Flipped classroom, web-based teaching method analysis focused on academic performance

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***Abstract*—** The paper aims to introduce the experimental teaching in elementary school, when within half a school year (five months), was to teach mathematics using the flipped classroom method. Teaching took place in the classical pedagogical experiment, where a control group consisted of one class of pupils and the experimental group then the second class of students. Have met the conditions of entry experiment (pupils achieved similar knowledge test score). For the application of the method has been used a short tutorial videos created by the teacher. The subject matter discussed was divided into a total of twenty five animated videos. Students completed the intermediate and final testing. In post-test, a statistically significant difference between the control and experimental group.

***Keywords*—** flipped classroom, web-based teaching, educational video, pedagogical experiment.

I. Introduction

From the beginning of 21st century web-based learning environments have become increasingly pervasive in education. On-line study materials are not only used for distance education, but also school classes offered on-line components that complement classroom activities. Online classes use websites that provide a user-friendly interface and easy access to text, graphics, audio, and video materials that may be used and managed in a consistent and convenient manner. Usually, these websites include basic course information such as syllabus, announcements lists, instructor notes and links to other digital resources, and very often integrate tools for synchronous or asynchronous communication, streaming video, and applications sharing. Online learning is different than traditional classroom-based learning. This is mostly due to the fact that teachers and students do not have face-to-face contact. Thus, the teachers can have little control over their students' learning situations. Online components are accessible when the student needs them and learning is self-paced, providing students the chance to identify their learning goals and objectives and create their own path through course material. Although more flexible than the conventional school classroom learning, the online environment increases complexity. Students are forced to determine their own learning strategies and manage their time and resources [1].

Currently, for the creation of online learning materials use mobile devices (the so-called m-learning). This trend corresponds to a typical behavior of today's Internet users to access content from several sources at once. We talk about the multicreening [2]. Multiscreening is a very strong direction, which are adapted to simple websites and also advanced web applications. One response to this trend is that with websites and applications began to promote the so-called responsive web design. If a page uses responsive web design, it means that it is designed so that its contents and appearance of the device for adapting a window size of website browser. This makes it possible for example that if the page appears on a small mobile phone display, automatically organize elements on the page and place themselves under the navigation links are displayed pop-up menu, which is better suited for touch control. [3].

Current uses of information and communication technologies in education aim to reflect modern practices. One of them is also the flipped classroom method where the learning environment can use any mobile technology.

II. Flipped classroom method

In 2007, high school teachers Sams and Bergmann, from the state of Colorado began recording their hours for students who missed out on their lessons. After some time, they found that the majority of their students use video for repetition, during homework. This formed the basis Flipped classroom teaching methods [4].

At the end of 2004, Salman Khan began explain math through video conferencing. Increasing number of requests for tutoring forced him to record his interpretation, further placed on YouTube. With the growing number of videos as well as their popularity grew. In 2008, Khan founded the nonprofit Khan Academy and launched the first version of its website. His web khanacademy.org contains more than 4,000 educational videos [5].

Flipped classroom model came from blended learning rotation-model implementation in which a given course or subject (e.g., math), students rotate on a fixed schedule between face-to-face teacher-guided practice or projects in classroom during the standard school day and online delivery of content and instruction of the same subject from a remote location after school. The primary delivery of content and instruction is online, which differentiates a flipped classroom from students who are merely doing homework practice online at night. The flipped classroom method accords with the idea that blended learning includes some element of student control over time, place, path, and/or pace because the model allows students to choose the location where they receive content and

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instruction online and to control the pace at which they move through the online elements [6].

