Illustrations and Animated Visual Presentations

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Abstract

Illustrations and animated visual presentations can help to bridging the gap between phenomena and their theoretical explanation, and especially focus on the time dependent aspects. If they illustrate facts and exhibit connections that still pictures can not achieve, they offer new opportunities for teaching and learning in physics. Some of those special features will be identified, classified and categorized according to the effects intended. In a pilot study students had to evaluate various animations and compare them with still pictures.

Introduction

Illustrations and animated visual presentations are increasingly used in multimedia applications. Can they help to bridge the gap between phenomena and their theoretical explanation? Research on learning effects of animations does not yield homogeneous results.

1 Approach in several steps

The efficiency of animations depends on numerous factors. General statements can hardly deal with the great variety of aspects. Our idea is to approach to the problem in several theoretically and empirically based steps:

The first step is based on theoretical reflections and categorization. Eight special features are identified, that only animated presentations can offer.

The second step is to look whether students see the animation to be helpful, too. Can dynamic visualizations present information in an attractive way, and do students think that they gain new insights? It is important that they can recognize and process the information.

The third step is to look on the learning process in detail. We focus on multicoding, cognitive flexibility, cognitive load and depth of processing. (But these aspects will not be discussed here because of time and space.)

In this talk the theoretical considerations are discussed and corresponding applications are shown. They are related to the assessments of students.

2 Special features of animations

If dynamic visuals can illustrate facts and point out connections that still pictures can not achieve, they offer new opportunities for teaching and learning in physics. Some of those special features particularly tailored to applications in physics will be identified. Objectives and the design of several examples from different fields of physics are analyzed. They are classified and categorized according to the effects intended and the method used for visualization. To keep concrete the statements are combined with an example from physics.

2.1 Temporal and spatial arrangements

The first four items mainly focus on aspects how to design information so that it can be processed effectively.

2.1.1 Sequencing pictorial information. A fundamental difference between pictorial and text based information is, that pictures present details simultaneously, while text deliver statements in sequence. Animations can add details step by step and thus combine advantages from both sides. The following pictures are hardcopies taken from an animation that explains why it's getting foggy when there is a temperature inversion in a valley.

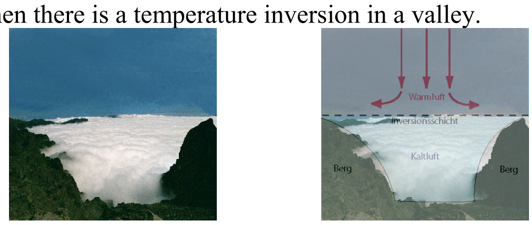

Fig. 1: snapshots from animation 1.

2.1.2 Restructuring or show structural similarities. On the surface the circuit diagrams shown in fig. 2 seem to be different (may be not only for beginners). Computer animations can show that they are equal and that they can be converted into one another by simple transformations.

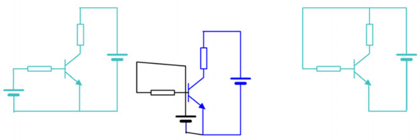

Fig. 2: snapshots from animation 2.

2.1.3 Visual hints in the course of events. Guiding attention with the help of visual hints makes sense in processes with complex dependencies or when several details should be noticed. Also in experiments those components that should be watched simultaneously can be emphasized by means of graphics. A corresponding animation will be shown and discussed.

2.1.4 Assistance for using different representations. Relate representations that are close to reality to abstract ones quite often cause problems for beginners. Animated illustrations can indicate how one representation is related to another, or even how a particular representation is created, e. g. a diagram with time dependent values,

The picture shows a snapshot from an animations that connects the movement of an oscillator to an $y(t)$-graph.

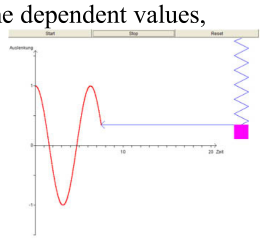

fig. 3: snapshots from animation 4

2.2 Illustrate what cannot be seen easily

The second four examples are intended to illustrate subjects in new ways. That way they offer a new quality of information.

