Learning from dynamic graphics: Does realism matter?

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Abstract. Despite that dynamic graphics are increasingly popular in educational settings, our knowledge on how to design them is somewhat limited. Here, we investigated the impact on learning of different kinds of dynamic graphics: realistic graphics, which were detailed representations highlighting structural aspects, and schematic graphics, which were simplified representations highlighting conceptual aspects. Thirty-six undergraduate students learned about plate tectonics from a multimedia presentation containing narrated dynamic graphics. Half the participants were provided with realistic graphics whereas the rest received schematic graphics. After viewing the presentations, participants solved tasks requiring structural and conceptual knowledge. The results revealed that participants in the schematic condition outperformed those in the realistic condition in the conceptual test whereas there were no differences between the conditions in the structural test.

Keywords: Multimedia learning; Dynamic graphics; Realistic graphics; Schematic graphics.

Introduction

Multimedia instructional messages, which are becoming increasingly prevalent in educational settings, are those including words and pictures that are intended to promote learning. Researchers have developed a number of guidelines about how to combine words and pictures to produce effective presentations (see Mayer, 2005), however, the question of how to design graphics has been less explored. One interesting question is what kind of dynamic graphic is better, realistic or schematic.

Based on the cognitive theory of multimedia learning (Mayer, 2005), the coherence principle establishes that unneeded or extraneous material has to be eliminated from a presentation in order to promote learning: when freed from processing unneeded material, learners are more able to carry out the germane processing that results in deep learning. Accordingly, it may be predicted that realistic graphics, which include unneeded details of the object being represented, work less effectively than schematic graphics, as these include only essential information. On the other hand, Goldstone and Son (2005) argue that realistic graphics, which include concrete information, can be better remembered than schematic graphics, since these exclude any concrete detail.

Regarding empirical research on the question, Scheiter, Gerjets, Huk, Imhof, and Kammerer (2009) had participants learn about cell mitosis from a multimedia presentation including narrated dynamic graphics. Some participants received realistic graphics, which were videos recorded via a microscope, whereas others received schematic graphics, which were animations based on simple line drawings. In two experiments, participants in the schematic condition outperformed those in the realistic condition in tasks requiring structural and conceptual knowledge (i.e., completing drawings and answering multiple-choice questions, respectively). This is in line with the coherence principle.

The specific goal of our research is to replicate these findings using to-be-learned materials on a different topic. Based on the coherence principle and the results of Scheiter et al., we hypothesized participants receiving schematic graphics to outperform their counterparts.

Method

Participants

Thirty-six undergraduate students participated in the experiment. They were randomly assigned to one of two conditions: approximately half the participants served in the realistic condition whereas the rest served in the schematic condition. The mean age of the sample was 20. All participants had low prior knowledge on plate tectonics. Participants reported that they used computers frequently.

Procedure and materials

First, participants solved the *prior knowledge test*. This was a paper-and-pencil test comprising five open-ended questions (e.g., “What is a tectonic plate?”; “How are mountains formed?”). Total scores ranged from 0 to 10. Then, participants started viewing the computer-based *multimedia presentation*. The presentation consisted of several modules comprising dynamic graphics with concurrent narrations. The modules described several events concerning plate tectonics such as the collision between continental plates or the creation of crust in the ridges. Dynamic graphics in the *realistic condition* were videos faithfully reflecting the physical features of plate tectonics (see Figure 1). Although they were not completely realistic, since plate tectonics could never be directly observed, they were the most feasible way of depicting tectonic phenomena in a real word-like manner. Graphics in the *schematic condition* were animations based on simple black-and-white line drawings, highlighting functional features of plate tectonics (see Figure 1). Although they were somewhat simplistic, schematic graphics preserved the essential information of plate tectonics. After viewing the presentation, participants solved the *structural test*, consisting of four open-ended questions about physical features of plate tectonics (e.g., “Describe what a ridge is”; “State the differences between the Andes and the Himalaya plate collisions”). Total scores ranged from 0 to 8. Finally, the participant solved the *conceptual test*, which included four open-ended questions about functional features of plate tectonics (e.g., “Could the Himalaya range have volcanoes in the future?”; “Imagine that eruptions in the Andes range stop, how would you explain it?”). Total scores ranged from 0 to 8.

