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Video tutorials- the educational media of tomorrow?

A comparison of the effectiveness of dynamic vs. static tutorial for procedural learning

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Abstract

Increased dominance of "How to" videos on the social networks, and the assumption, that people show higher performance and are more engaged while learning through videos. The present study aimed to assess the effectiveness of the dynamic instructions compared to the static equivalent. Based on the recommended instructional design guidelines for software learning, two conditions were developed: dynamic (video based) & static (on-screen presentation) tutorial. 30 participants (mean age 38) were individually assessed by random distribution of learning materials. Results showed no significant difference found in retention and transfer tests ($F(1, 28) = 130.27$, $MSE = 319.70$, $p<.0001$). Furthermore, both groups completed training within almost the same timeframe (dynamic - $M=28.80$; static - $M=29.13$). Participants found both condition quite difficult to study, however they didn't put much effort to learn, therefore showed low motivation. These findings do not support our hypothesis and bring issue for future research.

Keywords: Instructional design guidelines, software learning, video tutorial, animations, multimedia learning, procedural knowledge.

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I would like to thank all participants – my work colleagues, classmates, friends and friends of the friends who volunteered to make this research happen.

Finally, I would like to thank my family to be present and patient, always encouraging and inspiring to persevere.

I'd like to dedicate this work to Sofia, Mikhail, Danute, Ricardas, Daiva, Ignas, Irina, Vladimir, Oleg, Marina and to my dad – Josif, who will always be in my heart.

“The illiterate of the 21st century will not be those who cannot read and write, but those who cannot learn, unlearn, and relearn.” *Alvin Toffler*

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1. Introduction

A new era of technology has disrupted learning and the way we acquire information. We face the time of change in how we learn (e.g. smartphone, learning platform), when we learn (accessibility 24/7) and why we learn (e.g. to develop new skills or to assemble wardrobe, etc.)? The arrival of YouTube on the internet in 2005 also marked the debut of the user as designer (van der Meij & van der Meij, 2014). Growing interest of user-made “How to” videos resulted in the rise of various websites, e.g. Vimeo, eHow, Howcast, Videojug, Wonderhowto. As a response to the demand, informational technology has also evolved and multiplied its accessible software offers. In the last decade, we can witness that the spread of knowledge is not anymore restricted to professionals. Anyone can record a video tutorial and publish it on internet, hence the diversity of final outcomes. Learning is omnipresent. Creation of short tutorials (2-5min.) became easier than ever. Integrated private or open source software (e.g. Camtasia, Screencast-o-Matic, etc.) enable any non-tech savvy[1] to use it intuitively and broadcast home-made video tutorials to the larger audience. Videos vary in *content* (kitchen recipes, evening make-up, etc.), in *form* (real-life scenes “How to tie a tie”, demonstration of the procedural or motor skills required tasks “How to perfectly align your text in Word”; animation based explanations “Anatomy of the heart”, etc.), in *length (from ~1min to ~1h)* and in *design*. As their primarily function is informational-educational, some questions arise: how effectively video tutorials support learning goals? Do we learn better from video tutorial compared to the static guidelines that we used to have before the videos “invaded” social networks? How specific design of the instructional video tutorials influences learning performance? Do we really appreciate learning from videos?

Researchers, in the field of multimedia learning, spent last two decades in comparing animated (video) and static (on-screen text and pictures) display effectiveness. It was found both - positive effects on leaning performance, as well as no significant difference. Areas that generated the most research on multimedia learning included reading, history, mathematics, chemistry, meteorology, complex physical systems, second language learning and cognitive skills (Mayer, 2005). Baek and Layne (1988, in Bétrancourt & Tversky, 2000) found that in 7 out of 12 studies animations improves learning of a mathematical rule (relation between time, distance and speed) over static graphics and text only conditions. But in 5 remaining studies found no significant differences between animated and static display. Palmiter & Elkerton (1993) conducted experimental research on interface procedures with 48 participants (mean average age: 24.9) concluding that animated display helped learners to accomplish tasks more rapidly and accurately during training compared to the text condition.

[1] Savvy – Someone knowing a lot about modern technology, especially computers (Cambridge Dictionary. On-line at https://dictionary.cambridge.org/fr/dictionnaire/anglais/tech-savvy. Last accessed on 5 November 2017)

However, in the delayed test one week later, the demonstration users were much slower and less performant than text only display group. In the recent meta-analysis, Berney and Bétrancourt (2016) investigated 50 papers yielding 140 pair-wise comparison of animated vs. static graphic visualizations in multimedia instructional material, found positive effect of animations over static graphics. The results of the Höffler & Leutner (2007) meta-analysis reveal greater benefits of animations for procedural-motor knowledge (“How”) rather than problem-solving knowledge or declarative knowledge (“What”). Nevertheless, there is little scientific evidence to support the hypothesis of the instructional benefit of animation (Berney & Bétrancourt, 2016).

In this work, we will attempt to reply to the questions above, bringing scientifically grounded theoretical support as well as conducting ourselves an experimental research to find out the effectiveness of each display. Out of the multitude of learning areas we will focus on procedural learning because this field is closest to our professional life, where the culture to use static display to learn software procedures is embraced.

2. Theoretical background

2.1 Procedural learning

2.1.1 What is specific to procedural knowledge vs declarative knowledge?

There is no doubt that the way in which new learning content interacts with previous knowledge has to be one of the crucial issues of any theory of learning and remembering (Baddeley, 2014). We state that we learnt something when a mental model of a specific phenomenon (e.g procedure to tie a nautical knot) is created in our long-term memory. To get to that end goal, the flow of the information is encoded, stored, and retrieved between short and long term memory systems (Baddeley, 2014). Procedural knowledge, as defined by various researchers (e.g., van der Meij & van der Meij, 2014; Höffler & Leutner, 2007; Solaz Portolés & Sanjosé López, 2008), is a type of knowledge that contains actions, rules to be followed to accomplish a certain task. Development of the procedural knowledge is directly connected to the information acquisition by procedural and declarative memory systems. To learn a procedure, first we need to learn (or know) a domain specific content (i.e., facts, definitions), thus declarative knowledge, also called conceptual knowledge, must be acquired. Further, learner constructs procedure by retrieving information from previous knowledge stored in long term memory. However, there is no clear boundaries where procedural memory starts and declarative finishes.

Schneider & Stern, (2010) discuss the interaction between conceptual and procedural knowledge acquisition in development of mathematical competencies. They raise the questions that already many researchers have examined concerning the naturally occurring order of acquisition of these two kinds of knowledge - which knowledge causally influence which? And, how to measure such interlinked with each other knowledge. In the Table 1, we present consolidated view that describe specificities of both knowledge kinds presented by Schneider & Stern (2010).

Table 1 - Difference between procedural and conceptual knowledge (Schneider & Stern, 2010).

Specificity	Declarative knowledge	Procedural knowledge
Overall	Represent conceptual (general, abstract) and core principles, facts	Associated with conditions to reach goals
Flexibility	Flexible for transformation	Inflexible for transformation
Storage	As schemas, semantic networks	Rather automatized
Connection	Not linked to the specific problem, task	Linked to the specific problem types
Verbalization	Can be explained	Hard to explain
Facilitation	Explicit information	Inferences
Measure instruments	Concept maps, multiple choice	Performance assessment

While conceptually it is possible to distinguish knowledge types, in practice they are difficult to distinguish, moreover, assessment methods do not line up perfectly with knowledge types and characteristics (Solaz Portolés & Sanjosé López, 2008). Thus, solutions of declarative assessment tasks might, to some degree, also reflect procedural knowledge, and solutions of procedural assessment tasks might reflect parts of declarative (conceptual) knowledge (Rittle-Johnson et al., 2001, in Schneider & Stern, 2010).

In the next chapters, we will focus on the procedural knowledge acquisition from static and dynamic form of media. By static representation we mean procedure steps presented on-screen with images and instructions to accomplish task. By dynamic display we refer to the animated instructions conveyed through video with or without narration.

2.1.2 Procedural knowledge acquisition from static display

According to the multimedia *animation and interactivity* principle, people do not necessarily learn better from animation than from static diagrams (Betrancourt, in Mayer, 2005). When instructions are given as static information (text with pictures), learner see them as series of single steps, whereas dynamic instruction is continuous and shows not only steps but also raise the salience of a location or object (van der Meij & Brar, 2017). Thus, when procedure is presented as static information, it is a series of segmented events (pictures), and learner needs to identify right boundaries of the information change and track how sets of fine-grained events group together into larger meaningful units (Zacks & Swallow, 2007). Event segmentation is the process by which people parse a continuous stream of activity into meaningful events (Zacks & Swallow, 2007). According to findings on event cognition, learners should construct an internal representation composed in several discrete steps rather than in a smooth and continuous manner (Newtson, 1973; Zacks, Tversky, & Iyer, 2001, in Arguel & Jamet, 2009). Thus, presenting procedure in static format is more likely to be efficient way to retain information as it requires users to interpret instructions, and to produce self-explanations during task execution (Catrambone & Yuasa, 2006, in van der Meij & van der Meij, 2014). This active way of learning enhances user understanding and helps increase learning performance (Mayer's, 2002 Multimedia principle). In addition, Bétrancourt & Tversky (2000) study demonstrates that pictures are computationally more effective than text for encoding relationships between objects or events (Larkin & Simon, 1987), they are effective mnemonics aids (Paivio, 1991) and they are effective attention-gaining and appealing devices (Rieber & Kini, 1991).

Palmiter (1993) discuss the difference of procedural knowledge acquisition from textual or pictorial instructions taking Bovair and Kieras (1986) process model (figure 1).

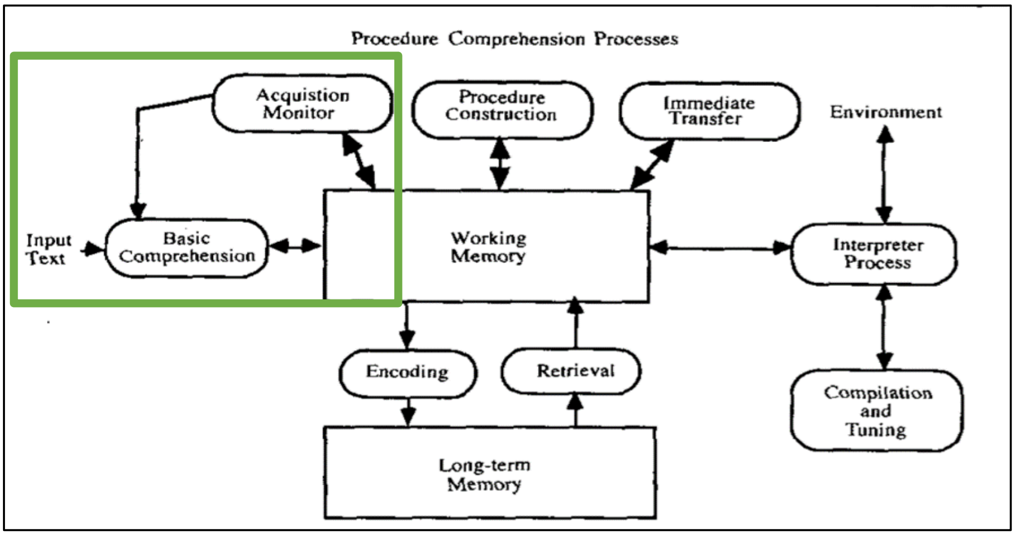


Figure 1 – Process model for acquiring a procedure from text (from Kieras and Bovair, in Palmiter, 1993)

When learners read instructions, they transform instructional sentences into the declarative form. Further, the construction process takes the explicit sentence structure (e.g. step number, step name, stated action) and combines it with overall procedure information (Palmiter, 1993). Besides active processing of information, important arguments favoring a static visualization over a video (dynamic) tutorial for procedural knowledge development are its structure, accessibility, pace control (van der Meij & van der Meij, 2014).

Accessibility to see tutorial structure at learner's own pace plays an important role in remembering process and supports user self-efficacy. Bethke et al. (1981, in van der Meij & van der Meij, 2013) indicate arrangement (structural order), pointers (index), and consistency (same information in the same place) as the key features that provides good paper tutorial structure and it's accessibility. Once tutorial structure is developed, user can process information easily at his own pace.
To develop procedural knowledge from static display, user should interpret given information (in sentence and in pictures) by compiling and fine tuning it, to fill-out missing inference explanation gaps. This process might lead to a longer information processing and acquisition time. It is therefore beneficial as it promotes active learning.

2.1.3 Procedural knowledge acquisition from dynamic display

Animation is one of the typical form of dynamic displays when learning procedure. Animation, as suggested by Bétrancourt & Tversky (2000), is any application, which generates a series of frames, so that each frame appears as an alteration of the previous one, and where the sequence of frames is determined, either by the designer or the user. When learner receives video input, he is processing the same flow of information acquisition through memory system as if he has received from static display. But, in contrast to static displays, the information conveyed might be more effective as it includes motion and micro steps, exact sequence and timing (Tversky, Morrison, & Bétrancourt, 2002) that helps learners perceive changes immediately. As memory is a multi-store system, superficially encoded material will be forgotten rapidly, whereas material that is deeply and elaborately encoded will be well retained (Baddeley, 2014). Therefore, animated display can be expected to ease transfer rather than retention (Bétrancourt & Tversky, 2000) and learner will spend less time in executing tasks.

