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Estudo exploratório dos efeitos de flexibilidade de interação na aprendizagem a partir de demonstrações animadas

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Resumo: Este estudo examina os efeitos de duas interfaces com controles de andamento da animação diferentes (flexível e restrita) na aprendizagem de tarefas usando programas de computador. Diferenças significativas foram detectadas: usuários com restrições aprenderam melhor um determinado passo, enquanto os outros fizeram uso intenso mas não necessariamente produtivo da flexibilidade.

Palavra-chave: *interação, instruções e animação*

Abstract: *This study explores how highly flexible and restrictive interfaces (varying in terms of animation pacing controls) affect learning software-based tasks. Though few, significant differences were detected: restricted users learned a certain step more efficiently, in contrast their counterparts made an extremely intense, but not necessarily productive, use of flexibility.*

Key-words: *interaction, instructions and animation*

1. Introduction

This study is motivated by the idea that designers should not only be concerned with the content and form of the instructional message, but also decide what degree of flexibility for pacing controls should be provided to users of animated instructional demonstrations. Ideally, such flexibility allows learners to tailor the pace and/or direction of the animation to their cognitive needs. Although important, little research has investigated this issue systematically and there is a need for carefully designed experimental studies that could capture nuances of the way learners interact with step-by-step animation (Ploetzner and Lowe, 2004). In order to explore this research gap, this study explored how the provision of two levels of flexibility for pacing controls affects learning from a step-by-step animation. The instructions taught 12 participants (6 per condition) how to perform software-based task, in which steps were highly dynamic and tightly linked.

2. Literature review

Existing research on the instructional effectiveness of pace control seems to be ambiguous: sometimes it suggests that high levels of flexibility benefits learning and sometimes it does not so. Basically, the research findings are as follows:

Highly flexible interaction can be provided within step-by-step instructional animation when:

- animation time is longer than 15 seconds (Plaisant and Shneiderman, 2005).
- animation is too fast, so it cannot be accurately perceived by user (Tversky and Morrison, 2002).
- controls are likely to be used to reduce the amount of “cognitive processing” required to learn (Schwan and Riempp, 2004).
- controls are likely to be used as a way to self-monitor learners’ limited cognitive resources (e.g., attention and processing). So, learners will, hopefully, allocate these resources to inspect animations segments that are critical for them and skip segments that are considered less relevant (Schwan and Riempp, 2004)
- controls are familiar to users, so they will not have the extra burden of learning how to use them (Hegarty, 2004; Schwan and Riempp, 2004).
- controls allow the transient nature of the animation to be modified and this facilitates learning. For example, learners can stop at specific frames and inspect and/or read them more carefully (Hegarty, 2004). Furthermore, learners can stop animation at a specific frame then switch to software and check if

their outcomes are similar to the one shown in the frame (Gellevij, 2002).

- learners are trained beforehand on how to use interaction flexibility strategically, instead of spontaneously (Lowe, 2006).

On the other hand, more restrictive flexibility can be provided when:

- any type of parallel activities (i.e., monitoring animation progress or deciding whether or not to interrupt or re-inspect animation segment) is considered a distraction and, as consequence, a detriment for learning.
- the observation of continuous rather than episodic animation is likely to help learners make sense of the internal relationship between steps (Lowe, 2004, 2006). In other words, when it is better for the learners to see the "big picture" of the step's intricacies in one go, rather than letting them see the "big picture" emerging gradually.
- animation is carefully tailored to meet users learning difficulties. So, for example, the depiction of critical information is emphasized visually (i.e., slow motion and automatic repetition) and explicit learning guidance is provided (i.e. captions and narration) (Lowe, 2004, 2005).

3. Method and material

3.1 The interface of animated instructions

The researcher designed the animated demonstrations used in this experiment because versions available on the training market were either too long or did not provide different interaction controls. The animations and their interfaces (i.e., restricted and flexible) were designed to be very simple, straightforward and efficient, thus textual and graphic information were reduced to the minimum necessary to maintain brevity without compromising clarity (preliminary versions of designs were tested with users and design specialists). The graphic user interfaces were designed to be very similar to the interfaces of popular media players (e.g., Youtube, Windows and Quicktime media Player), so the participants would be familiar with how these interaction controls work. For two reasons a *step numbers* button (a less common control) was also included: (1) it allows the user to jump to specific steps, and (2) this interactive device is becoming a standard feature for instructional demonstrations available on the market (e.g., Howcast.com, 5min.com smart player).

The features of the restrictive and flexible interfaces

The restricted version has only one interaction control: the *play button* that merely activates the

animation (figure 1). The flexible version displays 5 interaction controls*: user-movable progress bar*, *play*, *return*, *step number* and *stop* buttons (figure 2).

