draft version. Tricot, A. (2022). Introduction to the special issue. Designing instruction for learning technologies, *L'Année Psychologique/Topics in Cognitive Psychology, 122*, 399-404

Introduction to the special issue. Designing instruction for learning technologies

André Tricot
Laboratoire de psychologie, Epsylon
Université Paul Valéry Montpellier 3
Route de Mende, 34199 Montpellier cedex 5, France
andre.tricot@univ-montp3.fr

As academics, most of us are teachers, so we are instructional designers: we design slides, on-line courses, texts, pictures, videos. We have some skills in designing problems, explanations, questions, helps, interactions. During the COVID-19 lockdown, teachers' skills as designers have been challenged, a lot, all over the world, from pre-schools to universities. Lockdown was an opportunity to realize a very simple fact: as instructional designers, we were novices in distance learning, we made many mistakes, our intuition-based skills were often not sufficient. As teachers, we sometimes forgot that research in instructional design provides us with very useful knowledge, just to do our job. Most of this knowledge comes from research in educational and cognitive psychology.

In a recent paper, Mayer (2021) presented 14 principles (i.e. research results, based on the Cognitive Theory of Multimedia Learning, replicated and «meta-analyzed») that every teacher can use when designing an instructional video. For example, the «Signaling principle» is very simple: «Highlight key material». Mayer provides an example: «Lecturer points to elements in slide as she mentions them». Several meta-analyses about the signaling principle have been published, showing nice effects sizes (d = 0.73 is reported by Mayer). All the principles presented by Mayer are evidence based and easy to use.

During the COVID-19 lockdown, most teachers designed their own learning material (Béduchaud, & Leszczak, 2020). They should have been particularly worried about the transient information effect (Leahy & Sweller, 2011), because many videos were used during this period, and videos are typical transient information. «The transient information effect occurs when explanatory information disappears before it can be adequately processed and leads to inferior learning than more permanent sources of information» (Singh, Marcus, & Ayres, 2012). According to Sweller, van Merri√´nboer and Paas (2019), in a review of the main effects based on Cognitive Load Theory, «Cognitive load effects that are found for transient information (e.g. self-pacing effect, segmentation effect, modality effect) are typically not found for non-transient or less transient information». One very simple way to decrease cognitive load in videos is to insert pauses. With a physiology teacher, during the lockdown, we implemented this principle (Aalioui, Gouzi & Tricot, 2022). We designed the very same video lecture in physiology, but one version was 21 min. long, the other one was 26 min. 30 s long, corresponding to the addition of 62 pauses of 5.15 s each. 195 medical students participated, randomly assigned to each condition. A learning gain was observed in both conditions, but was 30% higher in the added pauses condition. Using instructional design principles works!

Moreover, we also tried a very particular way to implement the Signaling principle: we added eye movement modeling examples in the videos (EMME, in the literature). EMME consist of recording the teacher's eye movements and materializing them on video to provide visual guidance as the teacher gives oral instructions. As EMME generally produce weak effects, but with short videos (5 min. or less), we thought that EMME can work with our 20 min. long video. We did not obtain a general effect of EMME on learning gain. Worst: high-prior knowledge students had significant lower learning gains with EMME. In sum, we tried to replicate a principle, but also tried to explore a challenging way to implement another principle. Doing that, we use instructional design results and we generate new results (even if negative). I think that designing instruction for learning technologies can be or should be based on psychology research results. As researchers we can contribute to this domain by providing new results and elaborating new theories.