Mayer's (2005) multimedia *modality* principle states that people learn better from graphics and narration than graphics and printed text. Important arguments favoring a video (dynamic) tutorial over a static tutorial lie in the affordances that video offers for *multimedia representations, congruity, and modelling* (van der Meij & van der Meij, 2014). Bétrancourt & Tversky (2000) highlights, that animations help reduce the computational difficulty of mentally processing temporal ideas; and that static display would need complex graphical devices to convey change over time, such as arrows, series of pictures, which would increase the learner cognitive load required to process the instructions. Therefore, animation should be particularly beneficial for memorizing and understanding of complex dynamic systems such as biological processes, natural phenomena or mechanical devices (Berney & Bétrancourt, 2016).

Besides benefits, there are limitations. Due to the animations transient nature, and temporal limits of working memory (Chandler & Sweller, 1991, in Höffler & Leutner, 2007), the element of interactivity is high and that imposes cognitive overload (see chapter 2.2 Multimedia learning and Cognitive load theory). If previous information is

needed to understand current information, any advantage of animations may be lost due to their transient nature (Sweller, 2016). The recommendation is to segment the task (Lowe, 1996, in Bétrancourt & Tversky, 2000) and control the pace to help prevent cognitive overload.
In summary, to develop procedural knowledge from dynamic display is beneficial when the information represents complex dynamic systems, natural phenomena or biological processes (Bétrancourt & Tversky, 2000), also when it serves to develop procedural-motor knowledge (Höffler & Leutner, 2007). For showing facts, dynamic displays are not necessarily the primarily choice of multimedia learning design, it can be conveyed through static visualizations.

In the next chapter, we will discuss the multimedia principles that should be considered when designing instructions as well as design guidelines to reduce cognitive load when learning software procedures.

2.2 Multimedia learning and Cognitive load theory

Procedural knowledge acquisition from multimedia instruction (regardless of static or dynamic format) falls under vast domain of multimedia learning. Multimedia learning was best identified and conceptualized by Mayer in 2005. Multimedia learning (figure 2) occurs when people build mental representations from *words* (such as spoken text or printed text) and *pictures* (such as illustrations, photos, animation, or video) (Mayer, 2005). The assumption is that learners can better understand an instruction when it's

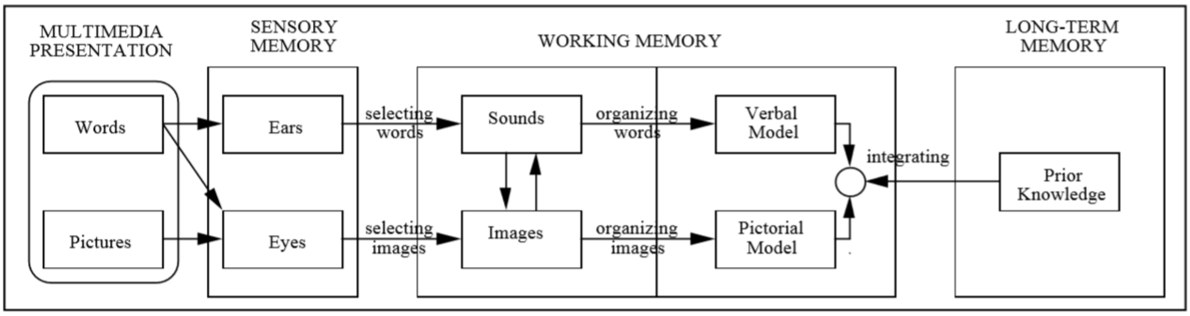


Figure 2 - Cognitive theory of multimedia learning (Mayer & Moreno, 2003).

represented in words and pictures than words alone. When user acquires information, learner's attention is focused at the same time on verbal and visual representations. Since short-term memory has a limited capacity for processing information received from visual/pictorial and auditory/verbal input (Mayer, 2002), learner can indeed focus on one single media at the time. This results into *split-attention* effect (Mayer, 2005) and in reduced learning performance.

Active learning requires carrying out a coordinated set of cognitive processes during learning (Mayer, 2002). Therefore, to enhance learning performance Mayer (2005) proposed a set of multimedia principles to guide instructional designer. His

recommendation is to design multimedia message considering how human brain works and specifically how to reduce unnecessary cognitive load in learner's working memory (Mayer, 2002; Mayer & Moreno, 2003).
Cognitive load is the amount of perceived mental effort that is related to performing a task (Paas & van Merriënboer, 1993). Researchers Mayer (2005), Moreno (2007) and Sweller (1998) have brought a considerable input around reduction of cognitive load effect in working memory while learning through multimedia. Sweller et al. (1998) & Sweller (2016) in the Cognitive load (CL) theory distinguish three types of cognitive load:

- Intrinsic CL – is the process to perform a task (e.g. learning the vocabulary of a second language or learning the symbols of the chemical periodic table);
- Extraneous CL - the way the information is presented (e.g. design elements in the tutorial);
- German CL – the information acquisition. It is associated with Intrinsic CL by assuming that it refers to the mental resources required to deal with intrinsic cognitive load rather than as an independent source of cognitive load (Sweller, 2010, in Sweller, 2016).

While designing instructional multimedia tutorial, the recommendation is to manage balance of intrinsic working memory load and reduce extraneous working memory load. In other words, to support meaningful learning, tutorial should propose directly with learning goals associated information and eliminate pictures, words that directly are not related with learning content.

In the following sections, we will discuss how multimedia principles and instructional design guidelines integrate cognitive load theory and enable procedural learning goals attainment.

2.3 Instructional design guidelines supporting procedural learning goals

Morain & Swarts (2012) study framed that many of the qualities that make instructional videos good are the same qualities that make good written procedures: clear goals, a structure that supports reading to do, concrete details, and user feedback. Users consult a "how to" video because they wish to know what they need to do to complete a task (van der Meij & van der Meij, 2013). They don't need to learn how the software works, but only their specific goal – their task to do.
The two goals that procedural tutorial should support are: task performance (enable or guide the user's task completion) and learning (instruct the user so that he or she can acquire the capability to perform trained and related tasks independently) (van der Meij, Rensink, & van der Meij, 2017). An instructional designer must keep in mind these two learning outcomes and find a right balance when creating tutorial.
Multimedia principles as described by Mayer (2002, 2005) & Tversky, Morrison, & Bétrancourt (2002) & Mayer & Moreno (2003) present general guidance on how to reduce cognitive load in working memory and increase learning performance. More

detailed guidelines on the software learning were consolidated by researchers van der Meij & van der Meij (2013) and van der Meij & Brar (2017). As an outcome of their studies, a set of “Eight guidelines for the design of instructional video” along with “Demonstration-based training (DBT) model” were presented as a concise view of accepted and scientifically proven key notions on how to design an instructional tutorial for software training.

The following instructional guidelines were selected by ourselves to guide the design of preparation of both instructional tutorial formats for our experimental research.

2.3.1. Instructional design to support task performance.

To support task performance, tutorials must enable or guide the user to accomplish a task (van der Meij et al., 2017). Already Gagne’s (1985) in his “Nine events of instruction”, underlined the importance of getting learner’s attention and providing “learning guidance” to stimulate active learning. van der Meij & van der Meij (2013) proposed to consider the following guidelines for user attention: provide easy access (Guideline 1); enable user control (Guideline 3.2); preview the task (Guideline 4); use highlighting to signal screen objects or location (Guideline 6.3).

Guideline 1 – Provide easy access.

Just as in a paper tutorial or online help system, the title should give the user a succinct description of the goal that is demonstrated (Farkas, 1999, in van der Meij & van der Meij, 2013). It is recommended that titles should be as short as possible, contain a verb (presented in gerund form) and an object, telling the user what task the video demonstrates and how to perform it (van der Meij & van der Meij, 2013). Bethke et al. (1981, in van der Meij & van der Meij, 2013) indicates that the first criterion to satisfy in the paper-based instructions is easy access. This condition can be achieved if tutorial has a good structural organization of the information, pointers (indicators of content), and consistency factors (common methods of ordering). These elements help user gain first attention, filter and select information through auditory and visual channels.

Guideline 3.2 – Enable user control

The user control functionality – start, pause, stop, and replay – is more important to animated displays, since static have inevitably user control embedded in their training material and can be manipulated by scrolling page up and down. These multimedia interactivity elements provide control over the pace, allowing learner to process essential information at his own rhythm. By stopping and replaying the procedure, user monitors selected information in his working memory. Pausing helps reduce cognitive overload due to the transient nature of dynamic displays (van der Meij & van der Meij, 2013). Based on the event cognition, users process information in segmented events. In this case, segmentation acts as a guide for constructing a relevant mental model. (Biard, Cojean, & Jamet, 2017). With system-enabled control or pausing learners understand and retain essential information with more self-efficacy and motivation.

Guideline 4 – Preview the task

A preview can increase learning by raising user awareness before actually beginning the task (Kriz, 2011, in van der Meij & van der Meij, 2013). In preview, it is recommended to inform learner of the end goal of the task. Featuring "before-after" state of procedure, enables user to start constructing a "big picture". This guideline is as well applicable for static guidelines tutorial by taking screen captures and informing user of before and after state. Mayer's (2002) multimedia *pre-training principle* states that students learn better when training on components precedes rather than follows a message. A preview can serve as an overall framework for the learning that lies ahead, helping the users get acquainted with these tasks (van der Meij & van der Meij, 2013) and vocabulary. Better transfer can be expected when students know names and behaviors of system components (Mayer & Moreno, 2003).

Guideline 6.3 – Use highlighting to signal screen objects or location.

Contextual cues, arrows, mouse clicks or highlighting one object in the software support user accomplish task. According to the multimedia *signaling* principle (Mayer, 2002), students learn better when instruction is signalled rather than non-signalled. When objects are highlighted on the screen, learner allocates attention to relevant material, thereby reducing working memory load on essential information (Mayer, 2002).

2.3.2. Instructional design to support learning performance.

To support learning performance, tutorials must instruct the user so that he can acquire the capability to perform trained and related tasks independently (van der Meij et al., 2017). To retain information, the user engages in an information acquisition process (*figure 1*), i.e.: selects relevant information, monitors its acquisition in working memory, organizes, and integrates in the long-term memory. To (re)produce what has been learned, the user must be able to recall or reconstruct the solution steps and monitor their correct execution (Bandura, 1986, in van der Meij et al., 2017). Acquiring procedural knowledge from static display will activate declarative memory, while from dynamic display – procedural memory outputs. However, the design guidelines should support cognitive learning goals and not the medium through which it's displayed. As this said, some particular design guidelines can be applied to support issues due to animated displays interactivity. The following instructional design guidelines, proposed by van der Meij & van der Meij (2013), support learning performance for both media formats: make tasks clear and simple (Guideline 6); keep videos short (Guideline 7); strengthen demonstration with practice (Guideline 8).

Guideline 6 – Make tasks clear and simple

As mentioned earlier, when viewing "how to" tutorial, the learner wants to know how to accomplish a task, and for this, he needs a simple and clear instructions. Bethke et al. (1981, in (van der Meij & van der Meij, 2013), propose that simplicity can be realized by using a vocabulary that suits the audience and by keeping the instructions for task accomplishment within the limits of the users' cognitive capacities. Designing tutorial with information, related directly with content, avoids cognitive overload of both visual & auditory channels. This guideline is in line with Mayer's (2002) multimedia *coherence principle* that states that all extraneous materials (irrelevant words, pictures, sounds) should be excluded to allow user to focus only on the relevant information.

Guideline 7 – Keep videos short

The transitory nature of videos can make it hard for the user to perceive them accurately and comprehend their content (van der Meij & van der Meij, 2013). As the learner processes information through visual and auditory channels at the same time, the length, pace and essential content of animated displays are important parameters to consider. Hence, the recommendation is to keep videos as short as possible: between 3 to 5 minutes for the total length of tutorial, and between 15 to 60 seconds for a sub-goal demonstration (van der Meij & van der Meij, 2013). This is ideal for keeping the user attention and engagement. In order to avoid overloading learner's working memory, it is recommended to introduce pauses, and segment tutorial in meaningful sub-sections (van der Meij & van der Meij, 2013).
Mayer's (2002) *segmentation principle* states that students understand better when it is presented in learner controlled segments rather than as a continuous presentation. This principal was grounded by multiple empirical research evidence (Zacks et al., 2007, in van der Meij & van der Meij, 2013). By segmenting videos with visible signs, like labels, contextual cues, enhance learner retain information and help construct mental model of entire procedure (Biard et al., 2017).

Guideline 8 - Strengthen demonstration with practice.

We learn by doing. Indeed, by applying knowledge practically, we control that new information was really retained, processed in working memory, and can be retrieved from long-term memory. To replicate the same or similar procedure, we activate inference inputs from procedural memory. To transfer knowledge, user permanently controls acquired information with the practice to accomplish.

2.4 Studies comparing static and animated display for procedural learning

Literature reviews on studies comparing animated and static visualizations report inconclusive findings regarding the effect of animation on learning (Betrancourt & Tversky, 2000; Hegarty, Kriz, & Cate, 2003; Moreno & Mayer, 2007; Schneider, 2007; Tversky, Bauer-Morrison, & Betrancourt, 2002, in Berney & Bétrancourt, 2016). The explanation comes from various factors: on one hand - speculative and rarely based on objective data (Berney & Bétrancourt, 2016), on the other – frequently, two conditions convey unequal amount of information, or non-equivalent procedures used in the conditions (Betrancourt & Tversky, 2000). E.g., dynamic display with narration and static without; not the same amount of procedure steps; pictures presented unequally, etc.

