Experiments in Education Supported by Computer Use: Teachers' Attitudes towards Computers

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Abstract: The article focuses on solving problems based on innovation and technology, which are currently manifested in education. There is a range of experimental educational systems based on information technologies, mainly in the sciences. This is why the research team aimed to address the following questions: Why do teachers employ PCs to support experiments in teaching? To what extent do they use PCs? What are teachers' motives for non-use of PCs? What are the differences between teachers of science, information science, mathematics and social science? What about primary school teachers? Do they employ PCs for experimentation to a lesser or greater extent? The answers to these questions were discovered through research conducted in 2016. The questionnaire was chosen by an explorative method involving 260 staff from 35 Czech schools as the sample. Based on the research findings, it was proven that in order to experiment in teaching, teachers employ PCs to a lesser extent. However, it is not possible to state this tendency as an unambiguous weakness. In the case of science, it is surprising that some teachers do not employ PCs despite the technological potential of computers today. The main reason for using computers for experimenting in teaching at both basic and secondary schools is higher pupil motivation.

1 INTRODUCTION

The educational experiment is one way a pupil may acquire new knowledge. It is possible to understand it as an intentionally induced process in which conditions are purposefully influenced. Assessment of the course of the experiment or its result is performed subsequently.

Using experiments in teaching enables pupils to become acquainted with basic practical work procedures and methods in relevant areas of human affairs while serving as a means to acquire or check a pupil's theoretical knowledge or to reconstruct already acquired knowledge. Thanks to the fact that the pupil acquires the experience directly, permanent and thorough acquisition of discovered knowledge is enabled. Experiments are suitable tools to fulfil the educational principle of connecting theory with practice. Experiments in teaching are, to some extent, a reflection of the scientific method. During the cognition of certain facts, the pupils acquire information not only about the fact itself but also about the selected study method and experimental devices.

The higher the value of a school experiment is, the closer is the selected method of study to the scientific methods and the closer the demonstrative device corresponds to the scientific device. However, the selected method and device meet all didactic requirements (Mirgorodskij, 1973). Appropriate and thought-out involvement of experiments in teaching leads to a deeper understanding of the content on basic terms and relationships. It is a precondition of a conscious penetration to the essence of cognition from merely phenomenon-based cognition; it facilitates the formation of certain term-based structures (Černá, 1995). While experimenting, pupils adopt necessary skills, which may be considered *active knowledge* and a certain readiness to perform certain practical activities (Podroužek, 2003). The educational aspects of the experiment are no less important, particularly the following:

- the experiment develops the readiness for

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independent and creative activity as well as logical thinking,
- the pupil obtains clear scientific and technical ideas about the object or phenomenon,
- the experiment develops pupils' positive and realistic attitudes about the practice,
- the experiment enables the discovery of rules, verification of theory, and cognition at a higher level,
- the pupil becomes convinced of the usefulness of results of the work,
- the experiment develops the pupil's ability to express themselves while they learn how to aptly depict the essence of the phenomenon,
- the experiment develops the positive attitude of pupils to a particular field while facilitating interest in the profession of a certain specialization.

The basic feature of an experiment is a relatively precise knowledge of relevant conditions in which it occurs and its repeatability with the same results. Experiments that do not require complex conditions, that are not time-consuming, and that have a clear course and predictable results are suitable for the educational purposes.

An experiment should not be confused with a demonstration: during an experiment, the conditions are actively influenced. If there is a phenomenon presented in the teaching, it need not to be an experiment but may be merely a demonstration observed by the pupils. This statement is supported by O. Šimik (Šimik, 2011), who states that the experiment differs from the demonstration mainly in its cognitive drive, but pupils themselves discover new relations and connections. Any activities linked to the manipulation with (learning) aids are then inaccurately called an *experiment*. However, if pupils manipulate substances, instruments or devices, they do not necessarily perform an experiment. Similarly, experimenting should not be confused with laboratory work. It is possible to realize the experiment in laboratory or natural environments. At the same time, not every laboratory activity has to be linked with experiments.

In various aspects, the educational experiments were considered by, e.g., (Song et al., 2016) or (Dziabenko et al., 2013).

2 THE SOLUTION AND RESEARCH GOALS

The science-driven solution lies in innovation and technology, which currently manifest themselves beyond the Czech Republic. It is possible to employ a whole range of experimental systems based on IT, mainly in the sciences.

However, experimenting is not linked solely to this category of subjects. Therefore, it is appropriate to examine the field of social science subjects as well, or to examine the attitudes of teachers teaching those subjects. A wide range of solutions emerge from the stated facts, e.g., why do teachers employ computers to support experiments in teaching? What are their motives for possible non-use? What are the differences between the teachers of science, information science, mathematics and social science? Do primary school teachers employ PCs for experimenting to a lesser or greater extent? We strive to answer the stated questions in the following text.

