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ANIMATIONS – A NEW COACH TOOL FOR DOING SCIENCE

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Abstract

In an ongoing research project since 1986, the AMSTEL Institute of the University of Amsterdam is developing Coach – a Multimedia Learning Environment for Science and Mathematics. This environment consists of integrated tools for data collection via interfaces and sensors, control of processes and devices, data video for measurements on digital videos and images, processing and analyzing data, modeling (system dynamics approach) and authoring of activities by teachers and students (texts, multimedia components, hyperlinks, etc.). It is meant to encourage an inquiring approach to science and facilitates authentic research activities of students.

The newest tool integrated in Coach allows creating and playing animations which can be driven by a sensor, by a model or by a program. The first classroom research results show that the addition of animations allow students comparing more richly different representations which results in better understanding.

1. Coach – Learning Environment for Science and Mathematics

Integrating the use of computers (ICT) into Education is still one of the most important issues in many countries. AMSTEL Institute of University of Amsterdam is already for many years active in educational research, curriculum development and development of hardware and software, which can be used in Science and Mathematics Education at primary and secondary school level.
Since 1986 AMSTEL is involved in a project of developing computer learning environment Coach. This ongoing project is driven by educational research, classroom experience and information technology. Main concept of this environment is the concept of an “open” learning environment that offers universal, scientific tools, which can be used to solve many different problems. These tools resemble technologies used by “real” scientists and facilitate an inquiry and active approach to science and mathematics (Mioduszewska 2000, Heck 2008).

The learning environment Coach 6 consists of the following integrated tools for:

- **Measurement** - collecting and displaying data measured via sensors.
- **Control** - controlling of processes and devices,
- **Data Video** - collecting data on digital video clips and digital images,
- **Modeling** - constructing and using computer models of dynamical changing systems,
- **Data processing** - the data collected in measurements, video measurements or generated by models can be further analyzed with help of many simple and advanced processing tools.
- **Authoring** - creating multimedia activities with text, pictures, video clips and internet pages.

Coach activities are mostly based on the selected tool for collecting data. Teachers can use ready-made activities or create their own multimedia activities as parts of their lessons materials.
Depending on the subject and the level of the students, teachers can make a choice of tools. They can enrich the activities with:

- texts with activity explanation or instructions;
- pictures with illustrations or equipment and experiment;
- videos or photos to illustrate phenomena or showing the activity procedure;
- web pages with extra information;
- measured data presented a graphs, tables, analog meters and digital values;
- models to describe and simulate phenomena.

The newest integrated tool which has been developed in Coach is Animation.

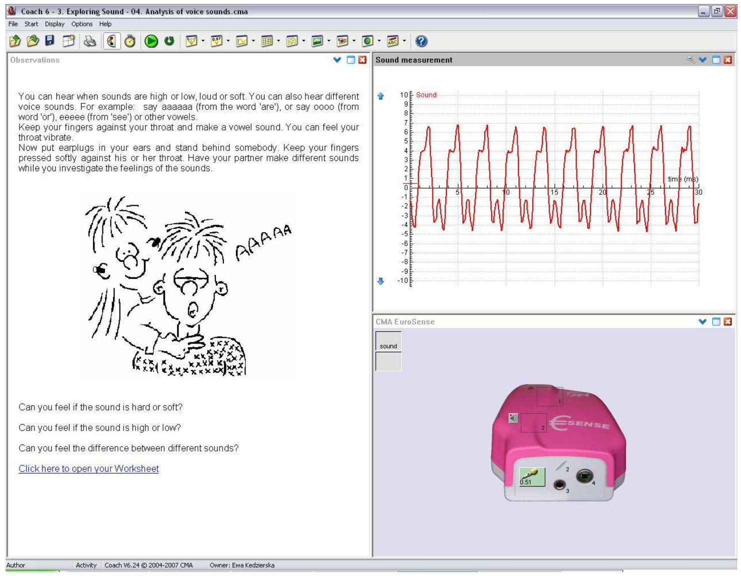

Figure 1: Analysis of voice sounds in Coach 6.

2. Animation

Presenting data in graphs or in tables may not be enough for students to fully understand the underlying principles of a phenomenon. Coach 6.3 is enriched with another way of representing the data – animations.

Coach animations consist of animated graphics objects, like ellipses, rectangles, vectors and pictures, which can be linked to model variables, program variables or sensor values to control their positions or sizes. The heart of an animation is a model, program or sensor data. This is the 'engine' which contains all the rules and formulas governing the variables involved and which leads to data as input for the animation.

Constructing an animation is an easy process: choose the desired graphical objects, place them on the animation stage and assign their properties which describe the way they are displayed and animated. Additional interactive control objects like buttons and sliders then can be added. These control objects allow altering parameter variables during the execution of the animation to interact with the system and to see the effect of those changes.