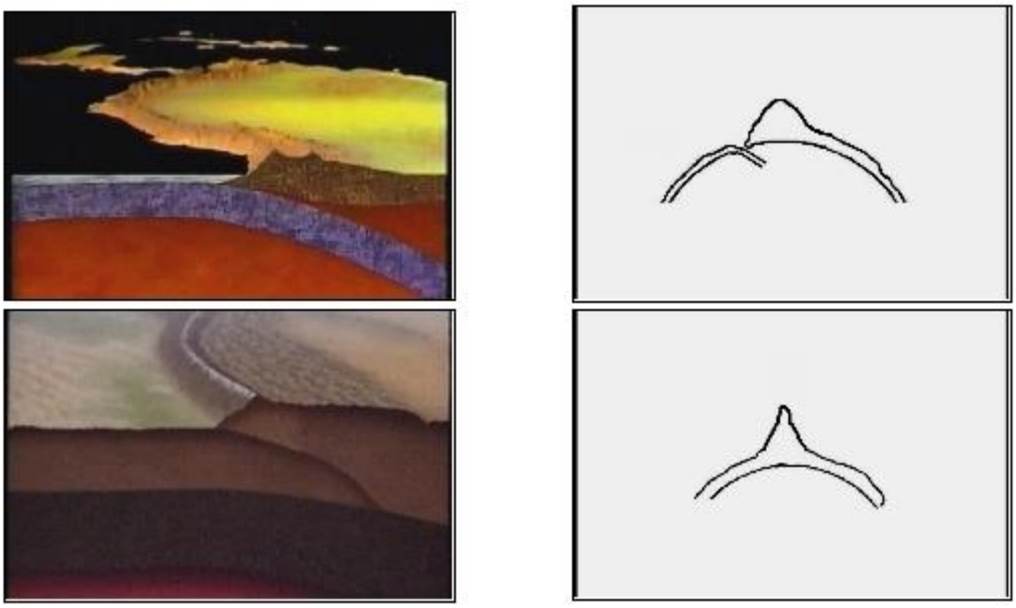

Figure 1. Snapshots from the realistic (left) and the schematic (right) graphics.

Results

Performances of both conditions in all variables are shown in Table 1. A MANCOVA with condition as the between-subjects factor and prior knowledge as a covariate revealed that there were no differences between conditions in the structural test, $F(1, 33) = 0.11$, $MSE = 2.52$, $p = .74$. This indicates that participants in the schematic condition and those in the realistic condition were equally able to understand the physical features of the components in plate tectonics. With regard to the conceptual test, the MANCOVA indicated there were significant differences between conditions, $F(1, 33) = 4.51$, $MSE = 1.99$, $p < .05$. This means that participants in the schematic condition were more able to understand the functional relations between the components in plate tectonics, as compared with those in the realistic condition.

Table 1. Means and standard deviations of all conditions in all variables.

	Prior knowledge		Structural test		Conceptual test	
	M	*SD*	*M*	*SD*	*M*	*SD*
Realistic	1.53	1.36	2.73	1.98	1.60	1.64
Schematic	1.19	0.93	2.73	1.43	2.51	1.28

Discussion

The coherence principle establishes that extraneous material, such as irrelevant details, should be excluded as it can hinder learning (Mayer, 2005). One prior study investigating whether participants studying cell mitosis learn more from schematic dynamic graphics as compared to realistic dynamic graphics found results consistent with the coherence principle (Scheiter et al., 2009): participants in the schematic condition outperformed their counterparts in structural and conceptual tasks. In our experiment, participants in the schematic condition outperform those in the realistic condition in the conceptual test. This replicates the finding of Scheiter et al. and represents additional support for the coherence principle. Overall, these results indicate that learners are more able to gain deep understanding of complex topics from graphics that eliminate extraneous material, as they allow learners to use all their cognitive resources in germane processing.

Despite the differences in the conceptual test, realism had no impact on the structural test, which is not in line with our prediction. One possible explanation for this is that the number of items we asked our participants to solve was low. It is possible that a higher number of items would be more able to capture differences between conditions. Another possibility is that schematic dynamic graphics are especially suited for conveying conceptual (instead of structural) knowledge, as they highlight functional relations between the components of a cause-and-effect system rather than its anatomical properties. Future work could explore this possibility.

A practical implication of our results and those of Scheiter et al. is that multimedia presentations have to use schematic (rather than realistic) graphics if they are to be effective.

References

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