VIDEO-STUDY OF THE ROLE OF EXPERIMENTS IN PHYSICS EDUCATION

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Abstract
The innovation of physics educational objectives leads to the accent on physics experiments. Experiments can be used in all teaching/learning phases: motivation, exposition, fixation, application and diagnostics. The contribution presents methodology of video-study and the research results demonstrating the role of experiments in physics education. The method of video-study is based on the analysis of video records of lessons. The importance of experiments in physics lessons is investigated, with a focus on their different roles. Research findings showed that experiments used by teachers are not always appropriate and sufficient for development of students' physics knowledge and skills.

1. Introduction
Experiment is one of the main didactic tools applied in physics education. We study the use of experiments in physics teaching/learning in lower secondary school, particularly with exploration of experimentation phases, structure and function. It is evident that the demonstration of physical phenomenon with the assistance of school experiments is one of the most illustrative and efficient tools a physics teacher can apply during his teaching. Moreover, inclusion of student's experiment into teaching develops students´ manual skills (Vaculová and Trna 2007). The research method we chose for analysis of experimenting in physics education in lower secondary school is a video-study method.

The aim of this contribution is to inform of the research outcomes acquire by the use of diagnostic video-study method and also to present video-study as an efficient research method significantly applying ICT. Primarily, the research was directed at phases of experiments in physics education.

2. Description and application of video-study method
This research method was applied on the role of simple experiments role during the physics education in lower secondary school. The core of the video-study method is an analysis of video recording of lessons. This method was developed in the end of the 20th century in relation to the TIMSS studies (1995 and 1999). Since 2004, the Centre for Pedagogical Research (CPR) in Faculty of Education, Masaryk University, deals with the video-study method in the project „Physics Video-study"(Janik and Míkova 2006). This method was transferred from the university workplaces in Germany (Kiel) and Switzerland (Zürich, Bern).

A video-study method includes a set of partial research activities. First part is a theoretical preparation, followed by practical activities. The research in itself comes after a pre-research based on the research goals assignment and selection of a research sample.

The video-study method used in our research consists of several phases:

- Making video recordings with the assistance of classic camcorders located in class-room. Rules for recording are described in relevant handbook and they are standardised to be comparable to an international research.
- Software processing of recorded data. The programs in question are vPrism, CatMovie and Videograph. In our research we use Videograph; it is a multimedia player of computerised video recording (including audio record).
- We use the program Videograph to accomplish several different tasks connected to the research; it is a record transcription, which means word-for-word transcription of an audio record into the text. Also the process of transcription is standardised for comparing with an international research.
- This software also enables a video recording coding - a systematic registration and classification of phenomena stored on the video recording. For this process, it is always essential to adopt or/and create a relevant categorical system first. Most often we use time

coding and phenomena coding. Before the research starts, we have to inform a researcher of the topic we are about to investigate and introduce him into a coding work.

- Final part of the research is an evaluation of acquired data in chosen statistic program. We evaluate our existing research in program SPSS (inter-rater-reliability calculation) and Statistica (descriptive statistics – results are tables and diagrams).

3. Video-study of experimentation phases in physics education

In preliminary research phase, Videograph program used for a video recording analysis was introduced. In our research, physics video-lessons recorded by Centre for Pedagogical Research in lower secondary schools (the seventh and eighth grade) in Brno were employed (Janík and Míková 2006). Twelve secondary schools were concerned, 13 teachers participated in a video-study. A record transcription, i.e. word-for-word transcription of an audio part of physics video-lessons were also provided by CPR. The next step involved creation of a categorical system (Novák and Trna 2007) for the phase of an experiment. In this instance, an adaptation of already created categorical system was concerned (Tesch 2005). For the categorical system (see Tab. 1) we made a handbook which defines categories for coding. It also highlights the exact lines between each category.

Table 1: Categorical system for coding – experimentation phases

Experimentation phases	5 – unclear
	4 – work following the experiment
	3 - experiment implementation
	2 - experiment preparation
	1 - experiment is not in progress
	0 - none

For better understanding of selected categorical system, we attach a brief characteristic of all categories:
5 – Unclear: proceeding activity cannot be categorised as any of the processes mentioned above (we aim to have as low number of this codes as we can, preferably none);

4 – Work following the experiment: this phase includes results, confirmed or disproved hypothesis of verifiable physical phenomenon etc;

3 – Experiment implementation: experiment is carried out in either demonstrational form conducted by teacher, or students´ experiment (e.g. laboratory task);

2 – experiment preparation: a part of a lesson that includes for example hypothesis, a procedure describing carrying out an experiment, draft or other motivation factors;

1 – Experiment is not in progress: teaching proceeds without any connection with an experiment;

0 - none: time before teaching, lessons are not in progress (break, time before bell ringing, teacher’s arrival and start of the lesson), teaching interruption and time after finishing lessons.