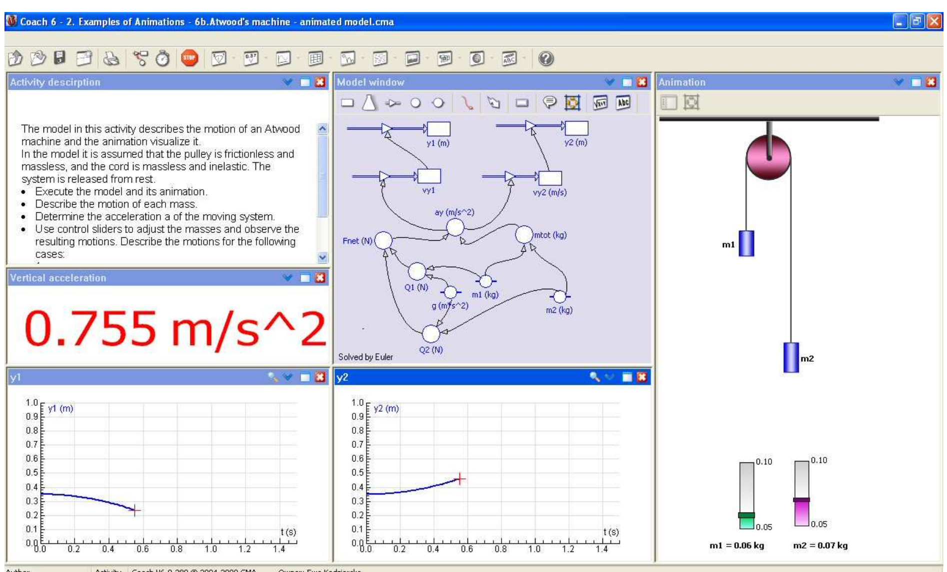

Figure 2: A graphical model of an Atwood machine and an animation driven by the model.

An example of an animation driven by a model is shown in Figure 2. The graphical model describes the motion of an Atwood machine system and the animation visualizes this motion. A student can interact with the animation through slider bars, that is, select the values of the masses before the start of the simulation or change it while the simulation runs.
An animation allows students to first concentrate on understanding a phenomenon with the help of simulations before going into the details of how the simulations have been implemented by means of computer models.

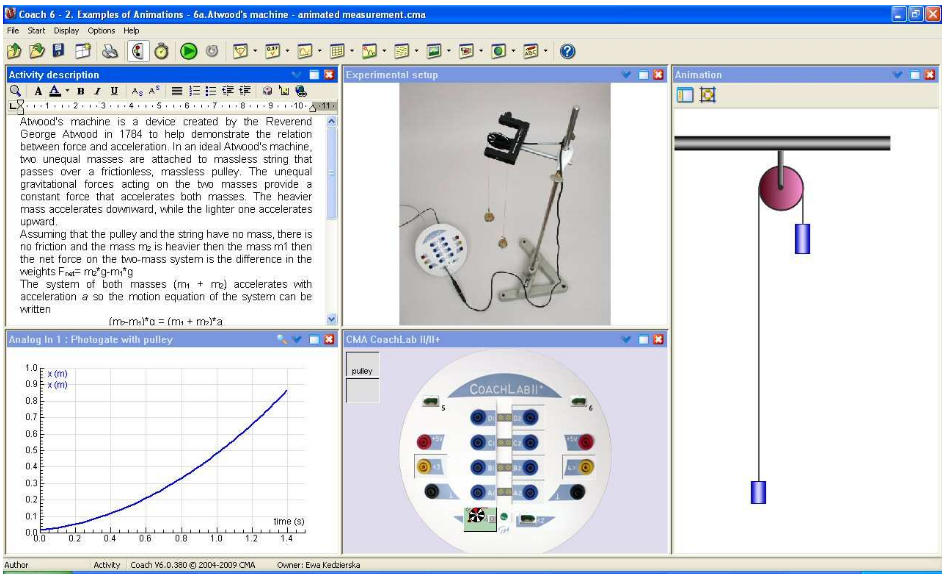

Figure 3: A measurement via the CoachLab II interface and Smart Pulley and an animation driven by the measured sensor values.

An example of an animation driven by a sensor value is shown in Figure 3. The mass in the animation moves according to the position measured by the sensor.
Visualizations provided by animations help students better understand the meaning of data. Synchronizing graphs with animation allows students to bridge the concrete visual display of a motion event and its abstract graphical representation.

3. First try-outs in school

The possible educational benefits of using animations with students were tested during a pilot project "Combining video analysis and model-driven animation in the second year of Dutch Secondary Education (13-14 years)". This pilot project was a part of larger research project on development of a learning path into computer Modeling in physics, performed at AMSTEL Institute by Onne van Buuren (Buuren 2009).