One of the studies comparing onscreen static tutorial with dynamic equivalent was done by Palmiter & Elkerton (1993). 16 participants in each of three conditions learned 18 programming tasks on how to use a Hypercard. There were animated demonstration group, text-only, and mixed - text and demonstration - group. Their learning performance was evaluated before, immediately after the training and 7 days later. The outcome of acquisition, retention and transfer tests showed that participants from animated demonstration group performed significantly faster and more accurate training performance than those reading instructions; and there was no significant difference found in performance between animated demonstration and mixed groups in the retention test after training. The results reversed 1 week later for text-only group, which participants performed faster and more accurate on retention and transfer tasks. Palmiter et al. qualified these outcomes to mimicry. That is, the video demonstrations may have induced superficial processing, with users more easily falling into the trap of an illusion of understanding (van der Meij & van der Meij, 2014).

Mayer, Hegarty, Mayer, & Campbell (2005) conducted 4 experiments, where college students received a lesson consisting of computer-based animation and narration or a lesson consisting of paper-based static diagrams and text. Each experiment had a different subject to be treated (e.g. how a toilet tank works, how ocean waves work), but the experimental conditions were equivalent in content. Out of 4 experiments, the learning performance (1 retention test question and 4 transfer test questions) results of paper-group yielded better results in 4 out of 8 tests and the was no significant difference for the rest. Researchers thinks that this study suggests only that when computer-based animations are used in instruction, learners may need some assistance in how to process these animations.

Höffler & Leutner (2007) meta-analysis of 26 studies from 1993 to 2004 comparing effects of animations versus static pictures revealed medium-sized overall advantage of instructional animations over static pictures. However, only animations that have a representational rather than decorational instructional function has real advantage on learning outcomes (mean weighted effect size of d = 0.40 versus d = -0.05). Animations are especially useful when the motion is depicted in the animation and it is the content to be learned; for procedural-motor knowledge rather than problem-solving knowledge or declarative knowledge is requested; when animation is highly realistic (e.g. video-based).

Arguel & Jamet (2009) conducted an experiment to investigate the impact on learning performance of presenting both – a video recording and a series of static pictures. They compared 3 conditions: video shown alone, static picture displayed alone and video plus static pictures. Participants were given 6min to view 5 videos on “saving gestures” and only once each video. Same time allocated for 2 other conditions. A paper-based 10 questions questionnaire was given right after the tutorials to evaluate information acquisition and retention. The results showed best performance for the mixed condition – static pictures shown along with video – group. The findings support *segmentation* principle and event cognition theory, where learners understand better when it is presented in learner controlled segments rather than as a continuous presentation (Mayer, 2005).

Ayres, Marcus, Chan, & Qian (2009) in two experiments students were taught to tie knots or complete puzzle rings either through an animated presentation or an equivalent sequence of static diagrams. Both experiments had similar procedures: 36 participants were presented to respective conditions on computer screen. Video condition was non-interactive, while participants controlled static. Total study time was a double of total video length (420s). After learning, participants were asked to execute tasks. The results showed that in both experiments students learnt more from the animation mode than the static one. Animations can be effective, even if transitory, provided they are realistic and teaching human motor skills. The results do not of course prove that the mirror-neuron system has led to more learning in the animated mode but lends some support to this hypothesis.

Berney & Bétrancourt (2016) meta-analysis investigated whether animation is beneficial overall for learning compared to static graphics, while also identifying moderator factors affecting the global effect. It comprised studies published until December 2013 comparing animated versus static graphic displays of dynamic phenomena. Out of 140 pair-wise comparison showed that animation were superior over static graphic displays in 43 comparisons, whereas 14 were in favour of static illustrations, and 83 showed no significant difference was found. Additional moderator analyses indicated higher performance when the animation was system-paced (not controlled by users); when verbal information was conveyed through the auditory mode; when the instruction did not include any accompanying text. These findings, as researchers' note, are surprising and not consistent with other research findings.

Biard et al. (2017) studied the importance of video segmentation in multimedia learning. 68 students were divided into three groups: noninteractive video, interactive video (with learner-paced control), and segmented interactive video (interactive video with system-paced interruptions). Participants took part in the study during their real-life course on orthotics and could watch video only once, on "How to make hand orthoses". After that, learners completed procedural learning test, then the recall test. The results showed the superiority of the segmented format for procedural learning, but no significant difference between conditions for recall test. Similar to Berney & Bétrancourt (2016) meta-analysis findings, users made very little use of the pause button when it was available. Biard et al. highlights the importance of system-paced animations and not controlled by users. Using segmented instructional videos was already acknowledge by multimedia researchers as having positive effect on memory and cognitive load.

van der Meij & van der Meij (2014) compared paper-based and video tutorials for software learning. They have divided sixth grade participants into 4 groups: Paper-based, Mixed A (paper-based preview and video procedure), Mixed B (video preview and paper-based procedure), and Video. Participants were taught some instruction about Word formatting options. The procedure consisted of pre-test and IEMQ questionnaire before training, 1 day later training session (50min) all conditions and post-test (20min) after 10min break. The results show “paper-based" group completed training tasks with 63% of success while "video-based" group 87% during the training. In the post-test, "video-based" group did significantly better than "paper-based". Mean success rate of 73% for video group compared to the starting level of 24%. The success of video & mixed conditions over paper-based was qualified to the use of design guidelines for software training that direct the designer to optimize video's strong qualities and moderate or reduce its relative weaknesses.

These studies with varying results and perspectives show that in the multimedia learning and animation the question of using videos or static displays for procedural learning is not finally responded. However, the trend is positive towards video usage for dynamic motion system representation, procedural-motor knowledge acquisition and with system integrated segmentation (not user controlled).

2.5 Meaningful learning outcomes measure

A good instructional design helps achieve a *meaningful learning* (Mayer, 2002). Meaningful learning is indicated by good retention and transfer performance, where the learning outcomes depend on the *cognitive activity* of the learner during learning rather than on the learner's *behavioral* activity during learning. (Mayer, 2002).

When learning, we acquire knowledge, skills, and/or attitudes. *Knowledge* acquisition as a specific goal of learning is associated with comprehension of cause-and-effect explanations in multimedia literature (Berney & Bétrancourt, 2016) and is typically done in sentences (in vocal or written speech) (Gagné & White, 1978). Having “knowledge” means the ability to assert in sentence, given learning input. *Skills* acquisition is interlinked with knowledge. The ability to do something (e.g. to state the information, to accomplish task following a set of rules, to move ourselves) will require to know “what” to do. Therefore, having “skills” will refer to the knowledge of “how” execution of a rule or strategy. Finally, *attitudes* are learner behaviors (e.g. motivation to learn) that are influenced by personal experience and outside stimuli (Gagné & White, 1978). Knowledge and skills can be measured and observed by major categories of learning performance - retention and transfer of learning. (Gagné & White, 1978).

While retention is associated to the comprehension of “what” was just learned, training transfer generally refers to the use of “how” trained knowledge and skill back on the job (Burke & Hutchins, 2007). The retention of knowledge is often assessed by means of fill-in questions, or by multiple-choice questions (Gagné & White, 1978; Solaz Portolés & Sanjosé López, 2008). To measure procedural knowledge, practical performance assessments are needed (Ruiz-Primo & Shavelson, 1996b, in Solaz Portolés & Sanjosé López, 2008). Procedural learning will be considered meaningful if the person is able to accomplish practical task. By transferring acquired knowledge in a different situation, the learner shows he learnt.

Measuring student's engagement through motivation, perceived learning difficulty and perceived learning effort will help understand learners attitude. Motivation is an indicator that could be defined as "an individual's willingness to return to an activity once external pressure to do so has ceased" (Rieber, 1991, in Bétrancourt & Tversky, 2000). Morain & Swarts (2012) discuss the factors that influence motivation to learn, and demonstrates 3 objectives related to narrator confidence, learner self-efficacy, engaging video design. A good video is determined when narrator deliver message in conversation tone, with self-confidence, shows he is knowledgeable and inspires self-efficacy. Narrator's voice over and actions are well coordinated and scripted. He builds expectations and fulfils promises. Further, the production of quality of the video is high (i.e. software used to create video, audio, text and transitions are used skilfully). When narration is not present, learners' motivation can also depend on the moderators such as general consistent structure, video accessibility, length, task relevance (van der Meij & van der Meij, 2013) as well as system-based pausing (Biard et al., 2017) that overall reduce information processing, enhances learners' confidence to accomplish task and ultimately increases motivation.

The theoretical support from experimental studies showed varying results on the learning performance studying with dynamic or static display tutorials. The study conducted by Mayer et al. (2005) yielded in significant results for static tutorial group on retention and transfer tests. Palmiter and Elkerton (1993) favored paper-based tutorial only in the performance test at one-week delay. However, Höffler & Leutner (2007), Berney & Bétrancourt (2016), Ayres et al. (2009), Arguel & Jamet, (2009) studies favored animated display tutorial. The objectives of these researches were different, some repeating reflections came-out supporting dynamic display. In short, a video tutorial shows motion, micro-steps that help reduce the computational difficulty of mentally processing temporal ideas; and that static display would need complex graphical devices to convey change over time (Bétrancourt & Tversky, 2000). An appropriate multimedia design (system-paced control to reduce transient nature, accessibility, and guidance to keep user motivated, etc.) aimed to reduce extraneous cognitive load and increase learning performance. The arguments presented for static display advocates in favor of event cognition, that states - learners should construct an internal representation composed in several discrete steps rather than in a smooth and continuous manner (Newtson, 1973; Zacks, Tversky, & Iyer, 2001, in Arguel & Jamet, 2009). The scientific evidence above gives us a solid background to design an experimental research and evaluate it.

3. Experimental design and research questions

The objective of our study was to further assess the effectiveness of dynamic procedural instruction compared to static equivalent for software learning. To achieve our study objective, two experimental conditions were developed: dynamic procedural instructions and static guidelines for instructional material that was tested and evaluated by 30 adults.

The instructional design of our two materials was elaborated by ourselves based on the recommended guidelines for software learning. The baseline was to create meaningful tutorial, that integrates only particular instructional design guidelines and support cognitive learning. The aim is that after processing the videos the users should be capable of completing retention and transfer (post-test and practical tasks) without the need for help (van der Meij & van der Meij, 2013).

Research question 1. How well dynamic procedural instruction support learning performance compared to static equivalent? We think that the group of learners with dynamic procedural instructions will report higher performance on retention & transfer tests as measures of learning performance. Earlier studies, conducted by van der Meij & van der Meij (2014) and van der Meij & Brar (2017), Biard et al., (2017) showed enhanced learning for animated display condition compared to the static. System-paced animations (pausing), video length, segmentation as well as anchoring task in the user task domain were moderators leading participants for good performance. Höffler & Leutner (2007) in meta-analysis provides evidence favoring video tutorial when it has representational rather than decorational instructional function.

Research question 2. What will be learners' engagement scores? We assume that learners will find less difficulty to learn and put less effort to acquire new information and therefore be more motivated studying video tutorial compared to static. Motivation, perceived difficulty, and perceived effort were measures to analyze learners level of engagement. In the recent study conducted by van der Meij (2017), motivation was integrated through the affective and cognitive design principles (van der Meij, 2017): user accessibility, consistent structure, a preview of task, promoting end goal as well as explaining from simple to complex.

Research question 3. Will be there a difference in completion time of the study? We hypothesized that dynamic group will be quicker to complete the training and tests. In Palmiter's and Elkerton's (1993) study, demonstration group were significantly faster and more accurate in training performance than the static group participants in the immediate performance evaluation.

