TO CLICK, OR NOT TO CLICK, THAT IS THE QUESTION

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Abstract This research deals with the high school students' response to involving new technology in the physics education. The goal is to measure the difference in the knowledge acquired with software for video measurement and without it. Using standard software for processing experimental data, Excel, the students focused their attention on where to click, instead on thinking about the results. This research presents the conditions in which this situation appeared.

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1. INTRODUCTION

When technology is used as a tool to support students in performing authentic tasks, the students are in the position of defining their goals, making design decisions, and evaluating their progress [1]. Video experiments are widely used in sports, crash tests, following of the fast processes in industry, and in the last few years (decades) in education. As computer technology develops, video measurements also develop.

Education is being partially transformed by new technologies. Today, the enormous amount of available information and even more, the increasingly rate of the information coming to the consumers, requires a transformative approach to education. It is imperative that the student of today learns how to be an information manager, rather than in information regurgitate" [2]

In this research two different approaches are used to measure the difference in the knowledge acquired by the students with video measurements supported by software and video measurement performed without software.

The first approach in video measurement uses Coach 5 as a software for supported video measurement (SSVM). With the Coach video data feature, various activities can be created for students to explore various motions. In the beginning the students have to set the frame of reference i.e. the axis and the origin, as well as the recording frequency. The experiment continues with many clicks on the moving object, during which the graphs and tables are automatically filled and drawn. During this process the students can watch how the

curves in the graphs are "growing". This gives students the opportunities to make a comparison between the trajectory and the graph.

The second approach uses video measurement without software, or in another words, manual video measurement (MVM). In order to perform this measurement, video player should be used, or software for video playback. We decided to use Media Player Classic. In this case, all values read from the video clip are manually imported in Excel by the students and calculated with the pre-imported formulas. Importing the formulas and calculating was done by the students, but with lot of help by the teachers. In order to measure the displacement, a meter stick is placed along the trajectory. The time intervals are measured from the recording frequency.

2. EXPERIMENT AND SAMPLES

The students had to investigate a free falling object and from these measurements, their task was to calculate the kinetic and gravitational energy in various positions as well as to discover the energy conservation law. The control group used SSVM, and the experimental group used MVM.

The sample consists of **eighteen** students from the first grade, high school, divided into two groups, experimental and control group, each of them with nine students.

Before they started with measurements they had a theoretical introduction about energy conservation law and briefly clarification about what they should do during the class.

During the classes the students from the experimental and control sample were given written instructions with detailed description of each step. In addition, the control group was given instructions how to import the values obtained by Coach in Excel in order to calculate gravitational and kinetic energy.
Here are the details of the activities for SSVM group:

1. Discover the relation between the velocity and time and position and time.

In order to fulfill this task, start the program Coach 5. Open the project Energy conservation law, and the activity Free fall. The video clip of the free falling object is already imported. Start the measurement by clicking on the green dot. Click on the moving object to measure the coordinates and the time. The program automatically reads the coordinates and time and imports them in table and graph. Repeat this procedure until the program comes to the last frame and turns off automatically (when the red dot becomes green again). The graph is ready to use. The students already know that the formula for the free falling object is $y = v_0 t + gt^2/2$. In order to verify the formula and to obtain the coefficients (the initial speed and the gravitational acceleration) right-click on the graph, go to Analyze and pick Function Fit. In the field Function type select the function $y(x) = ax^2 + bx + c$ and click on the Auto fit. From the two options Add Graph and Replace Graph, select Add Graph. The velocity of free falling object is given by the formula $v = v_0 + gt$. In order to verify this formula and to obtain the coefficients (the initial speed and the gravitational acceleration) right-click on the velocity-time graph and from the Function type select $y(x) = ax + b$.

2. Calculate the kinetic energy for each position using the formula

$$E_k = \frac{mv^2}{2} \qquad (1)$$

3. Calculate the gravitational energy using the formula

$$E_p = mgy \qquad (2)$$

4. Calculate the difference between the gravitational and kinetic energy in various positions.

The students from the experimental group also got a written instruction with a description what they should do.

Here are the details of the activity /instructions for MVM group:

1. A free falling object is video recorded, with a meter stick next to the path of the object. The video clip is recorded with 24 fps. This means that the time interval between two frames i.e. between two consecutive positions is 1/24 s.
2. 2. You are given an Excel document with prepared worksheet (Fig.1). Read the coordinates from the meter stick and write their values for the given time in the second column.

