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**ANIMATED CLASSROOM DEMONSTRATION TOOLS FOR PHYSICS  
CLASSES AS AN INNOVATION FOR IMPROVING EDUCATION  
QUALITY IN REMOTE SCHOOLS OF KYRGYZSTAN**

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*Most remote schools in Kyrgyzstan can't provide efficiently physics experiments due to lack of proper laboratory facilities. Graphically modelling and simulating Physics laws and concepts will help students understand profoundly physics and improve their modelling and simulating skills. In this current article is considered the modelling physics laws of mechanics, electricity and optics. It will help students to analyse processes occurring during implementation of these laws. Creating virtual laboratories on physics for remote schools in Kyrgyzstan will be able to provide economically cheap methods of teaching and it gives opportunity for remote school students to learn physics profoundly.*

**Keywords:** *proof animation, modelling, simulating, computer science, physics, demonstrative tools, remote schools, Kyrgyzstan.*

**Introduction**

Teaching is art. Pupils' engagement to the class belongs to teachers' creativity and experience. Especially science teachers need more than explanation the scientific concepts and laws. They need to show students experiments and use demonstration tools to help students to understand science better. According to OECD (Organization for Economic Co-operation and Development) performance in science of students in Kyrgyz Republic is very low. Kyrgyz students took 62<sup>th</sup> place among 65 participant countries [5]. They checked the performance of students in writing, reading, mathematics, and science. The poorest results of Kyrgyz students were in mathematics and science. This is because of lack of qualified teachers and lack of proper laboratory facilities in science, especially in physics, chemistry and biology.

There are many reasons which bring education of Kyrgyzstan to these results. The main reason that there are not enough qualified teachers is low salary, because of that, young graduates do not want to work at schools, they choose other jobs with higher salary. The second reason that there are not enough books and laboratory facilities in science at remote schools. The last but not least reason is economic condition of Kyrgyz Republic, and many student of remote schools work in fields to help their parents, mostly this is the only resource of their income.

Many remote schools now have computer classes due to the government program of supplying all schools with computers. Economically electronic demonstrative tools, simulation and virtual laboratories would be the best solution of remote school problems because you do not need to buy expansive laboratory equipments. Simulating science will improve efficiency of teaching science and improve science achievements of students. For example teaching physics by simulating physics concepts and laws will give more opportunities for students to understand better by visualising and intuitively feeling how these physics concepts and laws work and learn simulation techniques at that.

Providing Physics books with simulation samples of physics laws and concepts will be extra resources for pupils to learn. In this sample we will try to use Proof Animation Program to simulate two Physics concepts and laws in Mechanics, and Electricity.

### **Problem Formulation**

Simulation of Physics laws and concepts by students will give them opportunity to profound their knowledge in Physics, and improve their computer simulation skills. Here we will simulate two problems and laws of two branches of Physics, and they are divided into two groups: mechanics, and electricity.

First group consist of the animation of simple pendulum, and behaviour of that pendulum on the surface of earth and the moon. The first animated problem is:

How many times period of pendulum on the earth is greater than on the moon?

Free fall acceleration:  $g_{earth} = 9.8 \frac{m}{s^2}$ ,  $g_{moon} = 1.62 \frac{m}{s^2}$ ,  $L = 0.2$  m.

Second group consist of animation of simple circuit. Second animated problem is:

A curtain light bulb draws a current of 0.1 A when a battery 1.5 V is connected across it. What is the resistance of the light bulb?

We will simulate these two physics problems in two dimensions with Proof Animation P5 student version, because it will be very good for school students to start learning simulation in two dimensions. Simulation will help students who are have weaker mathematical background [2].

Virtual animation now gives us opportunities to do physical experiments economically cheap and ecologically safe. Now nuclear scientists use supercomputers to do nuclear reaction experiments. [3].

In countries like Kyrgyzstan students do not interested in science not only because of economic condition but also they do not have access to high technology educations. School children are always happy to see animated movies so animated experiments also will be attractive to them, and doing those animated experiment by themselves will improve their achievements not only in physics but in computer science too.

### Problem Solution

During the class teacher may use the simulation as demonstration tool. After providing a new theme to the students, teacher can give task to solve some problems shown bellow.

#### Pendulum problem

How many times period of pendulum on the earth is greater than on the moon?

Free fall acceleration:  $g_{earth} = 9.8 \frac{m}{s^2}$ ,  $g_{moon} = 1.62 \frac{m}{s^2}$ ,  $L = 0.2$  m.