This special issue presents five research papers in this domain. Ali Darejeh, Nadine Marcus and John Sweller ask how it is possible to improve the design of e-learning platforms. In two experiments, they investigate methods of increasing interactions between the subject content and the learner. In the first experiment, authors evaluated the effect of learning software using narrative-based e-learning systems that delivered the teaching content using either animation or interactive animation. Interactive animation enabled users to interact with the animation by clicking on the animation content, which provided a simulated software environment for teaching the target software. In the second experiment, interactions between the subject matter and the learner were increased by adding a pedagogical agent with full body gestures to the narrative-based e-learning system, that used interactive animation to test whether this type of interaction between the content and the learner can affect the cognitive load of novice users while learning software applications. Experiment 1 indicated the positive effects of engaging the motor system and interacting with the teaching content when learning software applications. The decreased learning times and decreased cognitive load while learning using interactions with the system only occurred for high, not low, element interactivity information. Experiment 2 showed the negative effects of a pedagogical agent in the form of a redundant decorative graphic that can be used to simply make a teaching environment more aesthetically appealing. The findings are in line with existing studies that found negative effects of decorative elements on cognitive load.

Leslie Jannin, Philine De Vries and Franck Ganier address a very basic question: when designing a video to support gesture learning, where should the camera be? In front of the model (heterocentric point of view) or on the same side (egocentric point of view). They also investigated the effect of the repetition of the procedure, that is a key element of procedural learning, and that is ignored in most of the video-based learning research. Two experiments are presented, involving medical students that had to learn how to do suture points. The authors recorded the evolution of performances during 5 trials (learning curve) but also how the participants took instructions on the learning material. During the first trials, the duration of instructions consultation was high for all the participants and then decreased with each new trial; the execution times decreased too. Egocentric perspective is more efficient regarding the quality of suture points. Longer duration of the task when faced with heterocentric instructions was observed. The authors conclude: «In terms of practical recommendations for the design of multimedia procedural instructions, it seems necessary to favour the egocentric perspective, the goal being to facilitate schema acquisition». But they are very careful and they add: «Different types of procedures will require different types of visual information: Egocentric instructions for guitar learning, for example, would be hard to use […] Choosing an egocentric perspective is therefore not automatically beneficial for all procedures».

Wilfried Mombo and Jerome Clerc investigate another basic and fundamental question in the domain of digital learning: is there a transfer of a problem-solving procedure presented in the real world (tangible) and in the digital world (touchscreen)? 103 participants aged 6 to 7 solved a tangible version of the Tower of Hanoi and then a touchscreen version of the Tower of Hanoi, or in different order (digital -> tangible; digital -> digital; tangible -> tangible). Authors measured the participants' levels of cognitive inhibition, as it may play a role in transfer. Results showed that transferring the procedure was accompanied by a decrement in performance. This decrement was followed by a recovery of performance in the following trials. Performance on the first transfer trial was better within-dimension digital condition rather than in cross-dimension tangible condition. Inhibition scores significantly predicted transfer performance. Like Darejeh et al. in this special issue, Mombo and Clerc outline that digital device can represent multiple learning contexts, in the sense of more or less seductive details surrounding the task presented on the screen. Varying the amount of such details would allow to vary both the degree of similarity of the tasks themselves and of their digital contexts of presentation. Future studies should be devoted to this question.

Julie Rochat, Eric Jamet and Estelle Michinov investigate the effect of support on learning by tablet-based drawing. Literature provides evidences that learner-generated drawing enhances learning, under certain circumstances. This task is demanding, time consuming, and can result in a poor-quality drawing. Therefore, supporting drawing activity during learning is a major challenge. But how to support drawing activity effectively? The authors investigate the effects of learner-generated drawing, either supported by verbal cues or unsupported, on drawing quality, learning, and monitoring accuracy among secondary-school students working on a pen-based tablet. 71 seventh graders had to read and understand three texts. Participants were randomly assigned to one condition: (a) illustrations were provided; (b) illustrations were not provided, students had to draw the illustrations, on a pre-drawn background; (c) illustrations were not provided, like in condition b, but important information was shown in bold in the texts. Results show that the last condition allowed learners to represent more elements in the complex drawing, not for simple drawing. Supporting drawing activity could be important when it is demanding, i.e. when there are a lot of elements to be generated within a drawing, involving selecting these many elements from the text. However, learners only generated drawings for just over half the expected elements within the complex drawing when it was highlighted in the text. Authors did not observe any effects of drawing and support on pictorial information memorization and comprehension. According to Rochat and her colleagues, «further studies are needed to better understand the conditions favoring its effectiveness».

