running head
(1) Colon
(1) 50 characters or less/short version of title
(1) all caps
(1) flush left

Question 5: What are the formatting requirements for the section header - second level? (4 points)

(1) bold
(1) flush left
(1) upper case first letter major word
(1) lower case first letter minor word (and, or)

Question 6: What are the formatting requirements for paragraphs? (4 points)

(1) Indent after section header -first level
(1) Indent after section header -second level
(1) double space
(1) Times New Roman, 12 (mentioned by multiple)

Coding scheme for Final Assessment Booklet

The participants must fix the given documents according to the following guidelines. For each correct modification, the participant gets 1 point. For an incorrect modification, participant gets 0 points. The maximum amount of points per task is written after in brackets the task name in bold. Under each task, the guidelines for giving points to the specific task can be seen. Participant can get between 1 and 5 points per task. The sum of points and the maximum score is 13 points.

Task 1 **(max 1 point)**
- 1 inch/2,5cm margins on all four sides 1p

Task 2 **(max 1 point)**
- Double line spacing 1p

Task **3 (max 3 points)**
- "Running head: CAPS" first page (1p)
- "SHORT VERSION TITLE" second page (1p)
- Right header corner page number (1p)

Task 4 **(max 5 points)**
- Times New Roman, 12 (1p)
- Double spacing (1p)
- Middle (1p)
- Not bold (1p)
- Few tabs down from the very top of the page (1p)

Task 5 **(max 3 points)**
- "Abstract" → center, not bold (1p)
- "Introduction"→ same title as front page, center, not bolded (1p)
- Titles below introduction: (1p)
    - Bold, left, not underlined