The research questions connected to this project were:

- Is it possible to involve students of 13-14 years into a complete modelling cycle?
- Can a combination of video analysis and model driven animations stimulate students to interpret and evaluate their models?
- Can this combination stimulate students to use or acquire new domain skills?
- What differences in behavior are there between well- and poor skilled students?

In the project an introductory series of five lessons on kinematics were developed. The materials were mostly focused on the way the students used different representations of motion (animation, formula, x(t)-graph, and v(t)-graph). The materials were tested in two different groups of 30 students each. After testing in the first group, it was possible to adapt part of the materials for the second group. In that way there were two research cycles.

As a context for a video measurement the start of a runner was used. The measurements of the students resulted in an x(t)-graph. The students had to study qualitatively the relation between the velocity of the runner and the slope of the x(t)-graph. Furthermore, they had to determine quantitatively the *mean velocity* of the runner over different intervals of time.
Then students were introduced to Modeling, the start of the video runner had to be modelled in a simple way. The animation included in the activity showed two runners, one driven by the video data and one driven by the model data. The model should have the same starting place and the same mean velocity as the video runner. The students had to determine the right values for these parameters from the x(t)-graph of the video runner, just as they had done in the lesson on video-analysis.

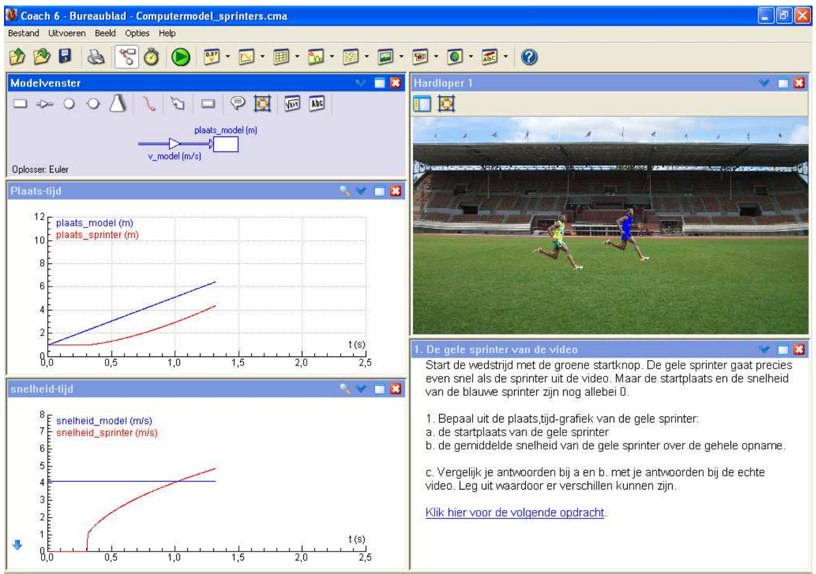

Figure 4: A model driven animation.
The animation shows two runners, a video runner moving according to the collected video data (red graph) and a model runner moving according to the generated model data (blue graph).

By means of questions and tasks the students were invited to compare video and model in each representation, and to compare different representations with each other. A fourth representation was offered by the formula, which the students had to use to determine the mean velocity of the video runner. This velocity had to be entered into the model. The run of the model provided them with feedback on the results of their calculations.

The first results of the research confirmed that it is possible to involve students of 13-14 years into complete modeling cycle. The combination of video analysis and model driven animations stimulates students to interpret and evaluate their models. The combination of animation and video acted as a debugging tool. Students still made mistakes in determining the mean velocity, but they clearly detected these and other mistakes by watching the animations and the x(t)-graphs, and they were able to correct these mistakes. Therefore we conclude that the combination of video and model-driven animation can act as a mechanism for self correction.

The research also showed that students were stimulated to use and acquire new skills like:

- comparing representations in order to get a better understanding of the more abstract ones;
- discussing different representations of the same movement;
- making and testing hypotheses about different representations;
- getting a better understanding of the relation between velocity and slope of the x(t)-graph by experimenting with different values for the velocity.

Differences were seen in behaviour between well-skilled and poor-skilled students. Poorer skilled students more often made use of the animations and their own experience with running. They seemed to avoid the more abstract and new representations. They also made more use of trial and error. After making a mistake, better skilled students still used all representations in order to correct their error, whereas poorer skilled students showed some 'decline' to the less abstract representations.

Conclusions

The development of the Coach environment is an ongoing research project. Improvements and extensions are developed based on practical experience and research. Coach animations extend the possibilities of creating interesting and exciting materials for students. The first research results show that the animations add a new way of representing data which can help students in better understanding of analyzed phenomena.

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Coach Environment http://www.cma.science.uva.nl/english