In the flipped classroom method is direct interpretation of the teacher replaced online video. Teaching is so that pupils learn through video with the subject matter at home online and come to school already with specific questions. Pupils can embed their questions under video as comment or debate in social network environment, which they share with the teacher. Teacher analyze questions and prepare learning activities focusing on problematical parts of subject matter. Easily understood part of the course will not pay too much attention. In class the teacher uses time efficiently because it focuses mainly those passages of the subject matter, which the students did not understand in educational video. During class, students learn to discuss and ask questions to the studied topics. In a way, they refines knowledge and gain a deeper insight into the issue. From passive listeners to become active learners. At home watching videos every student gets an opportunity to follow in the matter at their own pace. At the same time they learn to be responsible for their own learning. Method flipped classroom gives the opportunity to better understand subject matter and allows each student to reach the maximum of their abilities [7].

III. Math Animated Educational Video

Flipped the context of innovation at all levels of the education system, the use of information technology and communications tools is becoming increasingly common practice. These technologies in education, enabling integration into an active method of teaching.

Thus, the use of new teaching-learning tools, as postcasting and networked educational videos [8], are tools in expansion within the academic setting. But the speed with which these technologies have appeared and progressively consolidated, lead to get first evidences in this moment and draw real possibilities scenario, in order to identify more efficient and effective learning methods and improve teaching quality.

Caspi, Gorsky and Privman [9] divide educational videos into three categories depending on use and purposes: demonstration videos, narrative videos and lecture sessions videos. First of these categories, demonstration videos, are a really good tool for explaining the technical and natural sciences in order to allow and improve autonomous learning, becoming more effective than other methods based on more traditional teaching, such as books and written or oral manuals.

Mathematics is a systematic way of thinking that creates solutions to real events. In teaching math teacher try to model reality through simplification. In mathematical educational videos just animation allows to simplify and allows students to focus on understanding the nature of mathematics. Widely used option is screencasting [1], the creator of the video is recorded using the software of your notes and display the records in your comment. Another option is to create a method of direct video animation without disturbing the cursor. The method of direct animation, there are sophisticated commercial programs or you can use a combination of freeware software resources.

Therefore, this method allows educators, to develop new teaching and learning strategies, adding a new dimension in the teaching material.

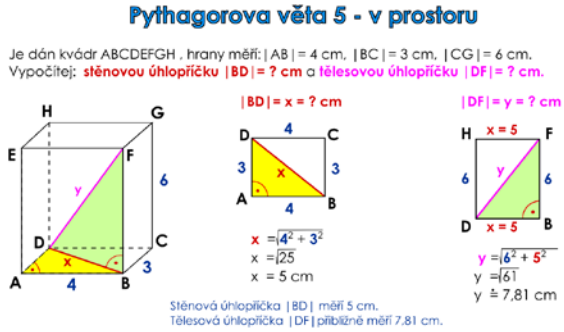

Fig. 1 Screenshot from direct animated educational video

IV. The Project

Traditional teaching methods (such as explanation, dialogue, description, laboratory exercises, etc. [10] and motivational teaching methods (such as dramatization, project training, field training, etc. [10] are used in conditions of secondary level of primary schools in the Czech Republic. The use of information and communication technology brings new possibilities, new procedures and methods. The project was focused on the application of flipped teaching method, when pupils learned some chapters of mathematics through educational online screencasts.

A. The project Aims

The aim of the research project was to implement training using the flipped classroom method and find out whether this method can help to increase students' academic performance. Based on your goals we have set the following hypotheses:

H_{01}: *In the resulting average score of pre-test we do not expect statistically significant difference between the control and experimental students groups.*

H_{02}: *In the resulting average score of intermediate test we do not expect statistically significant difference between the control and experimental students groups.*

H_{03}: *In the resulting average score of post-test we do not expect statistically significant difference between the control and experimental students groups.*

B. Methodology

Long term classical pedagogical experiment was used to verify the functionality of created screencasts [11]. We worked with the control and experimental group (always one class of the same school year). The control group of pupils progressed by traditional teaching methods, especially new exposition of the new curriculum took place during lessons. The experimental group had available educational videos that was specially created for the purpose of the experiment. For

distribution educational videos were created websites (prevracenatrida.cz).