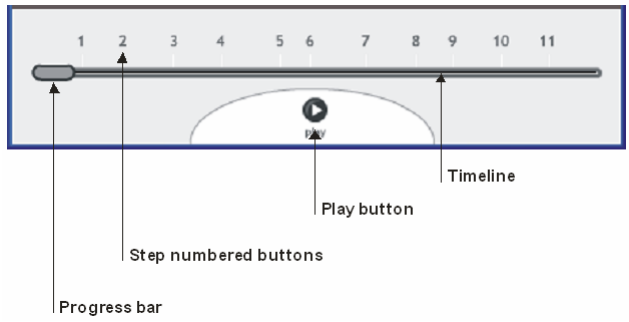

Figure 1 – Overview of the restricted interface. In this interface only the *play* button is an interactive control. *Timeline*, *progress bar* and *step number* buttons are purely visual features that help the participant to monitor animation progression (i.e., the different durations of steps are represented by the distance between the step number in the timeline).

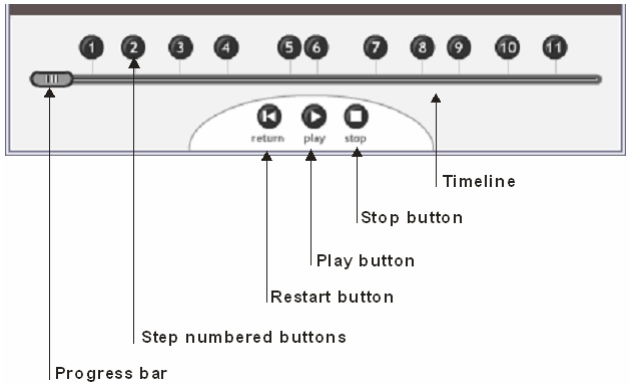

Figure 2 – Overview of the flexible interface. *Play* button and the *progress bar* allow any animated sequence to be played. *Step number* buttons allow jumping to specific step's caption frame. *Stop* button allows animation to be interrupted at any point. *Restart* allows replaying the animation from start point.

3.2 The task to be learned

The task chosen for this study is related to graphic vector-based software Bézier tools (i.e., CorelDraw's "pen tool") to draw arches. Participants are asked to redraw two arches that are linked to each other (see figure 1). In order to be accurate, participants will be required to realise that the task has sequences of actions that are interlinked and that requires coordinating mouse manipulation and keystrokes simultaneously. So, participants are expected to remember how to carry out sequence of steps as continuous set of operations and not as discrete and easily interruptible parts. This means that if learners interrupt practice because they do not remember what to do next, they will need to undo all previous interdependent steps and restart the sequence. For analytical purposes steps were organized into three subtasks: (1) Selecting the pen tool in the main icon menu and then in the sub-menu; (2) Determining the start point and pointed corner of the arc; (3) Determining the start point, round corner and third point of second arc.

3.3 Test design

Measurements

The measurements used to make comparisons between users of flexible and restricted animation are classified into four categories: (1)

time, (2) mistakes, (3) interaction and (4) post training task. The categories of time and mistakes contain an overall measurement and this is broken down into small sub-components. Other specific measurements are applicable only to users of flexible interfaces, they are: single control activation, steps played, steps stopped and number of interruptions.

Tools used for monitoring user performance

The analysis of a participant's performance requires a combination of time data and descriptions of the way that interactions controls were used. So, two pieces of software were used to monitor time and user actions: "Activity Logger" (records the time) and "Wink Debugmode" (takes a screenshot at every keystroke or mouse click).

Participants and basic procedure

Twelve participants took part in this study on a voluntary basis. Six used the flexible animation and six used the restricted version. The choice of animation was allocated to each participant in a randomised manner. All participants had low level of familiarity with the graphic software used in this experiment. However, all of them were familiar with standard media players' interactions; therefore, they would not have to learn how they work. Most of the participants were aged between 25 to 44 years (10), one was aged between 45 to 64 and one over 65. This selection of participants complies with the objective of this study, which is to explore how a group of novices in the graphic software domain uses interaction controls. One laptop with 14 inch display (resolution of 1024 x 768 pixels) was used to carry out the test. The individual experiment sessions took between 20 and 30 minutes to be completed.

The procedure is based on the following sequence of activities: (1) Participants were asked to learn how to perform the proposed task using animation. To do so, they could use interaction controls as much as they like. Two windows were opened: one containing the animation and the other the graphic software. (2) Participants were free to observe and interact with the animation and practice with the software as much as they needed. They were asked to inform the researcher when they thought they had learned the instructions and felt confident to demonstrate learning. (3) Finally, participants were asked to demonstrate learning by executing the task without the support of the animation.

4. Results

This study provides evidence that there are some significant differences between the two versions:

- On average, users of the flexible version switched between animation and software 3 times more often than users of the restricted

version, W(6,6) = 55, p<0.05. Users of flexible animation also made more use of interaction controls by activating them 10 times more often than users of the restricted version did (who could only use the play button), W(6,6) = 57, p<0.01.

- The analysis of mistakes per step revealed that users of flexible animation made more mistakes in one single step (i.e., step 5) than users of restricted version, W(6,6) = 52.5, p<0.05. However, no difference was found in the remaining steps.

