

8. Finally we can apply command Polynomial with defined list of points. Graph of cubic function appears in the window Graphics. The formula of the cubic function is written into the Algebra window. All three windows together with described data and graph are displayed in figure 8.

## 5. Conclusions

The organization and guiding of learning activities focused on experimentation with various representations of data and investigation of relations between data is important for acquisition of mathematical concepts and knowledge. Understanding of mathematical knowledge is basis for development of students' competences to apply mathematical knowledge and skills in various situations and for problem solving.

Dynamic geometrical systems provides advanced tools for implementation of stimulating learning environment which allows work with various representations of data for use of different types of models. Our experience shows that the system Geogebra considering extensive options and easy availability belongs among the most utilized software systems in mathematics teaching. Although we have described only some of the possibilities of its use in the investigation of sequences in this article, Geogebra is versatile system usable in the mathematics education at primary schools and secondary schools and also universities.

It is necessary that teachers appropriately and meaningfully use the system Geogebra in mathematics teaching, to create not only guides explaining the environment and the commands of the program but also to provide teachers proposals and examples of its use in teaching of concrete topics. Then it depends on the skills and mastery of teacher as he can use offered digital tools to create a stimulating learning environment in which students can actively acquire and develop knowledge and skills and also discover new knowledge.

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## VIDEO RECORDINGS OF SCHOOL PHYSICAL EXPERIMENT

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**Abstract.** *The computers and the Internet have become powerful tools for teaching and learning physics at all levels of science education. This paper presents the preparation and the implementation of video recordings of school physical experiments which are available via internet, especially for the teachers of basic and secondary schools. This paper includes examples of videos for teaching physics and analysis of physical phenomena using free video analysis and modelling tool Tracker. The second section describes experiments with video clips. Finished projects and demos can be found on the website <http://pokusy.upol.cz>.*

**Keywords.** Experiment, ICT, physics, video analysis, video clips

## 1. Introduction

Information and Communication Technologies (ICT) provide a wide range of possibilities in teaching physics. A possible way of motivating students in teaching and learning physics is to use ICT in physics and science lessons. It is necessary to combine traditional and simple experiments with multimedia.

We live in a time of development of information technologies, which will certainly be reflected in the educational process. The school environment must be changed – the leading role of the teacher in physics education must be changed to the role of a discussion manager and an organiser of student's activities. The school education has to come closer to student's practical life and this can be done only by improving the ways of student's own activities. Only then the student will be prepared for life in the changing society. From this point of view, the experiment has a basic didactic and methodological function and students have to recognize the importance of experiments in science [2].

Nowadays, several types of experiments are used in physics teaching and learning: classical experiments, hands on simple experiments, virtual and remote control experiments (enables users control of real experiment from a remote location using internet and an ordinary web browser [1]) or video recording of an experiment.

The following text will discuss video recording of an experiment that was created at the Department of Experimental Physics in Olomouc, Czech Republic. All materials contained in the article are available on-line to teachers, students and the public on the website [www.pokusy.upol.cz](http://www.pokusy.upol.cz) [3] (see Figure 1) for free.

## 2. Video recording of an experiment

Real, classic, face to face experiments are a key factor of experimentation in primary and secondary schools. Working in the traditional school laboratories provides a direct contact with real measure equipment and offers an immediate feedback of the teacher or the classmates. Students gain practical skills during the preparation and measurement of individual experiments in these laboratories. However, there are situations when it is appropriate to replace or supplement the classic experiment to experiment with video recording. Without a doubt, it is necessary to replace a real experiment in these cases: dangerous experiments, long-term

experiments, very fast experiments, microscopic and macroscopic experiments and financially demanding experiments [6].



Figure 1. Website [www.pokusy.upol.cz](http://www.pokusy.upol.cz)

The web page [www.pokusy.upol.cz](http://www.pokusy.upol.cz) is divided into two parts. The first section is based on the master thesis of Zdeněk Pucholt [4] and contains 10 physical experiments with video analysis. Nowadays, there are many video analysis software packages, such as AviStep, Logger Pro, Physics ToolKit, Tracker and VianaNET. At our department we decided to use the program Tracker for video analysis.