Ruchi Gupta, Nadine Marcus and Paul Ayres investigate the impact of gender differences and spatial ability on learning from instructional animations. Many studies have found learning from animations to be an advantage, especially when compared with static representations. However, some research has also found examples where static pictures are not such a disadvantage. These inconsistent results could be explained by learner characteristics, like gender and spatial ability. Authors compared learning effectiveness of instructional animations with 72 university students. Participants were randomly assigned to one of the conditions showing a paper-folding shape construction: animation, animation + narration, animation + gesturing. Overall, the narration condition was found to be superior to the gesturing condition, which in turn was superior to the basic animation condition. However, this pattern was entirely generated by females. For males no significant differences were found between conditions. Furthermore, females scored higher than males even though there were no spatial ability differences. The inclusion of two spatial ability measures led to more fine-grained analysis by controlling for this important individual attribute. The Punched Holes Test was found to be a better predictor of performance than the Mental Rotations Test showing that a careful selection of spatial ability tests is needed in instructional animation research. Gupta, Marcus and Ayres conclude that «future research into instructional animations should include gender and appropriate spatial ability measures, otherwise the findings may be inherently misleading.»

This special issue illustrates that research in educational and cognitive psychology can produce useful knowledge when designing instruction for learning technologies. Thanks to COVID-19 lockdown, we know that designing instruction can be very challenging and that we need more knowledge and skills in that domain. In return, research in educational and cognitive psychology has the opportunity to address new questions. The transient information effect is (almost) a new question: why and how human process transient information? What are the differences in working memory when processing transient information vs. non-transient information? Are the constraints linked to transient pictures and transient sounds actually comparable? Other important questions are addressed in this special issue: When is a (non-human) pedagogical agent with full body gestures relevant for learning? When is it not? Why are the effects of gestures different when the pedagogical agent is human? How to improve transfer of problem-solving procedures from the digital world to the real world? Why is egocentric perspective for gesture learning not always efficient? How to support learning by tablet-based drawing? How to improve instructional animations by integrating the impact of gender differences and spatial ability?

References

Aalioui, L., Gouzi, F., & Tricot, A. (2022). Reducing cognitive load during video lectures in physiology with eye movement modeling and pauses: a randomized controlled study. Advances in Physiology Education, 46(2), 288-296.

Béduchaud, D., & Leszczak, E. (2020). Les effets du confinement sur l'activité des enseignants du primaire et du secondaire. Rapport d'enquète. IFE, ENS Lyon. http:// ife.ens-lyon.fr/ife/recherche/groupes-detravail/ documentation-confinement-etenseignement/ rapport-enseignants

Leahy, W., & Sweller, J. (2011). Cognitive load theory, modality of presentation and the transient information effect. Applied Cognitive Psychology, 25(6), 943-951.

Mayer, R. E. (2021). Evidence-based principles for how to design effective instructional videos. Journal of Applied Research in Memory and Cognition, 10(2), 229-240.

Singh, A. M., Marcus, N., & Ayres, P. (2012). The transient information effect: Investigating the impact of segmentation on spoken and written text. Applied Cognitive Psychology, 26(6), 848-853.

Sweller, J., van Merriënboer, J. J., & Paas, F. (2019). Cognitive architecture and instructional design: 20 years later. Educational Psychology Review, 31(2), 261-292. L'année psychologique/Topics in Cognitive Psychology, 2022, 122, 399-404

draft version. Tricot, A. (2022). Introduction to the special issue. Designing instruction for learning technologies, *L’Année Psychologique/Topics in Cognitive Psychology, 122*, 399-404