Which impact can computer animations have on the development of mental imagery?

The development of spatial abilities and mental imagery is one of the primary aims in geometric education in primary schools. There are hopes that the new media have an especially great potential when it comes to the development of spatial awareness and abilities in children at primary school age. However, not much research has been done yet to find out whether this claim holds true. This is the motivation for the present study.

Ideas and concepts from philosophy, psychology and the field of mathematics education and didactics helped to form a detailed understanding of the notions of spatial abilities and mental imagery. They refer back to mental models and formed the starting point for this work.

The focal point of the study is the investigation of the effect and impact of the use of computer animations on the development of mental imagery of primary school learners.

Therefore, computer animation programmes were analysed with regard to their design and their potential for learning. Afterwards learners were observed when using the computer animations. Subsequently, they were interviewed and asked to evaluate the impact of the computer animations on their learning.

The video data was analysed using basic principles of the ‘qualitative content analysis’ and ‘objective hermeneutics’. Three prototypical patterns of behaviour could be observed. These are illustrated by three learners, ‘Michi’, ‘Jan’ and ‘Johannes’. Michi and Jan represent two extreme poles on a spectrum whereas the case of Johannes functions as an example of the prototypical learner situated in the middle. In the analysis of the learners, ‘Cognitive Load’ emerged as one of the determining factors for the interpretation of individual behaviour patterns. Cognitive load (based on the Cognitive Load Theory by Sweller & Chandler) moderates the interplay between a medium and the individual (learner). It helps to describe the influence of animations on mental developments:

Michi, as one participant at one end of the spectrum, experiences a cognitive overload. The combination of ‘acting and observing simultaneously‘ poses an excessive demand on her. The computer animations reduce her cognitive load by offering

her a structure and acting in her place. As a result, Michi can develop a first mental representation of the action.

In the case of Johannes, one can observe that he is overstrained, when he has to hold and coordinate higher numbers of elements mentally. The computer animations reduce his cognitive load by offering him visual aids at points where he gets stuck. This helps him to fill the gaps in his mental models, or even to correct his models where they are wrong.

Jan, at the other end of the spectrum, is not overstrained. On the contrary, he progresses quickly to the stage where he has developed sufficient mental models to do the required tasks. The computer animations do not hinder the development of his own mental models but they do not help him either. They are simply not necessary, as they do not produce information that is useful for him. Thus, the computer is not necessary for his learning.

In the field of cognitive psychology it is well known that animations have a facilitating and an enabling function. My results provide a characterisation for a deeper understanding of the occurrence of these functions.

What all learners have in common is that they undergo analytical processes of concrete and mental ‘observing’ and concrete and mental ‘simultaneous acting and observing’. In this process learners conventionally observe actions, either their own actions, those by other people or computer animations, may they be concrete or mental actions. The aim for the learner is to detect constitutive features and to develop mental representations.

There are learners, who are overstrained when performing concrete and mental ‘simultaneous actions and observations’. This is the reason why they cannot develop their own mental representations. Thus, it is necessary to reduce the cognitive load in the first place. In the beginning, it is useful to let someone or something else perform the action (‘Fremdhandler’) in order to support the learner’s development from purely watching towards a goal-orientated and operative observing. As soon as the learner is able to do this, he will then be capable to develop his skills for ‘acting and observing simultaneously’. Ultimately, this skill is the basis for the ‘operative principle’.

The findings of this thesis indicate that we need a broader understanding of the term ‘operative principle’. The value of the ‘operative observation’ needs to be

highlighted. The broader understanding needs to include the ‘development of the operative observing’ as well as the ‘operative observation’ itself as a pre-stage of the ‘operative principle’.

Finally, an extended notion of ‘mental imagery’ is suggested, which places more importance on the ‘mental observation of the inner ‚Fremdhandler’.