	A	B	C	D	E	F
1	t (s)	y (m)	t2-t1 (s)	y2-y1 (m)	v (m/s)	tk (s)
2	0					
3	0,04					
4	0,08					
5	0,12					
6	0,16					
7	0,2					

Fig.1: Worksheet that was given to the students.

3. Selected **XY scatter** from **Insert chart** and select the option **Scatter only with markers**. *X*-axe is standing for the time, and *y* is standing for the position. On any of the dots right-click and select the option **Add Trend line**. The theoretical formula is

$$y = v_0 t + \frac{gt^2}{2}. \qquad (3)$$

In **Trend/Regresssion** select **Polynomial, order2**. On the same window select **Display equation on chart**. Polynomial, order 2 means that the curve is parabola.

4. The average velocity in interval Δt is given by the formula

$$v = \frac{\Delta y}{\Delta t} = \frac{y_2 - y_1}{t_2 - t_1} \qquad (4)$$

Calculate the time intervals t_2-t_1, and the position change y_2-y_1 in the corresponding columns [t2-t1 (s) and y2-y1 (m)] and use them to calculate the speed using the eq. (4). Insert the values for the speed in the corresponding column [$v(\text{m/s})$].

The obtained value for the speed is average speed for every of the time intervals. That means that the speed value stands for the time $t_{21} = (t_2 + t_1)/2$

Insert this correction for the time in the corresponding column [tk(s)].

5. Construct the velocity – corrected time graph. The procedure is the same as for the previous graph. When selecting the **Trend/Regresion type,** select linear function. The calculation for the kinetic and gravitational energy is the same as the control group.

3. THE RESULTS AND DISCUSSION

In order to measure the change of the students' knowledge in the two groups the students were pre-tested and post-tested. The test consists of eight questions, each question testing different knowledge. Six of them were multiple choice questions, while two were open ended questions. The questions are based on the previous researchers' experience and other authors' experience [4, 5]. In the multiple choice questions, distracters are included in the offered answers. The same test was given at the pre-testing, before the video classes and at the post-testing, after the video classes. Therefore, the criterion is the same too. In this paper, the results from the last two questions, 7th and 8th, are given, which test the knowledge and understanding of the diagrams, which describe motion. In the seventh question, only one option is correct, and the goal is to see can the students recognize the object's motion from the shape of the curve in the position - time graph. In the last question, two options are correct, and the goal is the same as in the previous question. Students have to determinate the motion of the object by the shape of the curve in the velocity – time graph.

The 7th question is:
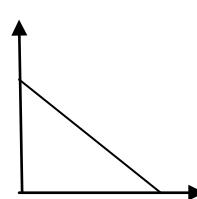
The four diagrams represent position-time graphs for four different objects. On which of those objects non-zero net force acts?
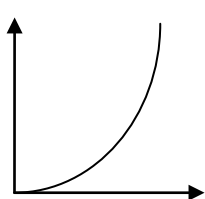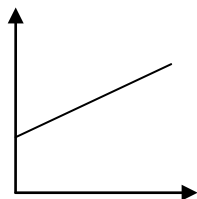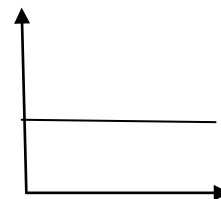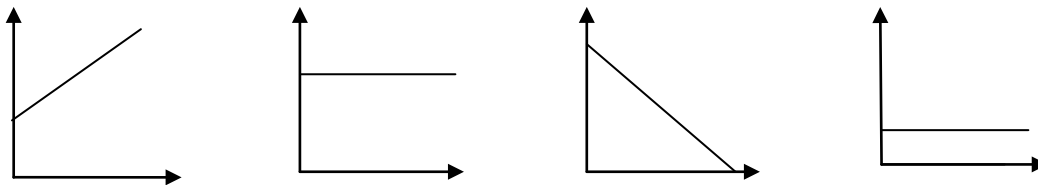

a)   b)   c)   d)

The 8th question is:

The four diagrams represent velocity-time graphs for four different objects. On which of those objects non-zero net force acts?

a)   b)   c)   d)

The distributions of the students' answers on 7th question from pre-test and post-test are given in fig. 3. Here, the students have to understand that if a non-zero net force acts on an object, then the object's motion is accelerated. This should bring them to the a) choice, which is the correct answer. The distributions of the answers show that big number of the students from the control group have chosen the correct answer on the pre-test, six students, while three students have chosen the b). But, at the post-test only two students have the correct answer and seven students have chosen the incorrect answer, b), which is a negative change. Other researches show that students do not pay attention on the quantities presented in the diagrams [5]. Weather it is position or velocity on the vertical axis it does not make any difference to the students. Sometimes they even explicitly change the quantity in the diagram. The shape of the graph in option b) is the same as the velocity – time curve for accelerated motion, which means that the students who do not have good understanding of motions and graphs, can easily be confused and mix up these diagrams.