4. Method

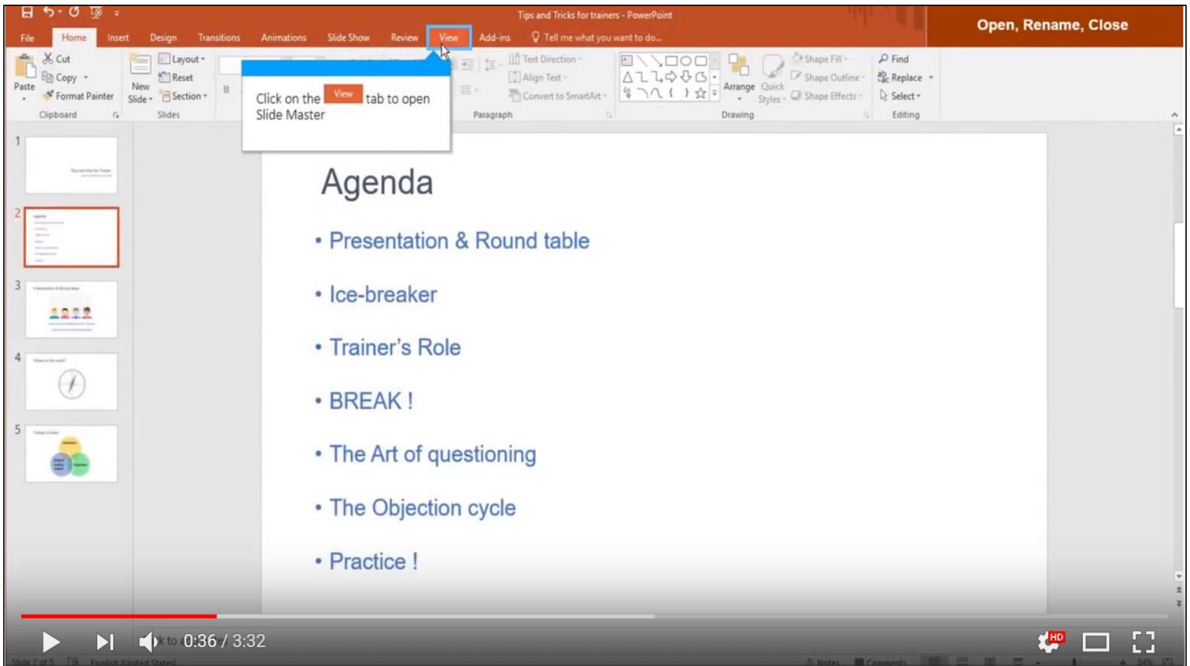
4.1 Participants

The target audience of our study were adults acquainted working with computer and Microsoft office, PowerPoint software. 19 females and 11 males, mean age M=38. The participants should know the basic commands of PowerPoint but not being experts in the field. A pre-selection questionnaire was introduced to recruit the right audience. Participants were assessed for their competence in working with PowerPoint, prior knowledge in Slide Master and their level of English. The participants were recruited from various environments: university (classmates), work (colleagues) and from personal relationships (friends and acquaintance). Random distribution formed 2 experimental groups.

4.2 Instructional materials

Tutorials

We have developed a tutorial about PowerPoint feature Slide Master using Active presenter (7.0) and WBS Instant Producer. The main goal of the tutorial is to learn how to prepare personalized Slide Master and Slide Layout (figure 3). Structurally, the tutorial is split in 4 units with 8 steps per unit in average. Static guidelines as well as video instructions have first three introductory (title, brief context, learning goals) and last concluding (review of what was learnt) slides.



Creating Powerpoint Slide Master

Figure 3 – Video condition

For the development of both conditions, we followed the procedural learning instructional design features as referenced in chapter 2.3. It's necessary to mention that first we developed video condition and then converted it to the static equivalent.

Video instructional tutorial

The total length of 3min 32s video recording was created to reflect the real software application. Some specific design features were considered when designing video condition.

Hanging contextual instruction (figure 4) - was introduced to support two multimedia principles:

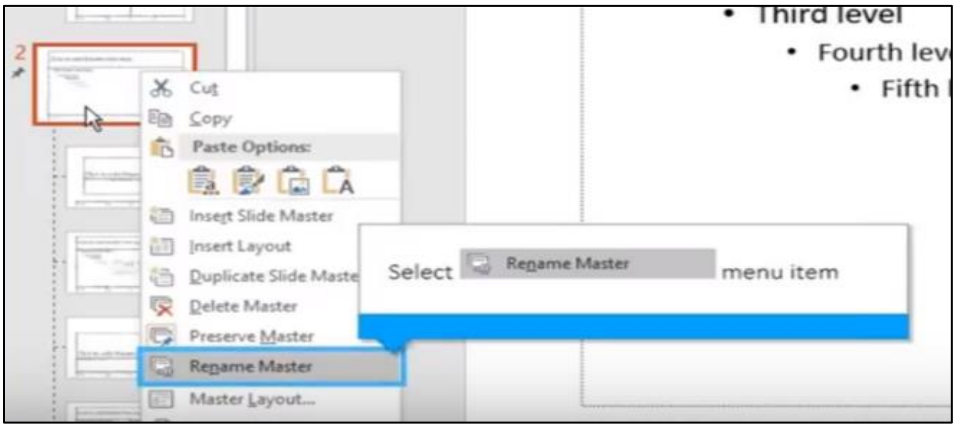


Figure 4 – Hanging contextual instruction

- *Spatial contiguity principle* that states that students learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen (Mayer, 2002).
- *Temporal contiguity principle* that states that if words and pictures presented simultaneously it helps keep mental representations in working memory at the same time, thus learners are able to build mental connections (Mayer, 2002).

Also, to avoid visual channel cognitive overload (Mayer's (2002) *redundancy* principle), and to support experimental conditions equivalence we **excluded narration** from video tutorial.

Labels were introduced to separate the 4 units (figure 5) of the tutorial.

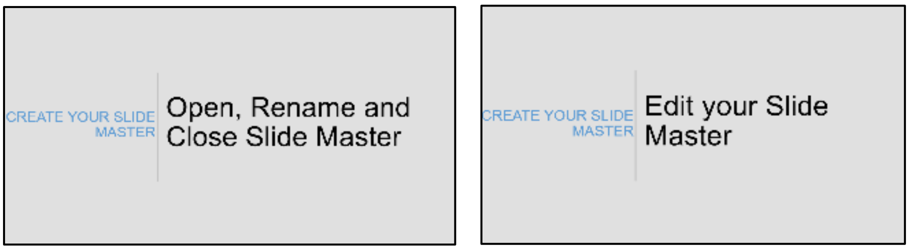


Figure 5 - Labels

It is a complimentary design feature that helps avoid working memory overload due to the transient nature of animated displays. It's in line with Mayer's (2005) *segmentation* principle of multimedia design - learners understand better when it is presented in learner-controlled segments rather than as a continuous presentation. But also, the empirical research indicates that even short pauses of 2 seconds may suffice to benefit the user (Spanjers, Wouters, et al., 2010, in van der Meij & van der Meij, 2013). Biard et al. (2017) study favors system-based pacing that we selected for the design of video tutorial.

Static guidelines tutorial

We have developed an equivalent static display tutorial to support the research. A 40 slides PowerPoint presentation with screen captures and all above mentioned objects were replicated. However, the "hanging contextual instructions" were replaced by **squared signaling objects** (figure 6) with guiding text that slightly moved to the top

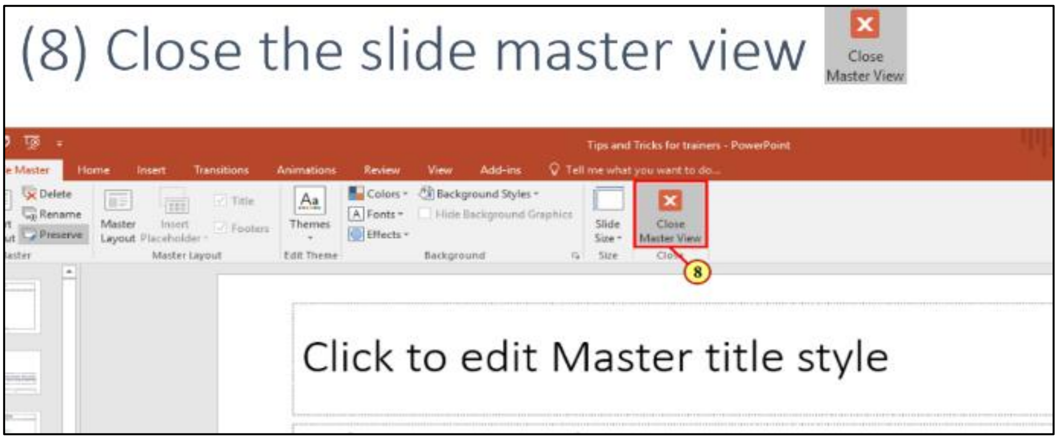


Figure 6 – squared signalling objects

of the presentation screen. We followed the same procedural design recommendations that are described in the chapter 2.3.

The specific static design feature – full screen captures rather than partial – were considered for this experimental condition. The scientific recommendation is to present a series of full rather than partial screen captures, because it animates the interface changes during task execution (van der Meij and Gellevij, 1998, in van der Meij & van der Meij, 2013). As per event cognition theory (Zacks & Swallow, 2007), learners constructs mental representations in the series of discrete events and not continuous.

Learning Performance – Retention (Retention test)

The Post-test was designed with 5 open questions that are identical to the just learned content and was meant to test retention (declarative knowledge). Along with questions, a screen capture was added to visualize the question (e.g. What is the Slide Master? Why would you need to rename your Slide Master? Please list at least 3 objects that you can add with "Insert Placeholder"; In which menu tab, you can find your customized Slide Master?). Learners were not limited in time to respond to the questions, however a guidance was given – one minute per question.
The results were evaluated manually using three-point system: 0 - 0.5 - 1 point. Where 1 point was given for a good answer. A maximum of 5 points could be obtained.

Learning Performance – Transfer (Practical Task)

The instructions to accomplish practical task, were designed as *identical* and *similar* to the learned content. A temple presentation on the PowerPoint was available to download after the Post-Test on Qualtrics. To facilitate the task execution, we have prepared an on-hand paper support with listed 11 steps and made it available upon learner was opening the file.
The results were evaluated manually: each step from 0 - 0.5 - 1. Where 1 point was given to correctly accomplished task. We didn't count the step 1 (Download and Open PowerPoint presentation as it was not part of the learned skills. A maximum of 10 points could be obtained for a practical task.

Engagement survey – Learning appreciation and Cognitive load

10 questions survey was adapted from Huang (2017) & Olinda and al., (2006) to collect user's engagement level on the 6-point Likert scale from "Strongly agree" to "Strongly Disagree". This survey was the wrapping part of the experiment.
The results were coded in the SPSS to separate the measures: motivation, perceived difficulty, perceived effort.

The three measures were evaluated:

- Motivation (4 questions) } learning appreciation
- Perceived difficulty (3 questions)
- Perceived effort (3 questions) } cognitive load

Memory game

As we measured learning outcomes right after the tutorials, we have introduced a memory game online (link: http://www.webgamesonline.com/memory/index.php) as an interfering task. One of the limitations that Palmiter et Elkerton (1993) found in their study is that students mimicry the demonstrated procedures. Therefore, we would like to avoid learner's mirroring what they have seen in the tutorials, but rather gather real learning performance.

4.3 Measurement instruments

Within this experimental research our 3 dependable variables are as follows:

- Study Time. The total time of experiment (studying, post-test and practice) was measured to evaluate if one condition had advantages compared to another.
- Learning performance (Cognitive Ability)
  - *Retention,* or learner's ability to show declarative knowledge acquisition through response to open question.
  - *Transfer,* or learner's ability to show procedural knowledge acquisition through application of just learned information in practical context.
- Engagement and cognitive load through learner's motivation, perceived difficulty and perceived effort as measures.

4.4 Procedure

Before the experiment

We have pre-selected participants based on the 3-point criteria: 1) good knowledge and usage of PowerPoint, 2) new to Slide Master, 3) good knowledge of English (B2). This way we could ensure that we can expect demonstration of the learning performance from the target audience. For this pre-selection, we have created survey (see annexes 4. Experimental study materials).
We considered only those participants with B2 or higher level in English, who were between beginners and intermediate (Q2 correct answer: a) b) c)) and who were not using it frequently or rarely (Q3 correct answer c) d)). The goal is to prevent experts to pass the experiment.

During the experiment

The experiment with preselected participants took place in a quite environment at Geneva University, at our home place or in the conference rooms at library depending on people's availability.
We have briefly explained about the experiment length, data protection and benefits to participants without explaining what precisely will be given. We have prepared the whole experiment using Qualtrics survey solution. Participants were randomly assigned to one of the experimental conditions, followed by the same set of 5 open retention test questions and 10 steps of Practical (transfer) tasks. At the beginning, learners were given time to read the information about the research and acknowledge the consent form.
During the experiment, we have measured the total study time using automated chronometer functionality embedded in Qualtrics. The experiment concluded with learners engagement evaluation (Huang, 2017; Olinda et al., 2006) that will measure cognitive load (perceived effort and difficulty) and interest (motivation).
In summary, each condition group will watch/read tutorial embedded in Qualtrics.

i. Recommendation was given to watch/read twice within approximatively 7min for procedural tutorial but learners were not limited to stop watching/reading after 7min.
ii. Then, participants played an online memory game for 2-3min or as soon as they complete it they could carry on.
iii. After the memory game completion, learners did a retention post-test (5 open questions);
iv. And procedural task execution - creation of the Slide Master following 10 procedural steps.
v. The experiment was wrapped-up with the 10-item questionnaire to evaluate learner's attitude and engagement.

After the experiment

We have debriefed the experiment with participants by recording their feedback as audio recording and thanked for their participation.

5. Results

5.1 Study Time data

The assumption of normality was evaluated using histograms (figure 7) and means of both experimental conditions (figure 8). This analysis showed the average study duration of both experimental conditions was 29 min (M=28.97, SD=6.39).