Fig. 2 Infograpic from website (prevracenatrida.cz)

There we also explain, what flipped classroom teaching method is. Students watched video during home preparation. They had the opportunity to comment each video and discuss the problematic part of the matter on the social network. Brief summary of the topic and explanation of the problematic parts was performed in classes. Emphasis was placed on independent work and deepening knowledge. At the beginning of the experiment the control and experimental group went through a didactic test (pre-test). In the middle of experiment students pass intermediate test. At the end of the experiment both groups then passed another didactical test (post-test). Twenty-five educational videos were created that cover the mathematics curriculum first half of the eighth grade. The researcher was also a math teacher for the experimental group.

At the end of pedagogical experiment pupils of the experimental group filled out a simple questionnaire, which consisted of three closed questions. The questionnaire was chosen as a fast feedback of pupils to the new method. Pedagogical experiment was conducted from September 2013 to January 2014.

Statistical software NCSS and Excel was used for data processing. Basic values of descriptive statistics were calculated for testing hypotheses, then Student t-test and the Mann-Whitney nonparametric test whereas the normality tests did not confirm unequivocally normal distribution of the collected data. Hypotheses were tested at a significance level $\alpha = 0{,}05$.

C. *Research sample*

Pedagogical experiment was attended by 54 students, 27 in the control and experimental class (Fig. 3, Fig 4).

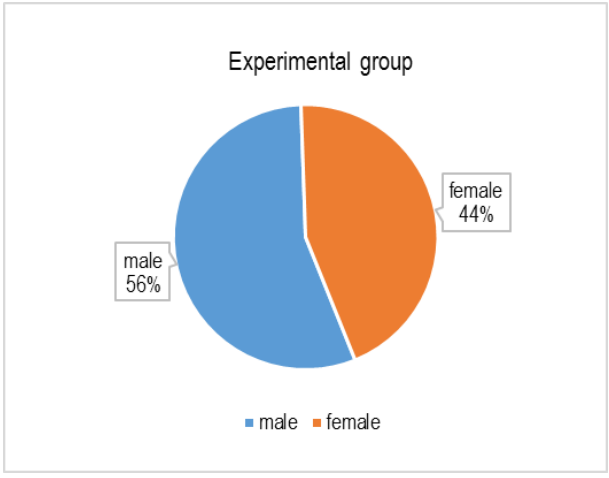

Fig. 3 Distribution experimental groups by gender

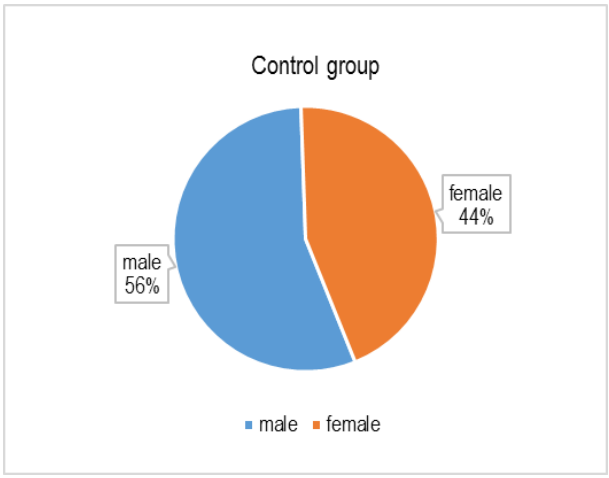

Fig. 4 Distribution control groups by gender

The average age of students in the control group was 13.4 years (standard deviation 0.96) in the experimental group was 13.2 (standard deviation 1.15).

D. *The research results*

The basic task to enter the pedagogical experiment was to compare the input knowledge of students. The pupils finished entering pre-test, the descriptive results are shown in Table 1.