The next step was introducing raters into coding for selected categorical system. This preparation runs during the pilot physics video-lessons originated from the TIMSS 1999 video-study. Measure of agreement between raters (see Tab. 2) is surveyed by way of Cohen’s kappa coefficient and degree of perfect agreement (inter-rater-reliability survey). After these instructions, coding of physics video-lessons for categorical system – experimentation phase – followed.

Table 2: Inter-rater-reliability for experimental phases

Lesson	Number of intervals	Category	ĸ (Cohen's Kappa) rater (1) and (2)	Perfect agreement rater (1) and (2)
Pilot _ A	296	FAEX	0,972	98%
Pilot _ B	296	FAEX	0,743	84%
Pilot _ C	294	FAEX	0,717	82%
Pilot _ D	309	FAEX	0,925	97%
Pilot _ E	301	FAEX	0,968	99%
Pilot _ F	286	FAEX	0,939	98%

4. Results of experimentation phases research in physics education

According to the given categorical system (see Tab. 1), coding of experimentation phases was completed. The process of coding was accomplished on 62 video-recordings of physics lessons, the topics „composition of forces“(27 video-lessons) and „electric circuit“(35 video-lessons) were concerned. In co-operation with CPR, graphic evaluation with following results was carried out (see Fig. 1):

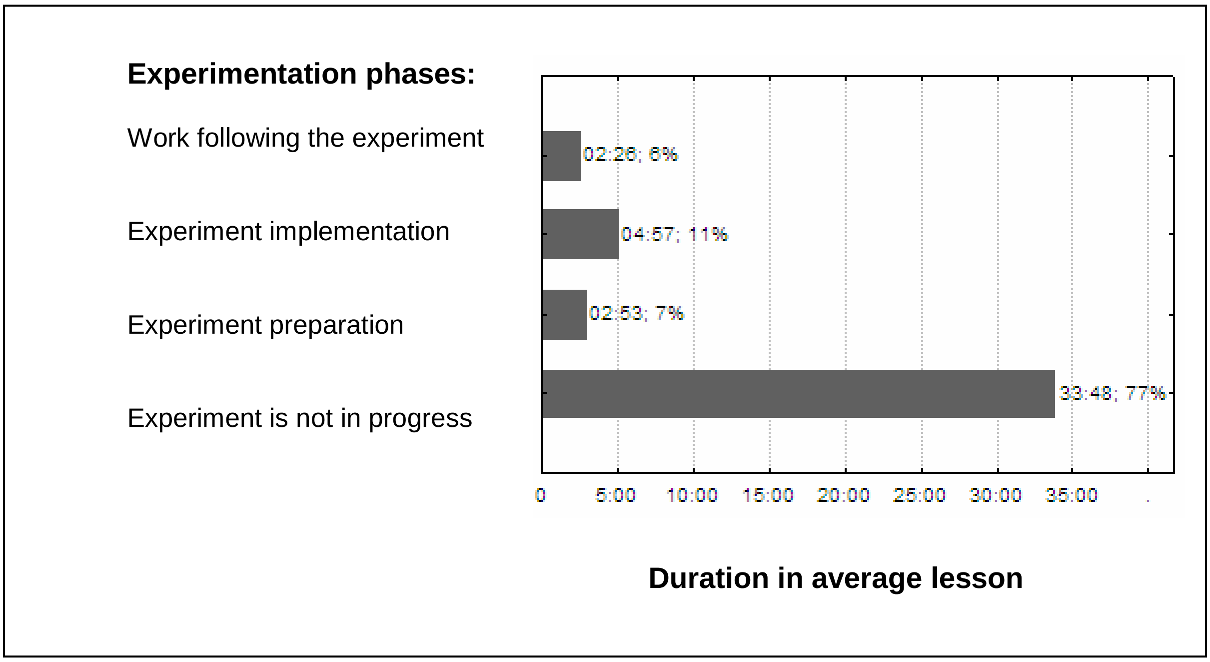

Figure 1: Representation of experimentation phases in physics lessons

Diagram in Fig. 1 indicates that the category „experiment is not in progress“is the most frequent one (77%) in coded physics lessons. If the categories which include an experimentation phase are compared, proportion of 6 % is the experiment preparation phase, 11% represents realisation and 7 % work following the experiment. It is interesting to find out that the experiment realisation lasts approximately the same time as experiment preparation and work following the experiment phases altogether. The next inspiring finding is that preparation of experimentation phase lasts about the same time as work following the experiment.