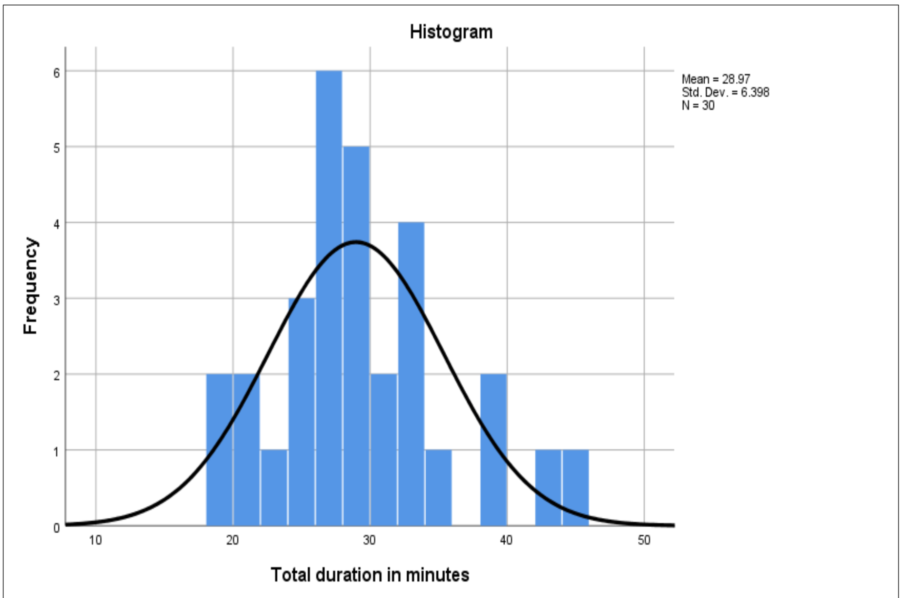


Figure 7 - Total study time for both experimental condition

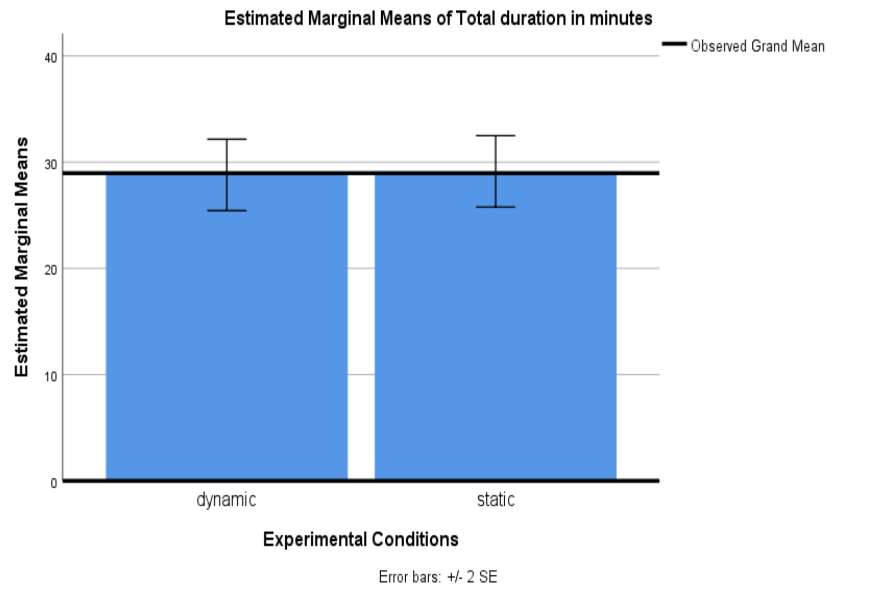


Figure 8 – Total study time per experimental condition

ANOVA analysis was conducted with total Study time of experiment as dependent variable (DV – Study time) and Experimental condition with 2 factors independent variable (IV – Static group; IV – Dynamic group). The analysis showed that, contrary to the hypothesis, the effect of the Experimental condition is not significant, $F(1,28) = .020$, $MSE = .833$, $p = .889$ ($p < .05$) (see annexes 1.1).

The results show that users, in static tutorial display, showed in average almost the same performance time as dynamic, i.e., for dynamic experimental condition - M=28.80, SD=7.60; for static experimental condition M=29.13, SD=5.18. Some learners despite the groups could finish tests in less than 20 min (min=19min). However, two learners from dynamic tutorial condition took more than 40min to complete the entire experiment (see annexes 1.2).

5.2 Performance tests scores – retention and transfer

The assumption of normality was evaluated using histograms (figure 9, 10) and mean score of retention (retention test) and transfer (practical task) measures (figure 11, 12). This analysis showed the mean score of retention M=3.67, SD=1.053 and mean score for transfer (practical task) measure M=8.28, SD=2.12 for both experimental conditions. The frequency of distribution of performance scores per experimental condition is slightly different but not significant (see annexes 2.1).

Transfer: dynamic group M=8.73, SD=2.25; static M=7.83, SD=1.95.

Retention: dynamic group M=3.83, SD = .97; static M=3.5 SD=1.13.

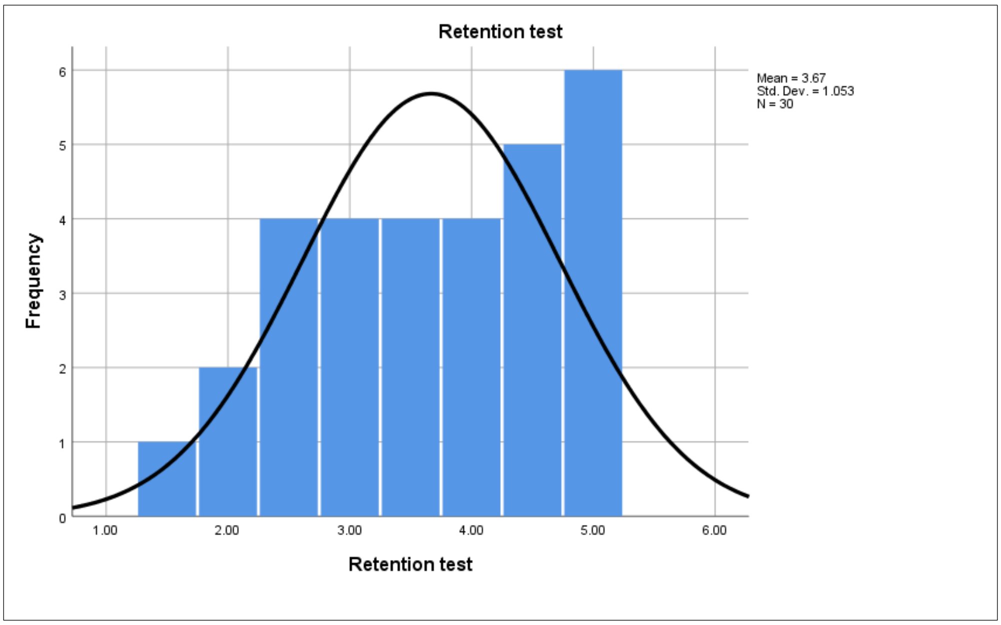


Figure 9 – Histogram scores to retention measure (Retention test)

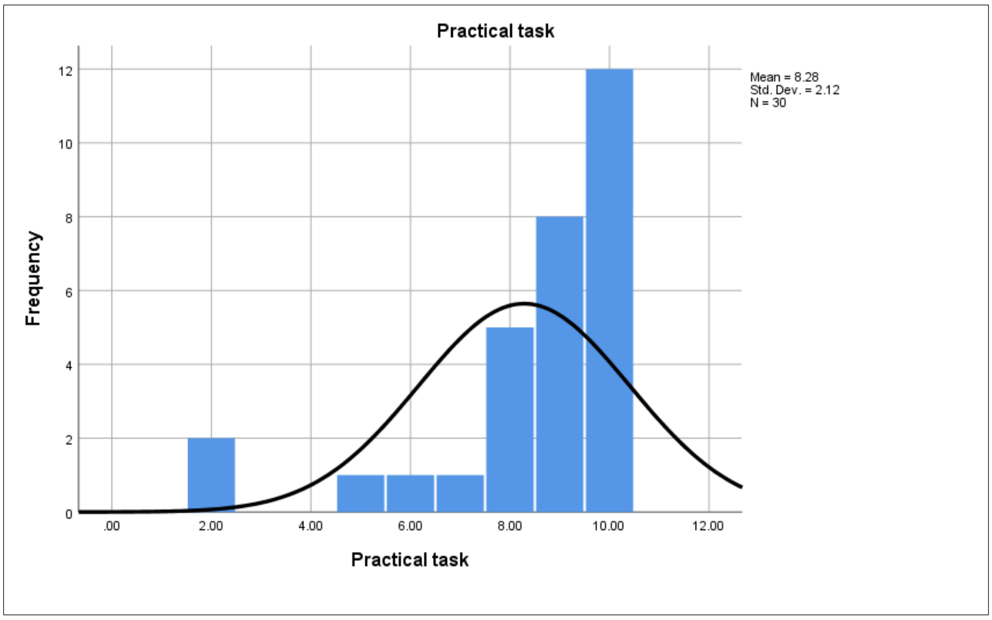


Figure 10 - Histogram scores to transfer measure (Practical task)

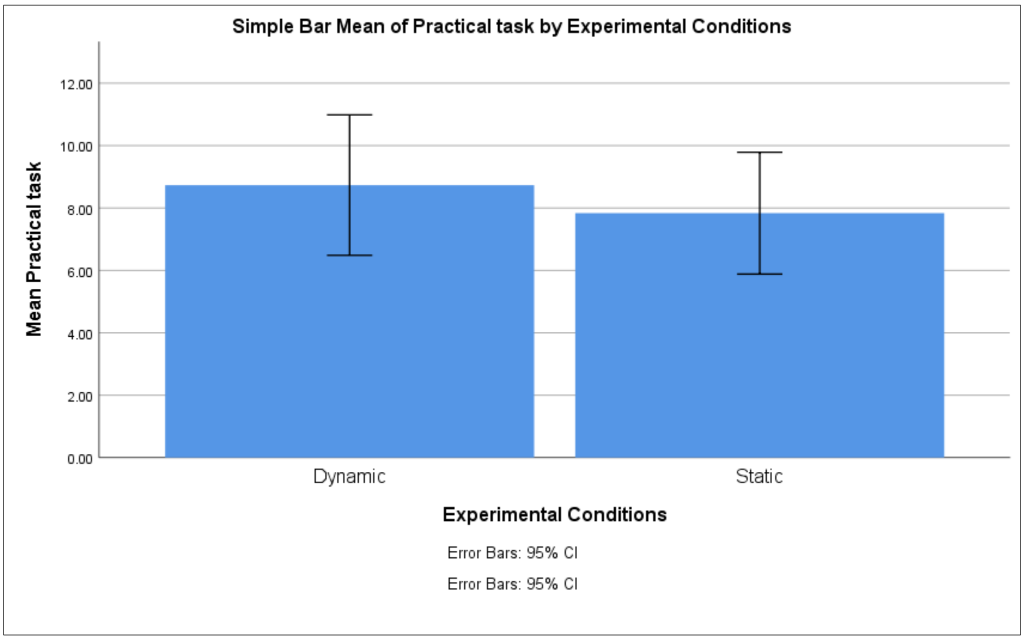


Figure 11 – Mean scores for transfer measure

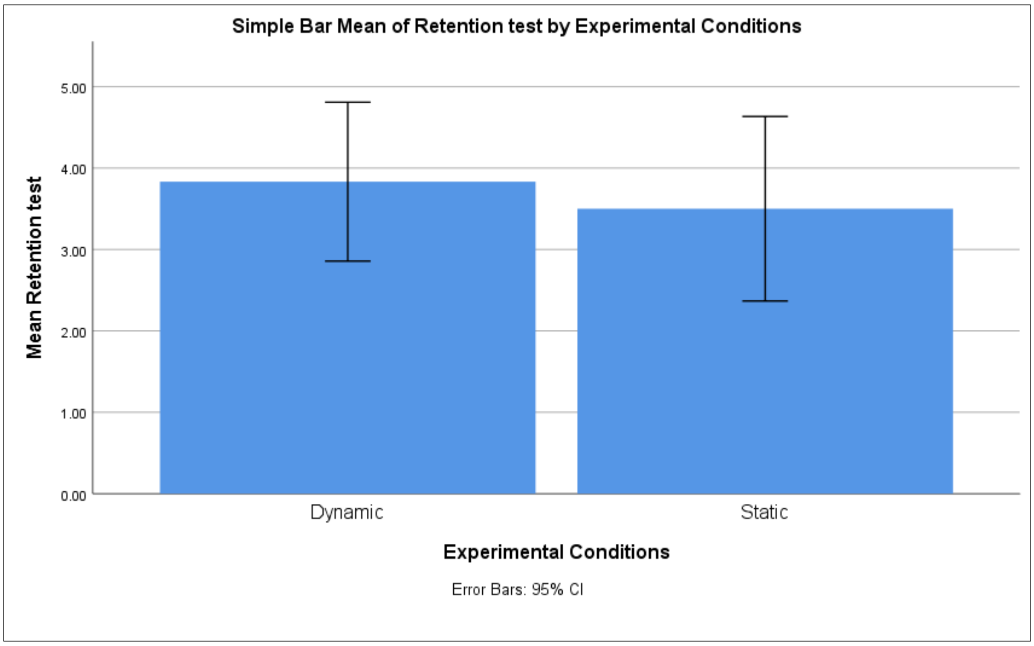


Figure 12 - Mean scores for retention measure

MANOVA analysis was conducted to measure learning performance through retention and transfer as 2 dependent variables (DV-Retention test scores, and DV-Practical task scores) and 2 experimental condition with two factors as independent variables (IV – Static display; IV – Dynamic display). The analysis showed that, contrary to the assumptions, the effect of the experimental condition is not significant:
Effect of Performance factor - $F(1,28) = 130.270$, $MSE = 319.704$, $p < .0001$;
Effect of Experimental condition - $F(1,28) = .491$, $MSE = 1.204$ $p = .489$. (see annexes 2.5).