2.2.1 Explain causal connections and models. Animations offer special possibilities for an illustration when cause and effect chains are based on time-dependent and spatial factors. – Are water waves really transversal waves? Where does the water at the crest of a wave come from? Where is the water, if there is a tough? In many textbooks you can read that the particles move in circles. Is this model suitable to describe moving waves? May be you can imagine, but an animation can offer a possibility to observe this.

2.2.2 Illustrate the time-dependent and spatial development of physical quantities. An animation can illustrate a process that is difficult to observe and show characteristics. Heat conduction is the process looked upon in fig. 4. The snapshot is taken out of an animation that illustrates the conduction of heat. The flow of energy differs totally from the way energy is transferred by mechanical waves. Only dynamic presentations can give an adequate impression.

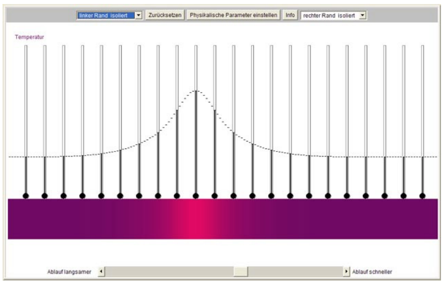

fig. 4: snapshots from animation 6

2.2.3 Discern phenomena in new ways. New techniques can make new approaches accessible. A film is made from a pendulum hanging from the ceiling. The specific feature is that the camera is placed on a rotating disc. Fading out colors and the background of the video clip gives new insights about the perception of movements in a rotating system: No one would say that the pendulum moves on a straight line. But when the background is faded in again, it seems to move on a straight line.

2.2.4 Analyze or derive abstract statements. Moon and earth are not connected with a stir axle. The motion of different points round the centre of mass is looked upon. Dynamic visuals can help to build up ideas about this complex movement.

3 Assessments from students

In a pilot-study we showed the animations to 16 students of our university. Among other questions they had to grade the attractiveness and the value of the information presented. We used the animations described in chapter 2 in comparison to still pictures. Scores were given in grades from 1-6 (1 is the best). The attractiveness of the animations (*attr. a.*) is assessed better than the attractiveness of still pictures (*attr. p*). The differences are significant / highly significant with one exception (2.1.2). Concerning the value of the information (*expl. a.* for animations and *exp. p.* for still pictures) the students set even bigger differences.

Nr.	2.1.1	2.1.2	2.1.3	2.1.4	2.2.1	2.2.2	2.2.3	2.2.4
attr. a.	2,3	2,7	3,0	2,1	2,6	1,9	1,9	2,3
attr. p.	2,7	3,5	3,6	3,3	3,3	3,7	3,3	4,1
P	2,7%	9,2%	4,8%	0,4%	4,7%	0,1%	0,2%	0,1%
expl. a.	2,3	2,7	2,6	1,9	2,1	2,3	2,4	2,3
expl. p.	3,2	3,9	3,8	2,9	3,7	3,6	3,6	4,1
P	0,1%	0,9%	0,7%	0,4%	0,1%	0,1%	0,6%	0,1%

Data concerning example 2.1.2 seem to suggest the hypotheses that the scoring depends on the fact whether the topic could be understood or not. Students who declared that they did not understand the topic, gave lower rates for the animations. Obviously the dynamic visuals were more confusing for them than still pictures. (Most problems were linked with the displacement of the energy supply.) But, of cause, this has to be tested with a larger population. We just started an internet based inquiry for that. (More date will be available till July.)

4 Outlook and general findings

We presented the material only with 3 or 4 sentences about the context in physics (written in html-document that also included the animations). But the students' comments indicate, that the context and additional information are very important factors.

In another test with 150 9^{th} graders we also offered animations. One result for that population turned out clearly: Students have to work with the material to support depth of processing. This seems to be a precondition that they think about details and that they can remember the content.