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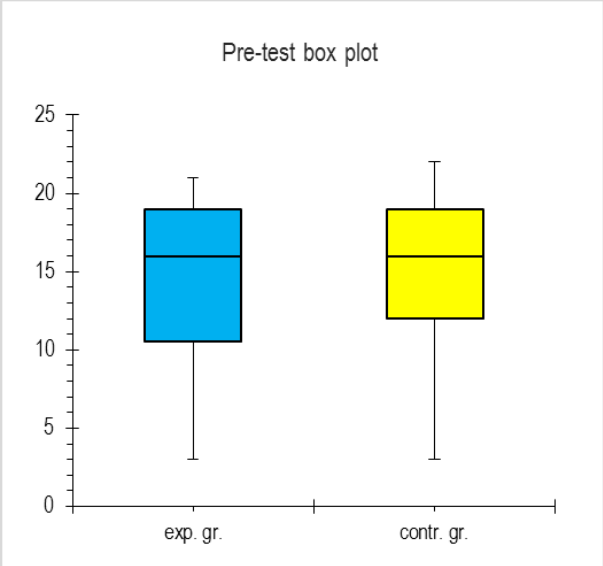

Fig. 5 Box plots for data of pre-test

Table 1 Descriptive Statistics for pre-test

	Experimental group	Control group
Mean	14,3	14,4
Standard deviation	5,45	6,1
Mode	19	-
Median	16	16
Minimum	3	3
Maximum	21	22
Range	18	19

To compare the level of knowledge of mathematics in the control and experimental groups of students, we drew on we drew on the formulation of the null hypothesis: null hypothesis:

H_{01}: *In the resulting average score of pre-test we do not expect statistically significant difference between the control and experimental students groups.*

The test results are shown in Table 2, and then Figure 5 shows the distribution of the input results in both groups

Table 2 Results for T-test and Mann-Whitney test for pre-test

	t-test	Z-value	Hypothesis H01
Control group	-0,0959	-0,3213	Accept
Experimental group			

Based on the results of the Student's T-test and Mann-Whitney test (see tab. 2) has been accepted and the null hypothesis was thus fulfilled the basic requirement of pedagogical experiment that the input is no difference between the control and experimental groups in the observed variables.

For this testing and subsequent testing of intermediate and output simultaneously with the parametric Student's t-test, nonparametric Mann I-Whitney test, because the data obtained clearly not a normal distribution (normality of data was tested by Kolmogorov Smirnov test, D'Agostino Skewness tests, D'Agostino Kurtosis and D'Agostino Omnibus).

Given that pedagogical experiment continued five months, we performed an experiment in intermediate continuous testing. Descriptive statistical results of both groups are shown in box plot (Fig. 6) and Table 3.

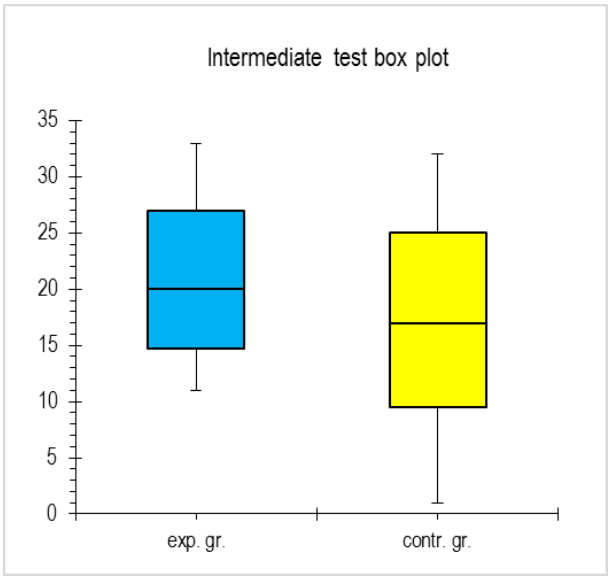

Fig. 6 Box plots for data of intermidiate test

Table 3 Descriptive Statistics for intermediate test

	Experimental group	Control group
Mean	21,0	16,7
Standard deviation	7,41	9,66
Mode	12	-
Median	20	17
Minimum	11	1
Maximum	33	32
Range	22	31

