In Proceedings of the 12th EARLI biennal conference on Research on Learning and Instruction, Aug. 28 - Sept. 1, Budapest (Hungary)

Building dynamic mental models from animation: effect of user control on exploration behaviours

Bétrancourt Mireille, Rebetez Cyril

Tecfa, University of Geneva, 1211 Geneva 4, Switzerland.

Please send correspondence to: Betrancourt@tecfa.unige.ch

Abstract

Though animation seems particularly adequate to convey explanation of dynamic systems, the literature reports many cases in which animation did not facilitate learning. The current explanation is that novices failed to adequately process the graphic dynamic information and to build a mental model from it. It is assumed that giving control over the pace of the animation enables the progressive processing of multimedia information and facilitates the construction of the mental model. We carried out an experimental study in which learners were given either no control or high control on playing a series of animated sequences accompanied with text information. We found no significant effect on learning performance. However, we observed various behaviours in studying the multimedia material in both conditions. The results comforted the assumption that giving learners control over the pace of the animation can differently affect learning performance depending on their actual use of the control device.

Summary

As animation changes over time, it should be particularly adequate in multimedia instruction explaining the functioning of dynamic systems. Although it is appealing and seems straightforward, animation is not always beneficial to learning (Tversky, Bauer-Morrison & Betrancourt, 2002). In multimedia research, learning is evaluated by the capacity of inferring new information from the mental model elaborated in studying the instructional material and from previous knowledge (Schnotz, 2005). The literature suggests that an explanation for the lack of benefits of animations lies in the difficulty that novice learners encounter to process effectively dynamic multimedia information. On the one hand they can be overwhelmed by the continuous flow of changing information, thus being unable to adequately process the text and picture information (representational relations, referential relations and co-referencing). On the other hand, novices studying animation often reported an illusion of understanding, leading them to passively and inefficiently process the information, which is described as an "underwhelming effect" (Lowe, 2004). In both cases, learners cannot build a mental model from studying the animation. One factor that can be introduced to avoid both overwhelming and underwhelming effects is user-control over the pace of the animation. Mayer & Chandler (2001) investigated a very minimalist control device, that consisted in breaking down the animation in short sequences, including a pause after each animated sequence and giving the learner control to run the next sequence. The results showed that learners who studied the controlled animation had better transfer performance than learners who studied the continuous animation. Using a full control device, Schwan & Riempp (2004) showed that users who had control over the pace and direction of videos learned more rapidly how to tie nautical knots than learners who could not act on the video. Using an animation depicting a pulley system, Schneider & Boucheix (2006) compared three levels of control: no control, partial control (Mayer and Chandler's control condition with 5 sequences) and full control. They found no effect of the level of control on memorization and comprehension performance. We assume that the effect of user control is mediated by the exploration behaviour performed during the study of the instructional material. Therefore we conducted an experiment comparing the effect of giving control to the learner on their comprehension scores and exploration behaviours.

Participants were 38 students from the university of Geneva (age M = 23.1; SD = 6), 12 of which were men. They were randomly allocated to one of the two experimental conditions according to the factor "level of control on the animation" with two modalities (no control and high control). The instructional material was designed to explain the combination additive and subtractive synthesis of colours. It was constituted of nine steps, each displaying one multiple-choice question and a short animation. A feedback was given after the participant indicated his/her answer. In the "high control" condition, participants could manipulate the direction of the animation (pause, forward, backward). In the "no control" condition, participants could not act on the animation except for restarting it when it came to its end. The participant could proceed to the next question only after the correct answer was given. The post-test consisted in 16 multiple-choice questions. Finally participants had to evaluate their subjective mental effort in studying the material.

We found no effect of the level of control on the total score (No control: M = 9.8, SD = 2.6; High control: M = 9.4, SD = 3.4; $F(1,36) < 1$). There was no difference either regarding the time taken to study the material or to run the animation. Therefore we further analyzed the participants' behaviour to study the material. In the no control condition, the number of times the learners chose to restart the animation (e.g. to play the sequence again) ranged from 3 to 14, with a mean of 8.5 for 9 sequences. Though this number seems low, we found a significant correlation between the number of restart and the comprehension performance (r = .559), while there was no significant correlation between study time and performance. In the high control condition, the total number of actions (pause, forward, backward) ranged from 0 to 23, with a mean of 11.8. But we did not find any significant correlation between the number of actions and the comprehension performance. Qualitative analyses are planned to qualify learners' behaviours in the high control condition. The results presented here show that giving control may differently impact learning depending on the actual use of the control by learners.

Lowe, R. (2004). Interrogation of a dynamic visualization during learning. *Learning and Instruction, 14*, 257–274.

Mayer, E. R., & Chandler, P. (2001). When Learning is just a click away: does simple interaction foster deeper understanding of multimedia messages? *Journal of Educational Psychology, 93,* 390-397.

Schwan, S., & Riempp, R. (2004). The cognitive benefits of interactive videos: learning to tie nautical knots. *Learning and Instruction, 14,* 293-305.

Schneider, E. & Boucheix, J.-M. (2006). Task specificity and user control during the elaboration of a mental model with text and animation. In *Proceedings of the EARLI SIG 2 Bi-annual Conference on Text and Graphics comprehension* (pp 24-29), Aug 30 – Sept 1, Nottingham.

Schnotz W. (2005) An integrated model of text and picture comprehension. In R.E. Mayer (ed.) *The Cambridge Handbook of Multimedia Learning* (pp. 49–69). Cambridge University Press, New York.

Tversky, B., Bauer-Morrison, J., & Betrancourt, M. (2002). Animation: can it facillitate? *International journal of human-computer studies, 57*, 247-262.