Effect of interaction of performance and experimental condition not significant F (1,28) = .491 p= .489 (see annexes 2.6).

5.3 Engagement – Motivation, Perceived effort and Perceived difficulty

The assumption of normality was evaluated using histograms (figures 13,14, 15) and means scores of 3 measures for engagement. From the histograms below and descriptive results (see annexes 3.1) we see that mean score for Motivation is M=8.13 (SD=2.97; min=4; max=15); Perceived difficulty mean M=11.17 (SD=3.05; min=5; max=16); Perceived effort mean M=5.73 (SD=2.19; min=3; max=12). Motivation histogram has normal distribution, while Perceived difficulty has less regular. Perceived effort histogram shows trend of distribution on the left side.

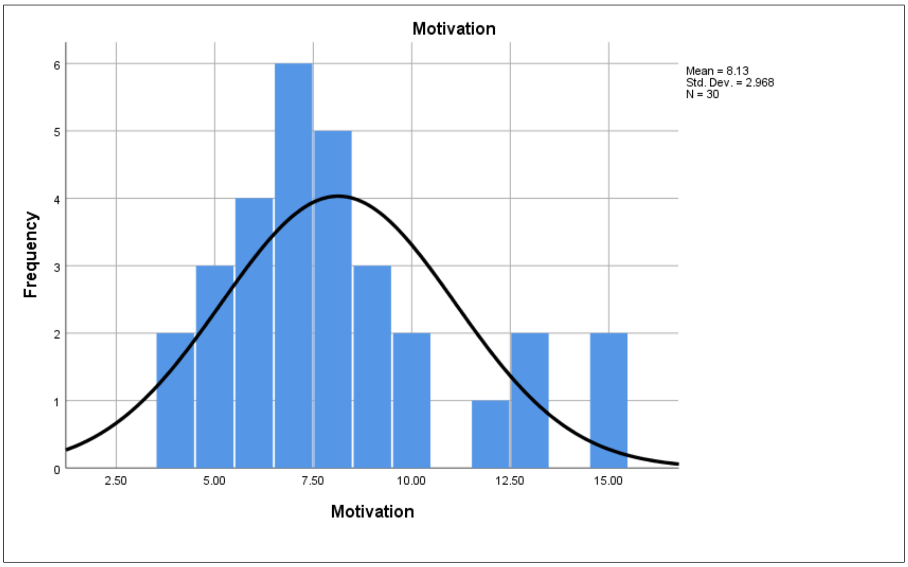


Figure 13 – Histogram of Motivation

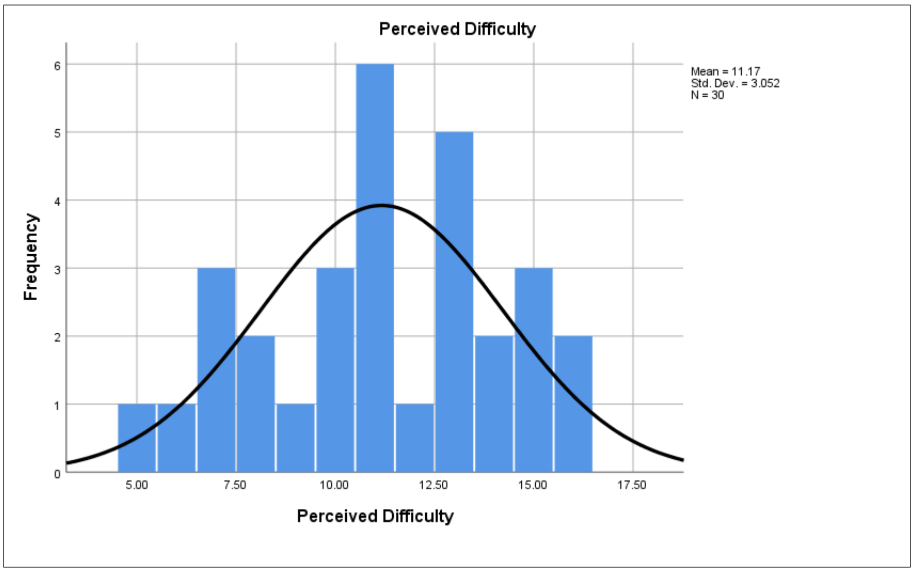


Figure 14 – Histogram of Perceived difficulty

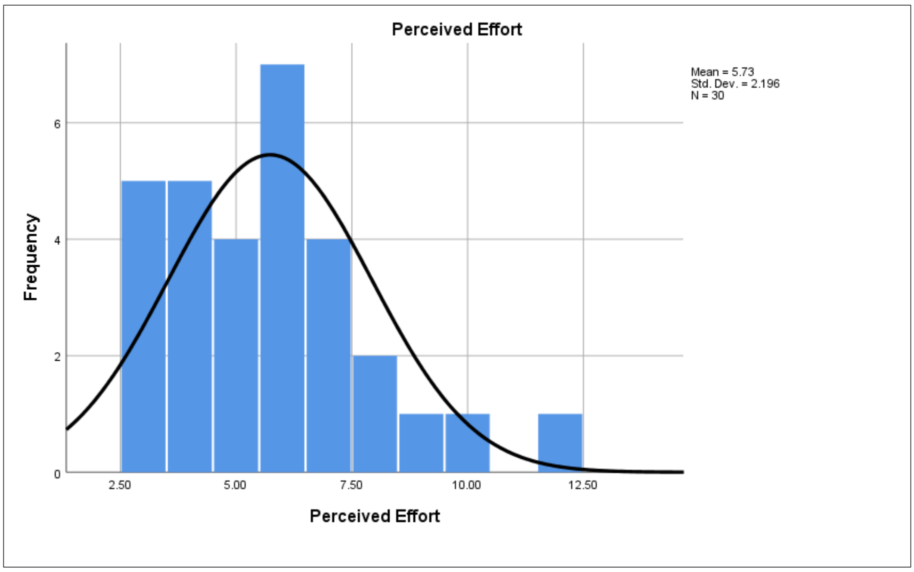


Figure 15 – Histogram of Perceived Effort

The below mean graphs (figure 16, 17, 18) the results shows the comparison between the measures (Motivation, Perceived difficulty, Perceived effort).

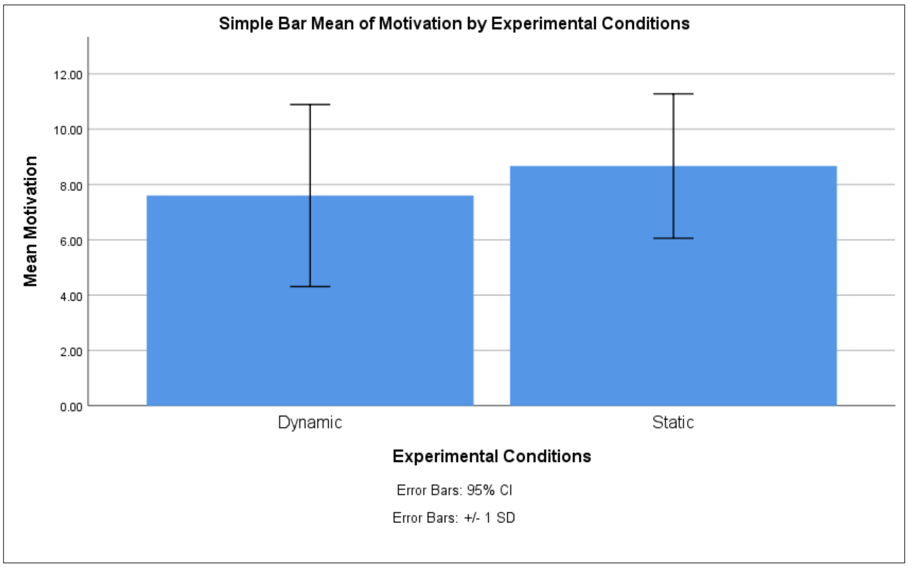


Figure 16 – Means of Motivation measure.

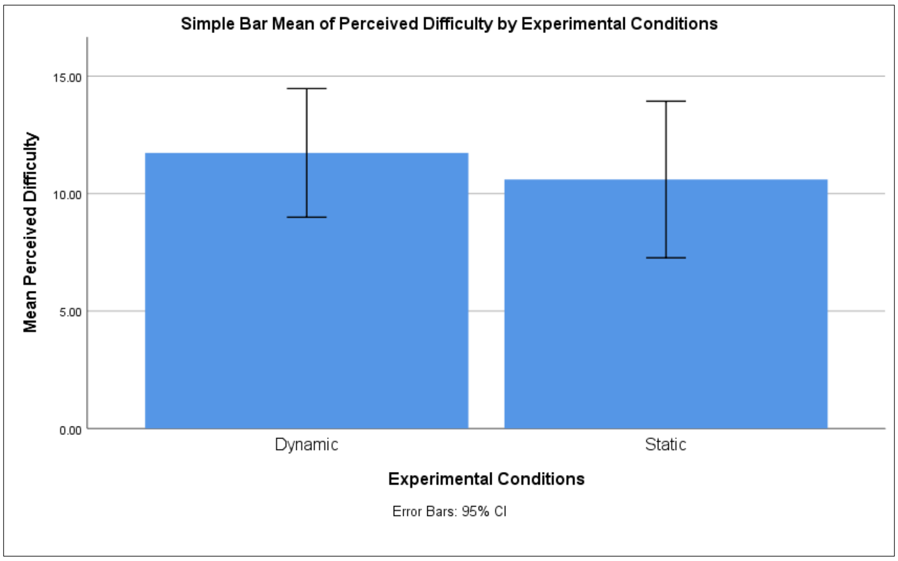


Figure 17 – Mean of perceived difficulty measure

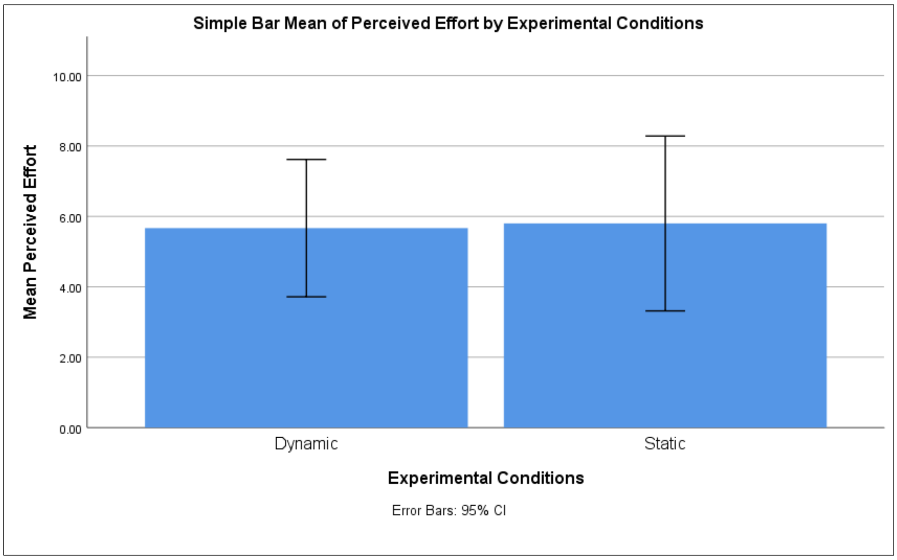


Figure 18 – Mean of Perceived effort measure

MANOVA (multivariate) analysis was conducted with three factor learner Engagement scores as dependent variables (DV – Motivation; DV – Perceived difficulty; DV – Perceived effort) and Experimental condition with 2 factors independent variable (IV – Static display; IV – Dynamic display). The analysis shows that, contrary to the assumption, the effect of the Experimental condition is not significant (see annexes 3.2.): Motivation – $F(1,28) = .968$, $MSE=8.533$, $p= .334$ ($p > 0.05$ non-significant); Perceived difficulty - $F(1,28) = 1.035$, $MSE=9.633$, $p= .318$ ($p > 0.05$ non-significant); Perceived effort – $F(1,28) = .027$, $MSE=.133$, $p= .871$ ($p > 0.05$ non-significant).

5.4 Summary of results

Study Time

There was no significant difference found in total study time per experimental condition. Even though the learners were told that the experiment will last approximately 30min, they were not limited from time perspective to complete tests earlier. These results

Learning Performance – retention and transfer

Learning performance was measured by retention test and transfer task scores and compared against experimental condition. Prior to SPSS analysis, a manual assessment was performed to evaluate each learner individually on both measures. A maximum score of 15 points was given to the learner who performed good retention (5 points) and good transfer (10 points) tests. As reflected in results, both – static and dynamic – groups almost all users successfully completed tests. Overall Mean success score was M=11.95, and only 2 out of 30 users (each in different condition group) didn't succeed to complete correctly and 3 users have got below the average of 12 points. Consequently, for 25 users, those results were above 12 points, could be stated the learning was effective.(Mayer, 2002).
Although statistically insignificant difference, still we would like to acknowledge the trend of scores on transfer task was lower for static condition group.