The second section includes school physical experiments suitable for teaching at the secondary school. There are about 50 experiments on the website and approximately 30 of them contain a short video clip with experiment.

## 3. Software Tracker

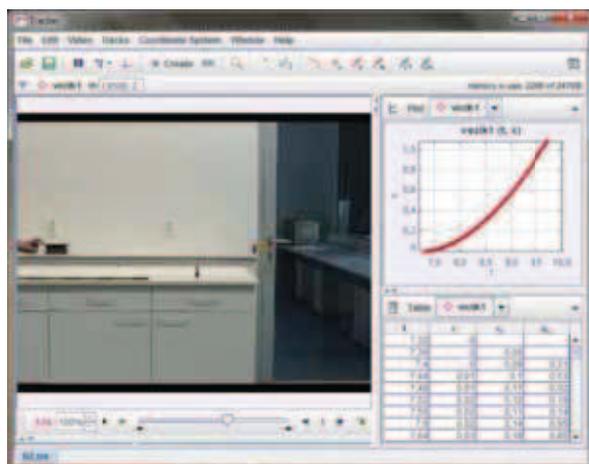
Program Tracker is a free video analysis and modelling tool built on the Open Source Physics (OSP) Java framework. It is designed to be used in physics education [5]. Installers for Tracker version 4.80 (available for Windows, Linux and Mac OS X operating system) are free downloadable from website <http://www.cabrillo.edu/~dbrown/tracker/>. To start the program, it is necessary to have JAVA

SE (Standard Edition) and QuickTime Player installed. The benefits of this program include:

- availability – free download;
- simple installation using the installation wizard;
- several languages;
- multi-platform application for Windows and Linux OS;
- broad support for input and output formats of videos and images;
- continuous development, adding new features and improvements.

There are some disadvantages, but on the other hand they are negligible in comparison with the advantages:

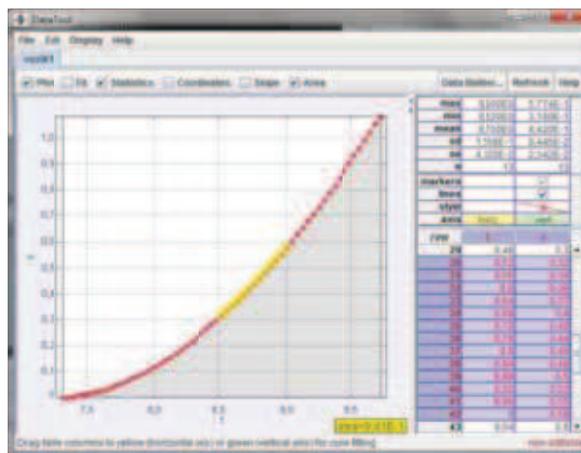
- the necessary cooperation with other programs (QuickTime Player);
- limited opportunities for representation of vectors of Forces (the velocity vector has the same colour with the vector acceleration);
- unsuitable graph export (impossibility of changing the size of the exported chart).



**Figure 2.** The main view of software Traker

The main view of software Traker displays the following components (see Figure 2):

- a main video view that displays video images;
- a menu bar that offers access to most program commands and settings;
- A player that controls the video playback and video clip settings;
- Additional views in attached view panes.



**Figure 3.** Picture displays a Data Tool with statistics, curve-fitting and other analysis capabilities

For video analysis in Traker program item Data Tool is used (see Figure 3).

Program Traker includes a broad digital library. The digital library enables users to browse and search collections of library resources such as videos and Traker experiments. Collections may be located on a local drive or remote server. Teachers can use these videos from archive and analyse them alone (e. g. [7]). We decided to make our own video clips from classical physics area. Four clips are from kinematics, two from dynamics and four videos are from the mechanical vibrations and waves area. Didactic analysis and video analysis of these experiments are described in detail on the website [www.pokusy.upol.cz](http://www.pokusy.upol.cz).