When comparing the results of the experimental and control groups, we drew on the formulation of the null hypothesis:

H_{02}: *In the resulting average score of intermediate test we do not expect statistically significant difference between the control and experimental students groups.*

In intermediate test (after approximately 2.5 months of experimental teaching) were not statistically significant differences in student performance. Null hypothesis was accepted .Testing was carried out using the same statistical tests as input and test results are reported in Table 4.

Table 4 Results for T-test and Mann-Whitney test for intermediate test

	t-test	Z-value	Hypothesis H02
Control group	1,8035	1,6124	Accept
Experimental group			

At the end of January (at the end of the fifth month of experimental teaching) was lower the output test. The descriptive results are shown in and Table 5. From fig. 7 can be seen that the experimental group students achieved higher test scores than the control group.

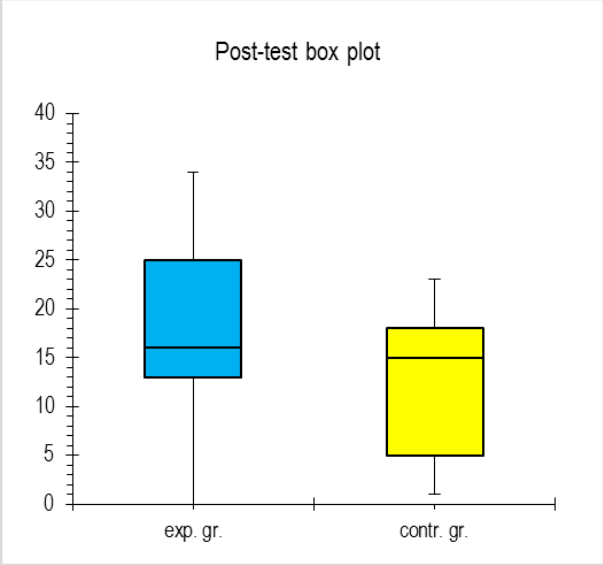

Fig. 7 Box plots for data of post-test

Table 5 Descriptive Statistics for post-test

	Experimental group	Control group
Mean	18,2	12,6
Standard deviation	7,87	7,02
Mode	-	-
Median	16	15
Minimum	0	1
Maximum	34	23
Range	34	22

Again we used the same procedure and taking the formulation the null hypothesis, we tested using Student's t-test and the nonparametric Mann-Whitney test.

H_{03}: *In the resulting average score of post-test we do not expect statistically significant difference between the control and experimental students groups.*

Results of testing the output of the test are shown in Table 6 and box plot (Fig. 7).

Table 6 Results for T-test and Mann-Whitney test for post-test

	t-test	Z-value	Hypothesis H03
Control group	2,6763	2,2093	Reject
Experimental group			

From the results shown in Table 6 shows that we reject the null hypothesis and we can conclude that he was found statistically significant difference in test results output in the control and experimental groups of pupils.

The results of the questionnaire showed that 96 % of pupils well understood screencasts content, to 89 % of pupils videos helped to understand the new mathematic matter and 96 % of pupils would like to continue teaching mathematics by flipped classroom method.

V. Conclusion

After evaluating the long term pedagogical experiment we can conclude, that there was significant difference in achievement (evaluated based on post-test) between pupils of experimental and control groups in the selected thematic unit of mathematics. Flipped classroom method, when students are studying a new educational material using educational animated videos, did significantly affect academic performance of students. Creative videos were evaluated positively. We assumed that the new method of teaching pupils interested, especially because the use of modern technology. Which was confirmed.

Research studies met our goals. Method of flipped classroom was tested in educational practice and based on long term pedagogical experiment using simple reflection questionnaire, we received useful result of testing this method in teaching.

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