When data of flexible animation's users is analysed in isolation, it is possible to realise that the high level of flexibility provided was not utilized uniformly:

- High level of variability was found in terms of how often individual steps were inspected. At least two users performed extremely different of each other: one made very few inspections while the other did it constantly. The other four participants carried out a similar number of inspections.

- Extremely high level of variability was also found in terms of how often the animation was interrupted. Two users interrupted the animation very often; two were intermediary and two very few times.

- No difference was found in terms of how often users activated individual controls. High levels of variability suggest that users seem to be very personal in the way that they choose to activate controls. Apparently, some users liked to use the same control very often (i.e., step button and play button), conversely some did not even try it out or did it very little.

However, correlation tests suggest that in at least two aspects users of flexible animation seem to be coherently uniform:

- There is a large and positive correlation between mistakes and number of inspections per subtask, r(16) = 0.713, p < 0.01; and between mistakes and interruptions per subtask r(16) = 0.697, p < 0.01.

5. Discussion

These results confirm that the simple provision of flexible pace controls can have a strong effect on the way in which users chose to learn instructions: in comparison to users of restricted animation, they will be very active and choose a rather fragmentary manner in switching between animation and software. Furthermore they generally will also feel very encouraged to make an extremely intense use of interaction controls. However, the issue of whether or not this intensity is easily converted into learning gains seems not to have an obvious answer. For example, no further differences were found in all 3 time-based measures, overall number of mistakes, mistakes per subtask and

questionnaire. However, there is an exception: users of flexible animation made more mistakes in one single step (i.e., step 5) than users of restricted version. Though subtle, this advantage for users of restricted version contrasts with existing research that suggests the opposite (Schwan and Riempp, 2004). A possible explanation is that some users of flexible animation could not grasp the intricacies between steps as easily as users of restricted version did. It might be that, like in other experiments (Lowe, 2004, 2004), users of flexible animation had more difficulty because they adopted a very fragmentary and stepwise way to inspect and practice instructions. Indeed, this is supported by the significant difference in how often users of flexible animation switch between animation and practice (3 times more than their counterparts), and by their intense use of action controls (10 times more than their counterparts).

Furthermore, Lowe (2004) ascertains that users of flexible controls tend to neglect information that, in spite of being visually subtle, is thematically critical. So, in this study, the most difficult step (step 5) contained important information presented in a textual and subtle form (the word “continue”), which would be critical to make sense of steps’ interdependence and simultaneity. According to Lowe and Schnotz (2008), learners will only use controls productively if they use them strategically. Otherwise, they are likely to adopt naive strategies to learn from animation. This view is supported by the fact that, even though the observation of animation in full length (i.e., without interruptions) helps the comprehension of its wholeness (Lowe, 2004, 2004, 2006), only one user of flexible controls in the current study has chosen to do so.

In the current study, users of flexible animation could not save any time learning instructions as users in other studies have done (Schwan and Riempp, 2004). A possible explanation for this lack of a positive effect of interaction flexibility is that the animation here was very straight-forward and clearly segmented (and labelled like in Ertelt, Renkl *et al.*, 2005). By being so, any potentially redundant information was kept to minimum. In other words, the comprehension of every single step might have been equally important for learning the whole task. Therefore, there were no animated segments that could be simply skipped or considered totally irrelevant.

There is some evidence to sustain the idea that users will use their interaction flexibility to inspect and interrupt subtasks that were more difficult for them (i.e., large positive correlation between mistakes and inspection, and mistakes and interruption) (Schwan, 2002; Hegarty, 2004; Betrancourt, 2005). However, these correlation tests do not indicate which variable leads to the other. So, constant inspections and

interruptions could either have a positive effect: help users to learn how to overcome mistakes (Schwan and Riempp, 2004); or a negative effect: obstruct the comprehension of the internal relations between steps (Lowe, 2004). This issue should be further investigated.

6. Conclusion

Although involving few participants, the detailed approach adopted here seemed suitable for a deeper investigation on effects that interactive features will have on individuals. This suitability is confirmed by the detection of differences between groups when they were learning a certain step (such detailed analysis is neglected in most research); and the observation that users of highly flexible controls are likely to make a diverse use of such interactive features. Due to this variability, it still not clear to what extent flexibility leads to noticeable learning gains; quite the contrary, detailed examination of data suggests that users of flexible controls made more mistakes than their counterparts, particularly in steps that need to be carried out simultaneously. The main considerations that can be extracted from this study are that:

- Learners (particularly beginners) might need to be guided or told beforehand how to use flexibility strategically, otherwise, they will make constant interruptions of the flow of the animation and this excess might not be easily converted into learning benefits.
- Designers should be careful about adopting generic and highly flexible media player's interface for all types of animated instructions. The level of flexibility and the design of pacing features should be coherent with the structural content and complexity of the instructional message. So, moderate flexibility can be easier to operate and, therefore, help users concentrate on learning the instructional message.

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