#### 4. Video clips with experiment

The second part of webpage of authors incorporates traditional and non-traditional school experiments. The aim of this website is to provide user-friendly and didactically comprehensive material for teachers that can be used directly in the classroom with using a computer and overhead projector, or it can be an inspiration for teachers to prepare real demonstration with real equipment.

Nowadays is on the website approximately 50 school experiments mainly from the areas of mechanics (examples of experiments: Atwood machine, fluid flow (see Figure 4), fluid pressure, pressure in vacuum chamber) and molecular physics (examples of experiments: surface phenomenon, thermal expansion, heat engines).



Figure 4. Experiment fluid flow



Figure 5. Video clip shaving foam in the vacuum pump

Each experiment contains brief theoretical introduction, list of tools, classification according to the curriculum, picture with

experiment, brief procedure how to prepare and conduct experiment, explanation of the phenomena and additional notes or links to other websites with similar experiments. Users registered on the website can discuss and comment experiments. About 30 experiments contain a short video clip, no longer than 2 minutes (see Figure 5). These experiments can be used in different stages of teaching (motivation, fixation, application or final revision). It is appropriate to combine the application for video recordings with real experiments [6].

## 5. Conclusions

Conducting experiments is a necessary part of teaching physics at all levels of science education and helps students to understand the basic natural phenomena and the principles related to the subject. There is a whole number of options that were not previously available. Video experiments are one of the possibilities. By combining physical skills and knowledge of computer it is possible to introduce new teaching element which brings a lot of benefits. As the information and communication technologies evolve, the concept of performing experiments in science education changes as well. The world around us is changing and we must change our approach to physical experimentation at school.

## 6. Acknowledgements

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## **AFFORDABLE TECHNOLOGY FOR EDUCATION IN PALESTINE**

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**Abstract.** *Palestine is a 3<sup>rd</sup> world country where education will help develop self-sustainability. Embedding technology into school education is encouraged. The aim of this workshop is to show how the Raspberry Pi can be used to introduce or enhance technology in education. The workshop will include; 1) a presentation on the difficulties of the provision of technologies in educational systems 2) hands on demonstration on how the Raspberry Pi can be used with different sensors 3) an introduction on the simple coding needed to run the devices that was developed to the purpose of using the Raspberry Pi in hands on experiments.*

**Keywords.** e-learning, Hands-on science using Raspberry Pi, ICT and the Raspberry PI, Raspberry Pi

### **1. Introduction**

Education is being challenged by the rapid development in technology. Schools cannot cope with this rapid change. Upgrading infrastructure and developing new professional development programmes are not easy low cost steps. Taking fast decisions without referring to research is another problem. Research usually takes several years and lags behind the fast pace of technology [7]. Therefore questions stand out about which technologies should educators be informed of. As though a technology might not be directly manufactured for education, but can be used for the purpose. Mobile technology is a clear example of technology used widely in education but were not synthesised for the purpose. They represent instant mobile accessibility to information as a very important commodity for education.

As ICT in education is growing fast, developing countries have no chance of keeping up. The problem of computer, technology hardware and software availability is a problem. Effective technologies are needed to enhance student understanding and learning specifically of scientific material. Science and technology education have a long standing history highlighted by the Science, Technology and Society; STS movement in the 1970s. Science educators suggested that science curricula should be organized around societal and technological issues [8]. There is also a need to build up students experience in modern technologies and in computer science hardware, software and applications. It is necessary to give ICT in education in developing countries a boost forwards to run in line with the world's progressive direction.

Some of the current uses for technology in education include computers, online tutoring and e-books. New forms of learning are emerging based on computer and mobile technology. Gps and simulations are also used. Developing countries do not have wide access to such technology, because of cost or lack of necessary infrastructure. Raspberry Pi might stand a chance in solving these problems.

### **2. E-Learning**

Teaching tools have reshaped education by providing information, resources, communication and collaboration at individual and institutional levels [8]. E-Learning is