Solution formula:

$$T = 2\pi \sqrt{\frac{L}{g}} \quad (1)$$

Answer:

$$T_{earth} = 0.88 \text{ s}, T_{moon} = 2.2 \text{ s}$$

**Period of pendulum on the Earth is 2.45 times faster than on the Moon.**

When students solve the problem teacher will give task to create animation of pendulum problem. Sample is in Figure 1. Here the steps how this animation was created.

- 1) Created Layout file. It was saved as Simple\_Pendulum.lay
- 2) In draw mode was drawn the rigid support bodies on which pendulum is suspended.
- 3) In class mode created Pendulum, and it was named as class1 string1
- 4) Back in draw mode used “place layout object” button to add two object classes (string2, string3) which had been created for two pendulums in class mode.
- 5) Bitmap pictures of the Earth and the Moon was added by “insert a bitmap picture button”.
- 6) Animation was saved again.
- 7) Created stream of commands for this animation. It should be created by Notepad or WordPad text editing programs. Stream of commands of this animation is shown below.
- 8) By using “Draw Static Text” button were written texts in animation.

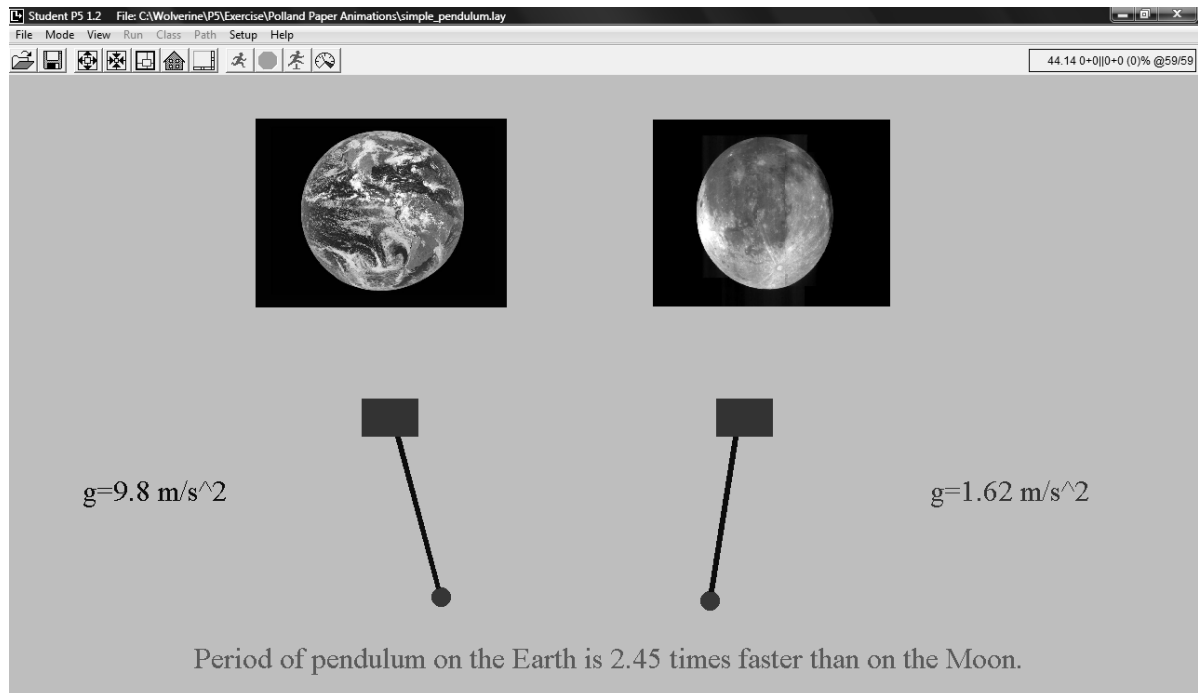


Figure 1. Create animation of pendulum problem

To move everything which was created in class mode and draw mode it is used the Trace Stream Commands. There are more than 40 commands. In current animation we can use only 3 commands: **time**, **place on**, and **rotate**. Here below is shown some part of Trace Stream Command of simple pendulum animation.

```

time 5
rotate string2 30 time 7 step 5
rotate string3 30 time 17 step 3
time 12
rotate string2 -60 time 14 step 5
time 22
rotate string3 -60 time 34 step 3

```

**Time** command is used to define when objects must move or when to implement other commands during animation. As you can see in above at time 5 class object string2 starts to move right side to the angle 30 degrees, speed is 7, and it will take 5 steps. Without using steps you will not be able to see smooth movement, it will jump from original position to the angle 30 degrees.

**Place ... on** command is used to place created objects in definite place of the animation or place created objects on paths. In current animation we used this command to place all class objects into animation.