Engagement (Students Attitude) – Motivation, perceived effort and perceived difficulty

A students attitude survey, designed by (Huang, 2017; Olina et al., 2006), was set at the end of experiment to assess learner's engagement level. The three-dimensional factors were tested: Motivation, Perceived difficulty, and Perceived effort. **Motivation** results show Means score of M=8.13, that means that learners were not so much motivated to learn either experimental condition. A maximum of 15 was given by learners from each experimental group. However, this evaluation is still far to reach the total available score of 24 points, to state that learners were motivated to study. This attitude could be related to the second Engagement measure – Perceived difficulty. **Perceived difficulty** results show Mean score of M=11.17, which explain that both groups found difficulty to learn. There is a slight higher trend of perceived difficulty in dynamic experimental group (figure 17) that might also explain the decreasing trend of motivation in that group of learners. If learner was not motivated to learn, then he found difficult to accomplish tests. Motivation and perceived difficulty can be related to the personal effort that learner put to learn training material. **Perceived effort** results show Means score M=5.73. This score is very low, which is positive on one hand, because 25 users could successfully complete retention and transfer tests. But on the other hand, it suggests that learners in either group didn't put a lot of effort to learn.

Some explanations to these results could be given based on the debrief sessions with users after the experiment. Overall, learners were self-confident in learning new procedure on the software that they already know, thus they did not put a lot of effort to learn. Regardless the tutorial format, learners were also mentioning that the content was well structured and easy to understand. However, the fact that animated display was going rapidly, they needed to concentrate more and therefore had difficulty to acquire new information. In addition, some specific experimental design features, like 1) introducing memory game, 2) animated tutorial without narration, 3) watching tutorial without taking notes 4) not being able to replay tutorial when practical task was asked to apply were aspects, prevented to appreciate the experiment and provoked difficulty to learn. Some other observations from the experiment, was that learners in dynamic group could locate faster where the Slide Master is.

6. Discussion

Theoretical implications

The scientific evidence, provided in the theoretical support, shows inconsistent findings when it comes to prove one of the medium superiority on learning performance. It is not rare that the failure is due to the two conditions differ from each other because of an unequal amount of information conveyed by both displays, or non-equivalent procedures used in the conditions (Betrancourt & Tversky, 2000).
Our first assumption was that dynamic condition group of participants would complete study faster. The results revealed no significant advantage of experimental condition on study time. This is in line with Palmiter & Elkerton (1993) study but only with *delayed* test results, where they also found that paper-based group performed at the same time as animated group.
We could not validate our second hypothesis on learning performance either. Surprisingly procedural knowledge was developed regardless medium. Participants could complete tests successfully and apply just learnt information. This supports active learning assumption (Mayer, Hegarty, Mayer, & Campbell, 2005).
Our third hypothesis was not validated either. We also assumed that learners watching video tutorial will put less effort to learn, will find it less difficult to complete and thus will show higher motivation. However, there was no significant difference among condition. These results support only those studies that found no significant difference of performance like Tversky et al.,(2002) and Ertelt (2007).

Practical implications

On the practical side, these results suggest that a well-developed static training materials could be considered as good as video based materials for procedural knowledge acquisition. Both conditions followed good instructional design guidelines for software learning. Thus, a good structure allowed easy access, control over pace and segmentation in 4 units with labels might helped learners to complete post-test and practical task equally good. Also, participants in the debrief session noticed that tutorials were well structured. A well-designed series of still frames can be as good or better than animation in promoting learning (Mayer, Hegarty, Mayer, & Campbell, 2005).

Limitations & Perspectives

One of the limitation regarding retention. This study evaluated learning performance immediately after tutorial. However, Palmiter & Elkerton (1993) evaluated learners performance 7 days later and the results reversed favouring text-only group of participants who outperformed demonstration group compared with the initial tests. In the delayed tests both groups showed almost the same level of rapidity and accuracy to perform the tests. This study could be further taken to assess learning performance with one week of delay.

Another limitation – absence of narration to convey the message. It is a recommended affective design guideline (Morain & Swarts, 2012). Berney & Bétrancourt (2016) study moderator analysis results showed that animations were more effective when the verbal information was conveyed through the auditory mode. It is also one of the multimedia design principles – *personalisation* – to further increase user interest in the tasks that are demonstrated, the narration should be personal rather than formal (van der Meij & van der Meij, 2013). However, we excluded it for two reasons: 1) to avoid *redundancy* that could provoke cognitive overload; 2) to have both experimental conditions comparable.

7. Conclusion

It is often assumed that technology is so advanced and sophisticated now that it will inevitably lead to enhanced learning (Ayres et al., 2009). This experimental research shows that to develop procedural knowledge for software learning is equally good with well-designed static as with dynamic tutorial. Therefore, this study do not support either dynamic display assumption either static but it does not contradicts it. It is known that video-based tutorial with a real life images, conveying motion supports best modelling of knowledge (van der Meij & van der Meij, 2014). However, static visualizations affords easy access to the structure and the content at a glance, helps construct mental model because it represents in a series of discrete steps that enhance active learning processing (van der Meij & van der Meij, 2014).

Implications for the practice

Implication for the practice might be that participants did not put much effort to learn because they already knew PowerPoint as a software. Learners found it difficult because they might not have expected to learn something “new” on the software that they already know – expert effect (Mayer, 2005). Even though the procedural steps involved change over time, the complexity of procedural steps were not so difficult to understand without animation. Therefore, static condition obtained as good performance results as dynamic.

Future research

The video was recorded with a professional software capturing screen movements at the relatively fast pace. Although we have scientific evidence for the length of the video tutorial (max. 5-7min) and time in between the events (1-2min) (van der Meij & van der

Meij, 2013), there is no scientific evidence on what should be the optimal video pace (not too fast, not too slow), so that user cognition could assimilate information immediately. This is an issue for future research.
The importance of the preview (before/after) screen was assumed, based on the software training guidelines (van der Meij & van der Meij, 2013), to help learners construct conceptual knowledge, however, it was not tested. This is another issue for future research.

We hope our study could bring one more evidence to the multimedia learning and animations field of research with conclusion that well-designed dynamic and static displays can be beneficial to the procedural learning.

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9. Annexes

1. Study Time – statistical results

1.1. ANOVA (univariate) Test of Between-subjects effects

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
Total duration in minutes * Experimental Conditions	Between Groups	(Combined)	.833	1	.833	.020	.889
	Within Groups		1186.133	28	42.362		
	Total		1186.967	29			

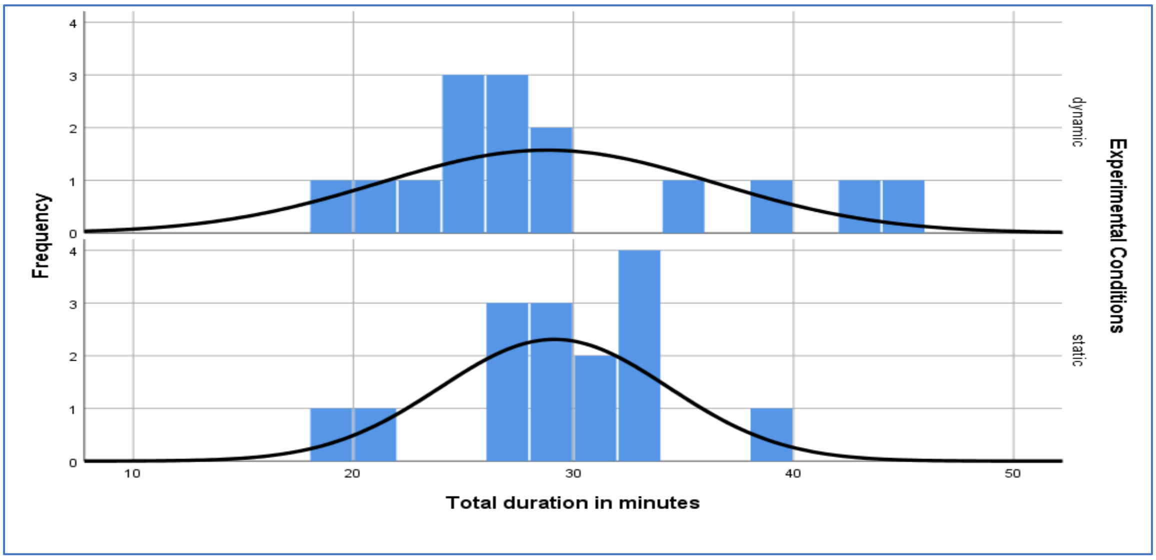
Tests of Between-Subjects Effects

Dependent Variable: Total duration in minutes

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.833[a]	1	.833	.020	.889	.001
Intercept	25172.033	1	25172.033	594.214	.000	.955
experimental_conditions	.833	1	.833	.020	.889	.001
Error	1186.133	28	42.362			
Total	26359.000	30				
Corrected Total	1186.967	29				

a. R Squared = .001 (Adjusted R Squared = -.035)

1.2. Histogram – Frequency of study time distribution per experimental condition



1.3. Univariate pairwise comparison – study time distribution per experimental condition

Pairwise Comparisons

Dependent Variable: Total duration in minutes

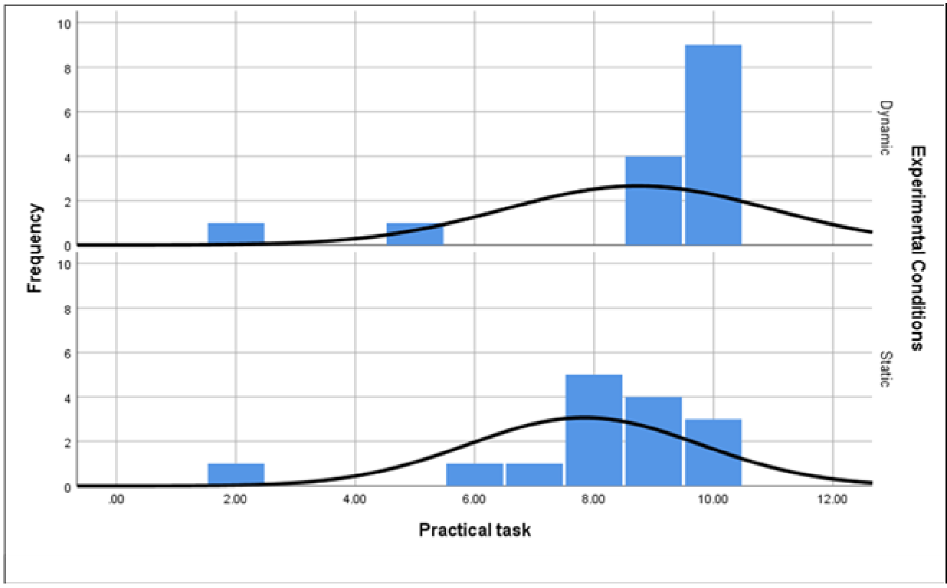
(I) Experimental Conditions	(J) Experimental Conditions	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Dynamic	Static	-.333	2.377	.889	-5.202	4.535
Static	Dynamic	.333	2.377	.889	-4.535	5.202

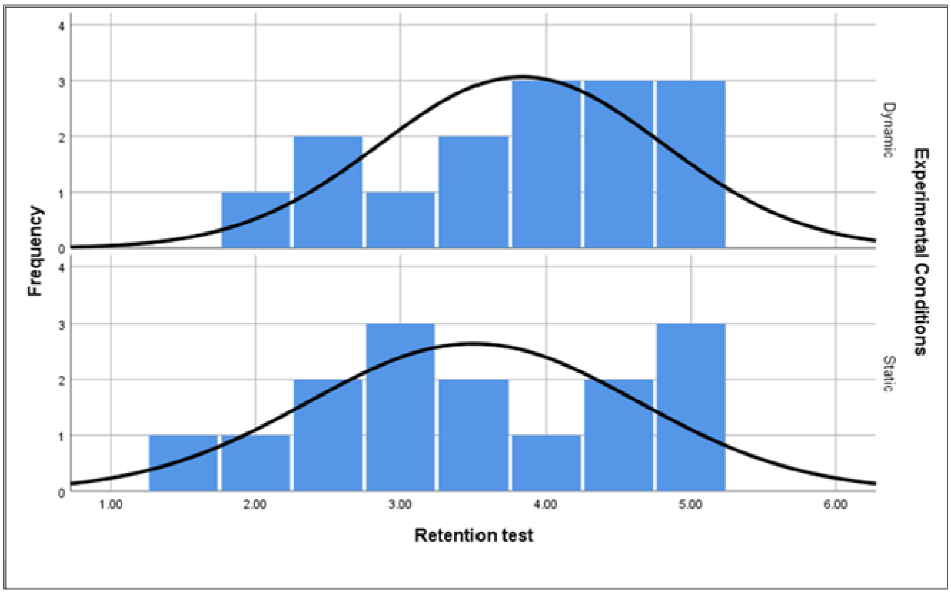
Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

2. Learning performance – statistical results

2.1. Histogram – Frequency of retention and transfer distribution per experimental condition





2.2. Descriptive statistics for practical task and retention test

Descriptive Statistics

	Experimental Conditions	Mean	Std. Deviation	N
Practical task	Dynamic	8.7333	2.25093	15
	Static	7.8333	1.95180	15
	Total	8.2833	2.12003	30
Retention test	Dynamic	3.8333	.97590	15
	Static	3.5000	1.13389	15
	Total	3.6667	1.05318	30

