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Enriching videos with interactive questions to enhance students' cognitive activity: concept and implementation

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Cognitive activation in mathematics learning videos

Cognitive activation and individual learning support are key factors that explain students' learning in traditional classrooms (Baumert et al., 2010). Learning videos seem to hardly support both factors. However, activation does not mean a physical activity; instead, active participation includes active thinking. In mathematics, cognitive activation needs to be focused on mental activities that fit to the learning goals (see Leuders & Holzäpfel, 2011). Cognitive activation further means that learners engage with the subject matter at a cognitive level that is as high as possible and appropriate to their learning requirements. Cognitive activation can thus especially occur when videos are combined with tasks or interrupted for the learner's own activities. Even basic interactive elements like playback control, segmentation and table of contents improve both learning and learner satisfaction. As technology develops, there is an increasing number of possibilities to design videos in a cognitively activating way and to support individual ways of using them.

We aim to make mathematics learning videos more cognitively activating. In our poster, we present didactic scenarios taking account of the type of content during activation and individual use.

Technical background: the H5P software

The free and open-source software H5P is based on HTML5 and allows to create interactive learning content (<https://h5p.org/>). In particular, videos can be embedded in a container that offers predefined question formats, among others multiple-choice, drag-and-drop, and free text questions. In addition, a table of contents with navigation can be added to the video.

Didactic scenarios

Like in classroom settings, questions can serve different purposes in video: they can assess prior knowledge, support comprehension of the presented ideas, underline cognitive conflicts or stimulate further engagement with the subject (Lim & Wilson, 2018). The question formats mentioned above can be used to activate both prior knowledge and newly acquired knowledge while watching the video. The force to respond to the pop-up questions or to fill in the blanks may underline students' cognitive conflict.

Self-explanations have been found to improve both conceptual and procedural knowledge in the context of learning from worked-out examples (e.g., Berthold & Renkl, 2009). They can be supported

with cloze texts. Renkl (1997) identified two types of successful self-explanations, anticipative and principle-based explanations. Implementing questions and cloze texts according to these types, we can encourage students to think ahead and establish links (anticipative explanations) as well as to reflect on the central principles underlying the presented content (principle-based explanations).

Practical Examples

In the project studiVEMINTvideos (Biehler et al., 2020), we develop videos embedded in digital learning material. The materials shall help students to autonomously review their mathematics knowledge when they transition to university.

To implement interactions in videos, we identify appropriate positions and question formats based on central problems and cognitive conflicts in the video. In the beginning of a video, we often opt for anticipative questions. In the end, we consider principle-based questions summarizing the main ideas. We adapt the number of interactions to the length of the video and try to vary the question formats within one video. In a video on the fundamental theorem of calculus, for example, we embedded three interactive questions. At the beginning, prior knowledge is activated by asking for the definition of the antiderivative with the help of a drag-and-drop question. After having explained the theorem, we explained how to generate an antiderivative. To consolidate this newly acquired knowledge and to transfer it to other functions, we embedded two single-choice questions to identify antiderivatives of given functions. Our poster will illustrate such examples. Further research will focus on students' learning with these enhanced videos.

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