**Rotate** command is used to rotate objects. We can define the speed of rotation too. In a sample you can see that in trace stream command are used positive and negative angles. These positive and negative signs are used to rotate the pendulum to

the right (when angle is positive) and to the left (when it is negative). Thus pendulum oscillates in animation.

### Building a simple circuit

A simple circuit contains energy source (e.g. battery cell), energy consuming unit (e.g. light bulb), switch and connecting wires. After introducing pupils with those elements of circuit and Ohm's law, teacher can show an animated version of a simple circuit. It will help pupils visualise and better understand those elements of circuit. Summarising the lesson when they solving simple circuit problems. Teacher can ask pupil to make an animation of the problem. Here below shown the sample of such problem with animation Figure 2.

A certain light bulb draws a current of 0.1 A when a battery 1.5 V is connected across it. What is the resistance of the light bulb?

**Solution:**  $R = \frac{U}{I}$  (2)  $R = \frac{1.5V}{0.1A} = 15 \Omega$

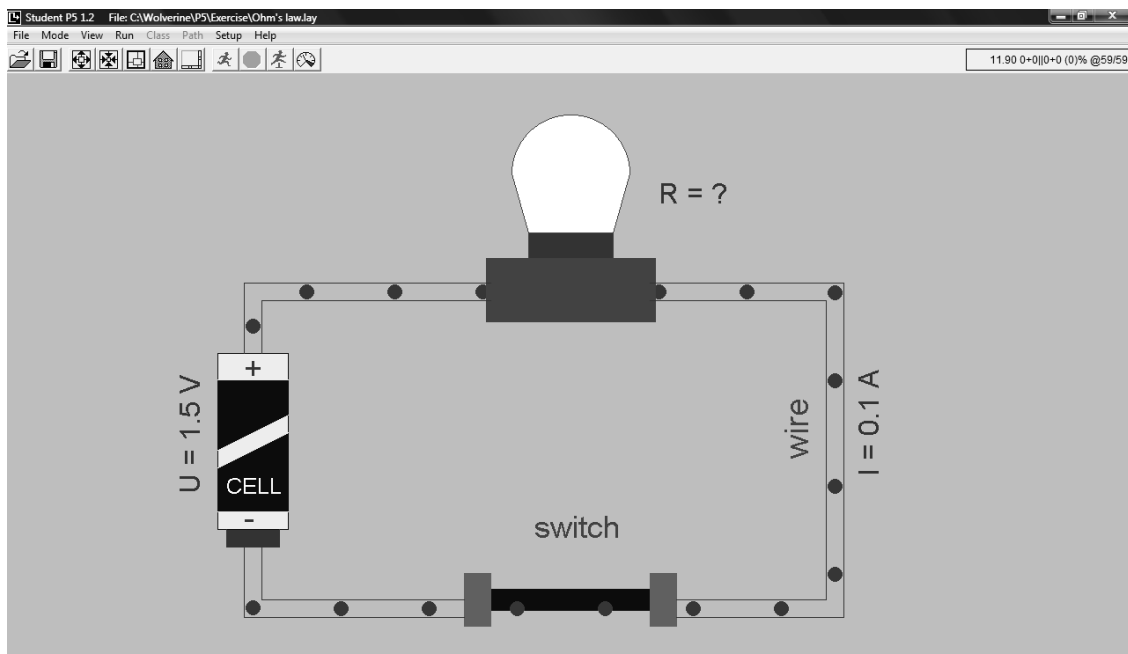


Figure 2. Animation of simple circuit problems

While demonstrating this animation pupils can get information about electrical circuits and Ohm's law. Here the steps how this animation was created.

1. Layout file was saved as "Simple\_Circuit.lay"
2. In class mode were created the lamp which is shining saved as "class1 lamp1", also created lamp which is off and saved as "class2 lampoff1", "class3 electron", and class4 switch
3. In draw mode these classes were added as object classes by the button "place layout object".
4. Battery was drawn in draw mode.

5. All objects were connected with straight lines which represent connecting wires.

6. The path for electrons was drawn in draw mode and in path mode was given to this path the directions and speed.

7. By the button in draw mode “draw static texts” were added all texts.

8. Created stream of commands for this animation. It should be created by Notepad or WordPad text editing programs. Stream of commands of this animation is shown below.

In Trace Stream Command of Simple Circuit animation are used **time create, destroy, and rotate, place...on at** commands. Here below is shown sample of these commands in current animation.

**Destroy** command is used to remove objects from animation.

**Create** command is used to create all objects which were drawn in class mode, and also to get back all destroyed objects.