2.3. MANOVA test of between-subjects of performance measures - retention & transfer.

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Retention test	.833[a]	1	.833	.745	.395	.026
	Practical task	6.075[b]	1	6.075	1.369	.252	.047
Intercept	Retention test	403.333	1	403.333	360.426	.000	.928
	Practical task	2058.408	1	2058.408	463.804	.000	.943
experimental_conditions	Retention test	.833	1	.833	.745	.395	.026
	Practical task	6.075	1	6.075	1.369	.252	.047
Error	Retention test	31.333	28	1.119			
	Practical task	124.267	28	4.438			
Total	Retention test	435.500	30				
	Practical task	2188.750	30				
Corrected Total	Retention test	32.167	29				
	Practical task	130.342	29				

a. R Squared = .026 (Adjusted R Squared = -.009)

b. R Squared = .047 (Adjusted R Squared = .013)

2.4. Pairwise comparison of performance measures - retention & transfer.

Pairwise Comparisons

Dependent Variable	(I) Experimental Conditions	(J) Experimental Conditions	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
						Lower Bound	Upper Bound
Practical task	Dynamic	Static	.900	.769	.252	-.676	2.476
	Static	Dynamic	-.900	.769	.252	-2.476	.676
Retention test	Dynamic	Static	.333	.386	.395	-.458	1.125
	Static	Dynamic	-.333	.386	.395	-1.125	.458

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

2.5. MANOVA test of measure Within-subjects for retention & transfer.

Tests of Within-Subjects Effects						
Measure: MEASURE_1						
Source		Type III Sum of Squares	df	Mean Square	F	Sig.
performance	Sphericity Assumed	319.704	1	319.704	130.270	.000
	Greenhouse-Geisser	319.704	1.000	319.704	130.270	.000
	Huynh-Feldt	319.704	1.000	319.704	130.270	.000
	Lower-bound	319.704	1.000	319.704	130.270	.000
performance * experimental_conditions	Sphericity Assumed	1.204	1	1.204	.491	.489
	Greenhouse-Geisser	1.204	1.000	1.204	.491	.489
	Huynh-Feldt	1.204	1.000	1.204	.491	.489
	Lower-bound	1.204	1.000	1.204	.491	.489
Error(performance)	Sphericity Assumed	68.717	28	2.454		
	Greenhouse-Geisser	68.717	28.000	2.454		
	Huynh-Feldt	68.717	28.000	2.454		
	Lower-bound	68.717	28.000	2.454		

2.6. Tests of between-subjects effects

Tests of Between-Subjects Effects					
Measure: MEASURE_1					
Transformed Variable: Average					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	2142.037	1	2142.037	690.317	.000
experimental_conditions	5.704	1	5.704	1.838	.186
Error	86.883	28	3.103		

3. Engagement (Students attitude) – statistical results

3.1. Descriptive statistics of motivation, perceived difficulty and perceived effort measures

Descriptive Statistics				
	Experimental Conditions	Mean	Std. Deviation	N
Motivation	Dynamic	7.6000	3.29068	15
	Static	8.6667	2.60951	15
	Total	8.1333	2.96803	30
Perceived Difficulty	Dynamic	11.7333	2.73774	15
	Static	10.6000	3.33381	15
	Total	11.1667	3.05223	30
Perceived Effort	Dynamic	5.6667	1.95180	15
	Static	5.8000	2.48424	15
	Total	5.7333	2.19613	30

3.2. MANOVA (multivariate) & Test of Between-subjects effects for DV – Motivation, DV – Perceived difficulty, DV – Perceived effort

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Motivation	8.533[a]	1	8.533	.968	.334	.033
	Perceived Difficulty	9.633[b]	1	9.633	1.035	.318	.036
	Perceived Effort	.133[c]	1	.133	.027	.871	.001
Intercept	Motivation	1984.533	1	1984.533	225.028	.000	.889
	Perceived Difficulty	3740.833	1	3740.833	402.034	.000	.935
	Perceived Effort	986.133	1	986.133	197.603	.000	.876
experimental_conditions	Motivation	8.533	1	8.533	.968	.334	.033
	Perceived Difficulty	9.633	1	9.633	1.035	.318	.036
	Perceived Effort	.133	1	.133	.027	.871	.001
Error	Motivation	246.933	28	8.819			
	Perceived Difficulty	260.533	28	9.305			
	Perceived Effort	139.733	28	4.990			
Total	Motivation	2240.000	30				
	Perceived Difficulty	4011.000	30				
	Perceived Effort	1126.000	30				
Corrected Total	Motivation	255.467	29				
	Perceived Difficulty	270.167	29				
	Perceived Effort	139.867	29				

a. R Squared = .033 (Adjusted R Squared = -.001)

b. R Squared = .036 (Adjusted R Squared = .001)

c. R Squared = .001 (Adjusted R Squared = -.035)

3.3. Multivariate pairwise comparison between DV (Motivation, Perceived difficulty, Perceived effort)

Pairwise Comparisons

Measure: MEASURE_1

(I) studentattitude	(J) studentattitude	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
Motivation	Perceived difficulty	-3.033*	.844	.001	-4.763	-1.304
	Perceived effort	2.400*	.540	.000	1.294	3.506
Perceived difficulty	Motivation	3.033*	.844	.001	1.304	4.763
	Perceived effort	5.433*	.717	.000	3.965	6.901
Perceived effort	Motivation	-2.400*	.540	.000	-3.506	-1.294
	Perceived difficulty	-5.433*	.717	.000	-6.901	-3.965

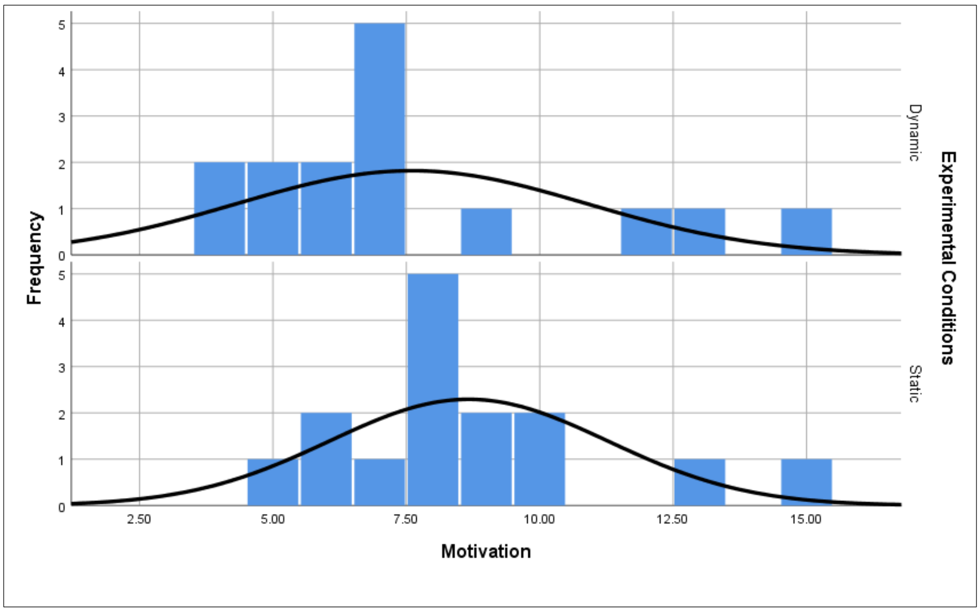
Based on estimated marginal means

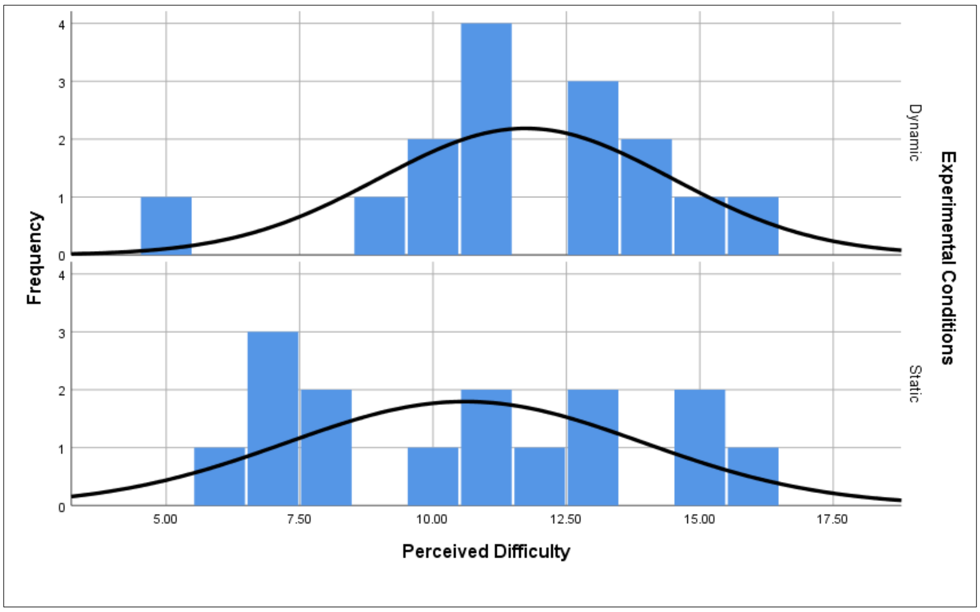
*. The mean difference is significant at the .05 level.

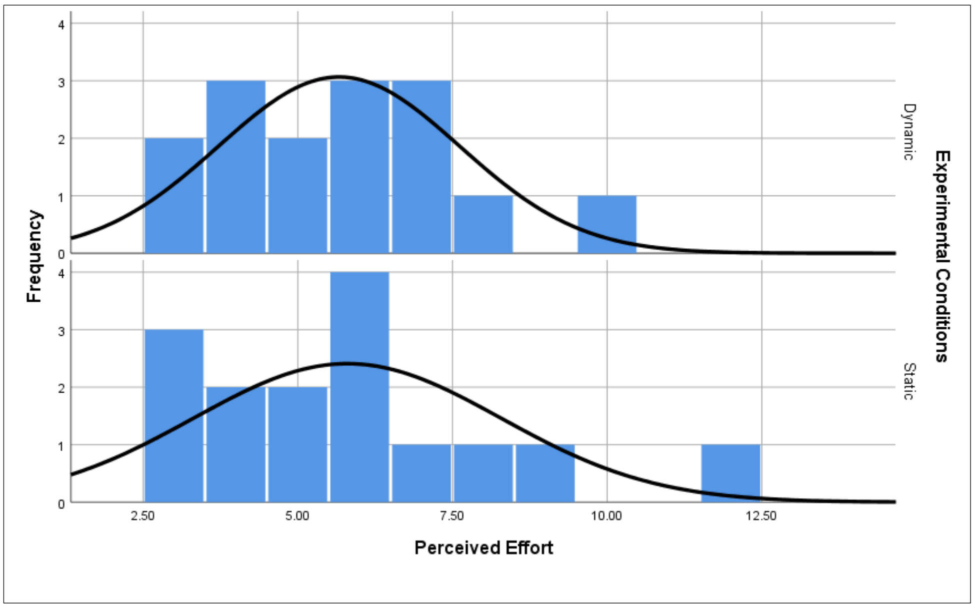
b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

3.4. Histograms of Engagement measures: Motivation, Perceived difficulty, Perceived effort per experimental condition.

Motivation (min=4; max=24); Perceived difficulty (min=3; max=18); Perceived effort (min=3; max=18).







4. Experimental study materials

4.1. Dynamic display "Creating PowerPoint Slide Master" experimental condition (also on Youtube).

4.2. Static display "Creating PowerPoint Slide Master" experimental condition.

4.3. Empty PowerPoint presentation for Practical (transfer task) exercise.

4.4. Practical task video evidences.

4.5. SPSS statistical data.

4.6. Experiment on Qualtrics.

4.7. Pre-selection survey questions:

1. What is your level of English?
   a) A1-A2
   b) A2-B1
   c) B1-B2
   d) B2 or higher
2. Please assess your level of knowledge in working with PowerPoint.
   a) Beginner (I know the basic functionalities)
   b) Between beginner and intermediate (I know a little bit more than basic functionalities)
   c) Intermediate (I feel that I know quite well PowerPoint)
   d) Advanced (I feel that I know very well PowerPoint)
3. How frequently do you use Slide Master?
   a) Frequently.
   b) Rarely.

c) It happened maybe once to use it.
d) Never used it.

4.8. Post-test questionnaire adapted from Huang (2017) & Olinda and al., (2006)

	Strongly agree	Agree	Slightly agree	Slightly disagree	Disagree	Strongly disagree
I liked studying about PowerPoint Slide Master	○	○	○	○	○	○
I liked studying this example and applying it in practice	○	○	○	○	○	○
Create and Customize Slide Master module was interesting	○	○	○	○	○	○
I am confident that I know how to create and customize Slide Master in different contexts.	○	○	○	○	○	○
I had a hard time understanding how to create and customize Slide Master in the different context.	○	○	○	○	○	○
To really learn how to create and customize Slide Master, I had to work hard.	○	○	○	○	○	○
Studying how to create and customize my Slide Master module by myself, was a difficult way to learn.	○	○	○	○	○	○
I carefully studied the explanations and examples.	○	○	○	○	○	○
I completed the practice exercises to the best of my ability.	○	○	○	○	○	○
I did my best to learn how to create and customize Slide Master.	○	○	○	○	○	○