If the obtained data are divided according to given topics (the fact of different numbers of coded video-lessons for both topics is considered), we can read in Fig. 2 diagram that experimenting is more frequent in electric circuit topic. It is also a stimulating fact that the experiment preparation phase of electric circuit curriculum is more time-consuming, while the composition of forces curriculum takes more time in a work following the experiment category.

We combine video study, questionnaires and interviews to get an in-depth picture of surface effects, structure of lessons, perception of students and output of a lesson measured with pre-/posttests. Our plan for future study is to explain very interesting facts about the duration of preparation, realization and follow-up phases of physics lesson by the use of questioning the participating teachers and with the application of the theory of constructivism. Next research task is to compare the results of this study with results of other studies that were made with the same category system to find regional differences.

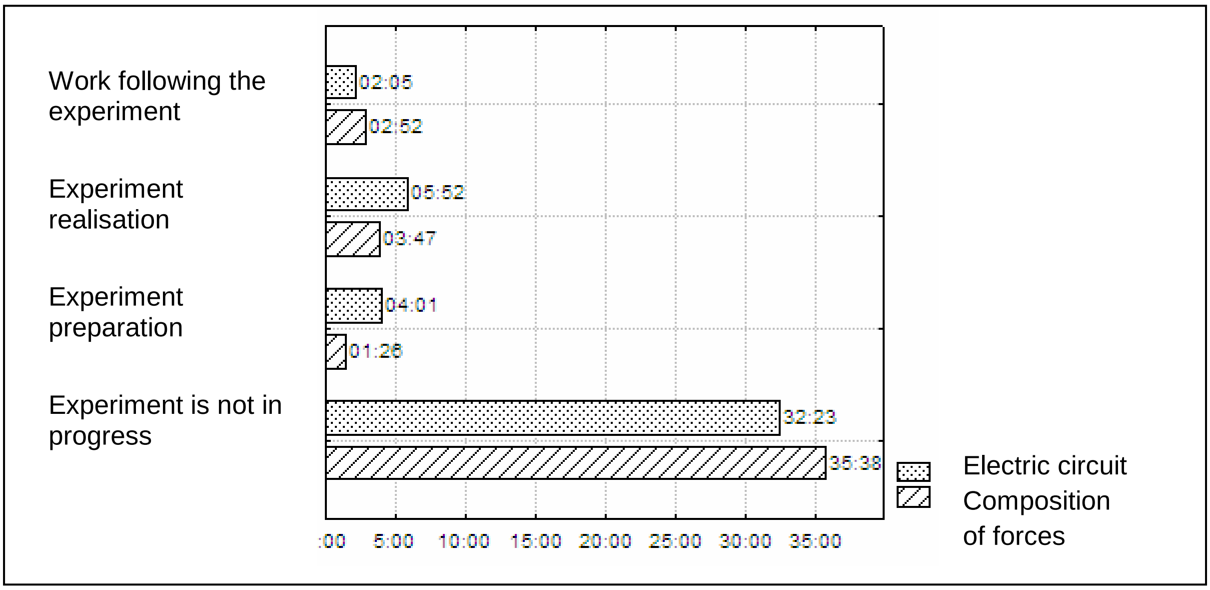

Figure 2: Representation of experimentation phases in physics lessons

5. Conclusions

As we have seen, presented research video-study method has great potential for application in educational research with the use of ICT; it is an effective didactic tool for physics education investigation. The method can be also used by teachers for auto-diagnosing (in action research etc.) or external analysis of their physics lesson. It is up to the teacher what is he focused on in his lessons, there are many options – teaching phase, applied methods in teaching, teaching strategy etc. It is also possible to evaluate students´ work – their activity during lessons, their response to lectures, prevailing students´ activity in classes etc. According to existing experiences, a video-study method appears to be suitable for research of didactical-diagnostics areas of teaching process and it opens up many options with ICT application.

References

Janík T and Míková M (2006) Videostudie, Brno, Paido

Novák P and Trna J (2007) Metoda videostudie jako diagnostický nástroj při realizaci RVP, in Moderní trendy v přípravě učitelů fyziky 3. Rámcové vzdělávací programy, Plzeň, Západočeská univerzita, 195-198

Tesch M. (2005) Das Experiment im Physikunterricht: Didaktische Konzepte und Ergebnisse einer Videostudie, Kiel, IPN

Vaculová I and Trna J (2007) Role fyzikálních dovedností v RVP ZV, in Moderní trendy v přípravě učitelů fyziky 3. Rámcové vzdělávací programy, Plzeň, Západočeská univerzita, 228-232