Most of the students from the experimental group have chosen the correct answer at the pre-test, seven of nine. This does not give space for big change and at the post-test all of the students from the experimental group have chosen the correct answer.
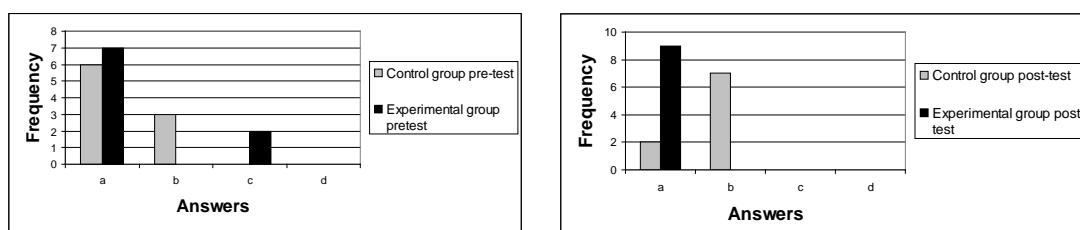
Fig. 3: Distribution on the answers of the seventh question on pre-test and post-test for control and experimental group.

The distributions of the students' answers on 8th question from pre-test and post-test are given in fig. 4. Here, the students have to understand that if a non zero net force acts on an

object, then the object's motion is accelerated. This should bring them to the a) and c) choice, which are the correct answers. Unlike in the 7th question, here they have two correct answers. The a) represents accelerated motion and c) represents decelerated motion. The distributions of the answers show that the answers of the control group are distributed in the correct answers, but, there is not any student who gave the both correct answers. Later, ate the post-test, all students from the control group have chosen only the a) answer, which cannot be taken as positive nor negative change.

Five students from the experimental group have chosen a) answer at the pre-test and 4 students have chosen a) and c) answers, which is complete correct answer. Unfortunately, only two students have chosen the complete correct answer at the post-test. This shows the general problem with understanding velocity-time graph. Students understand position-time graphs easier, but when comes to the velocity-time graphs, additional activities are needed to overcome this problem.
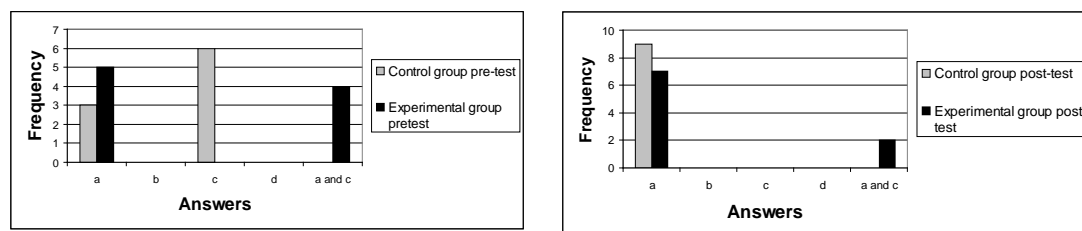
Fig.4*: Distribution on the answers of the 8th question on pre-test and post-test for control and experimental group.

According to the results given in fig.2, the number of the students who answered correct to the seventh question is smaller on post test than the pre test for the control group. The experimental group has more correct answers on post test than the pretest.

As for the last question where two options were correct, we have to take in advance and the number of the students who chose only one correct option because the number of the students who chose the two correct options is too small. So for this question the number of students who decided for the option in which the shape for the velocity - time is the same as the shape which they get on the experiment is biggest for both groups.

4. CONCLUSION

The most of the students were focused on the problem where to click, instead on the results. The advantage of this approach is that students collect data manually so their conclusions and answers are based on their previous as well as new experience. Unfortunately, their previous experience with software supported video measurement or Excel is too small so this problem is transferred on their usage. Maybe if the students use longer Excel or manual

video measurement as a tool they will show better results, which opens new subject for further research.

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