**Place...on at** command is same as Place...on, except there we use preposition **at**. If **at** is included, the Object is placed *offset* units beyond the beginning of the first segment of the Path [7]. For example in our case electron3 is placed on epath starting 50 linier units beyond the beginning of the first segment.

```
create class3 electron4
destroy electron10
rotate switch1 30 time 5 step 5
place electron3 on epath at 50
time 110
end
```

During the animation shining lamp will be destroyed by **destroy** command and substituted with lamp which is turned off. In animation it indicates that when switch is off, lamp will be turned off. Electrons will be destroyed also which indicates that electrical current stopped.

When the switch is on in animation, we will use **create** command to get back all destroyed class objects. Of course lamp which is turned off will be substituted with shining lamp. Electrons will start to flow through wire again.

**Rotate** command in current animation is used to turn the switch on and off.

All Trace Stream Commands should be terminated by the END command.

### **Building Presentation**

Teaching physics laws with animation will be easier if these all animation are collected in one presentation. So presenter during the presentation will not reload the program after presenting each law. The presentations can be built as linear or hierarchical. Linear presentation is very simple. It has only simple ordered list of commands [7]. Each command is executed once, in sequence, unless a user

intervenes. In hierarchical presentations, commands are organized as groups, with optional subgroups, allowing the user to quickly navigate through a presentation [7]. Here below is shown the trace of command for building linear presentation of our animations.

```
group Physics Animation
item simple pendulum
run dissolve simple_pendulum
item Simple Circuit and Ohm's law
run dissolve simple_circuit
endgroup
end
```

While building presentation of animations as demonstration tool the teacher can add text slides too. All slides have to be prepared by Microsoft Word, and it must be saved in RTF format. Presentation trace commands stream have to be written by Word Pad or Note Pad text editing programs, and must be saved as text only.

### **Conclusion**

These animations could be used by teachers to demonstrate Physics laws and to raise school pupils' interest in science. These animations are very easy to make because there were used only basic commands and figures. Learning how to animate will also be very interesting for school children. So learning will be fun for them. That is exactly what we need while teaching students. Simulation can be very useful during solving the problems in Physics. Before solving the problems students can animate the problem which will help to understand the problem profoundly. At last but not least virtual science laboratories will be economically best solution to countries like Kyrgyzstan. But most important thing is delivering science to students properly and more interesting. In the future it will be very good to prepare animation for physics school textbooks for teacher and pupils.

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**ДЕМОНСТРАЦІЙНІ ІНСТРУМЕНТИ АНІМОВАНИХ КЛАСІВ ДЛЯ УРОКІВ  
ФІЗИКИ ЯК ІННОВАЦІЯ ДЛЯ ПІДВИЩЕННЯ ЯКОСТІ ОСВІТИ У ВІДДАЛЕНИХ  
ШКОЛАХ КИРГИЗСТАНУ**

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Більшість віддалених шкіл Киргизстану не може забезпечити ефективних фізичних експериментів у зв'язку з відсутністю належних лабораторних приміщень. Графічне моделювання та імітація законів і понять фізики допоможе студентам глибоко зрозуміти фізику та полішити їх навички моделювання та імітації. У статті розглядається моделювання фізичних законів механіки, електрики та оптики. Це допоможе студентам аналізувати процеси, що відбуваються в ході виконання цих законів. Створення віртуальних лабораторій з фізики для віддалених шкіл у Киргизстані зможе забезпечити економічно ефективні методи навчання та дасть можливість студентам віддалених шкіл пізнати фізику.

**Ключові слова:** анімація, моделювання, імітація, комп'ютерні науки, фізика, демонстративні інструменти, віддалені школи, Киргизстан.

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УРОКОВ ФИЗИКИ КАК ИННОВАЦИЯ ДЛЯ ПОВЫШЕНИЯ КАЧЕСТВА  
ОБРАЗОВАНИЯ В ОТДАЛЕННЫХ ШКОЛАХ КЫРГЫЗСТАНА**

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Большинство отдаленных школ в Кыргызстане не могут обеспечить проведение эффективных физических экспериментов в связи с отсутствием надлежащих лабораторных помещений. Графическое моделирование и имитация законов и понятий физики поможет студентам понять суть физики и улучшить их навыки моделирования и имитации. В статье рассматривается моделирование физических законов механики, электричества и оптики. Это поможет студентам анализировать процессы, происходящие в ходе выполнения этих законов. Создание виртуальных лабораторий по физике для удаленных школ в Кыргызстане сможет обеспечить экономически эффективные методы обучения и даст возможность для студентов отдаленных школ глубоко изучать физику.

**Ключевые слова:** анимация, моделирование, имитация, компьютерные науки, физика, демонстративные инструменты, отдаленные школы, Кыргызстан.