Therefore, the research aimed to determine whether basic school teachers use computers (or ICT) in order to complete experiments. The aim was not only to provide the answer *yes* or *no* but also to explain the reasons that led to their actions – to discover why they do or do not use computers.

The research focuses on both basic and secondary schools. Both stated levels of education are different in their essence – they have different senses, and they employ different methods. Therefore, we are aware of the fact that it is not possible to perform a mere comparison. However, the observation might provide results that may become an impulse for innovative changes and additional research.

3 FORMULATION OF RESEARCH ASSUMPTIONS AND METHODS USED

It was not possible to achieve the stated research goals without transforming them into research assumptions, which were verified by quantitative methods. The research assumptions stated in the following chapters were gradually formulated and verified.

The research assumptions were verified via research data obtained in 2016 while using methods aimed to discover frequencies of responses on individual items of the questionnaire. The

questionnaire was chosen using an explorative method, and it enabled a relatively effective measurement of data. Its construction was realized in accordance with methodological standards, see e.g., (Cohen et al., 2007) or (Newby, 2014). The questionnaire was distributed among 850 staff members– 260 staff from 35 Czech schools responded in total.

4 EXTENT OF TEACHERS' USE OF COMPUTERS FOR EXPERIMENTS

The questionnaire item *Do you employ computers (information and communication technology) tools in your teaching for experiments?* aimed to discover the extent of teachers' use of computers for experiments. In the first phase, we just focus on the results, including mere frequencies; however, we will further analyse the results in the following chapters.

The research assumption was stated as follows: *more than 50 per cent of basic and secondary school teachers use computers for experiments.*

The obtained data were classified and processed. Their summary is presented in Figure 1 below.

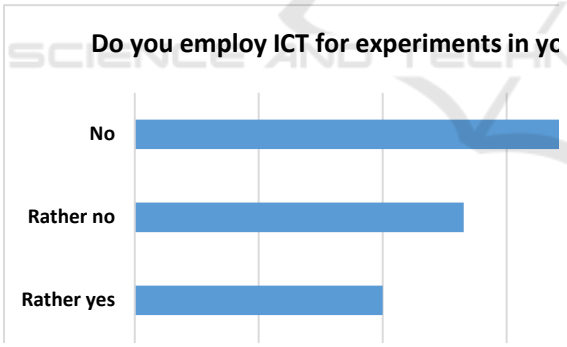

Figure 1: The extent of teachers' use of computers for experiments (basic and secondary school teachers).

If we look closer at the obtained data, we notice that 47 per cent of teachers do not use computers for experimenting at all, and 27 per cent of teachers use them insufficiently (rather not). Although we could call this result ambiguous, it gives us valuable information: a large group of teachers do not use computers. This conclusion introduces the possibility for further inquiry. We will try to reveal which teachers are involved in the following sections of this article. Nevertheless, the results lead us to a decision that we ***reject the research assumption that "more than 50 per cent of basic and secondary school teachers employ computers for experiments".***

Before we proceed to study the results in greater detail (for basic schools and for secondary schools separately), let us tackle the reasons why some teachers use computers for experiments. We present these possible responses: It is less demanding for me to teach while employing computers. Why should they not be employed when the school once purchased them? Teaching satisfies me more, and I am experiencing the feeling of satisfaction and joy. The pupils' knowledge is at a higher level. Pupils are more motivated to learn.

The results obtained based on the study are presented in Figure 2 below.

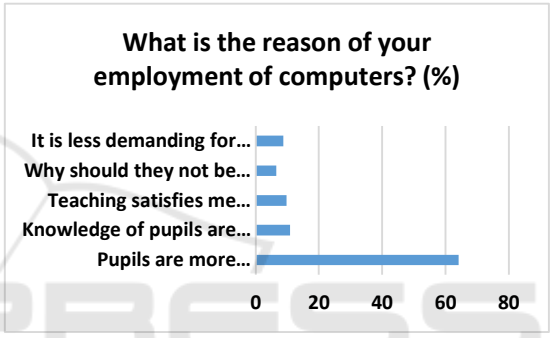

Figure 2: Motivation of basic and secondary school teachers to employ computers for experiments.

In this case, the results are basically unambiguous – 64 per cent of teachers state that pupils are more motivated to learn, and therefore, it is possible to assume that teachers include computers and experiments in their teaching because of this fact. Their application is, of course, linked to the development of knowledge, etc.; nevertheless, the teachers could select just one from the possible responses. They may consider the increased motivation of pupils as the main contributor.

We will focus on the analysis of reasons linked to the non-use of computers for experiments. Teachers selected one of the following possible responses: This possible use does not relate to my subject. Why should I do that when the main point is to teach somehow and not to get tired by that? I do not have enough time to teach; I just need to easily and quickly present the subject matter to pupils. I do not have enough time to prepare this type of teaching while using ICT. I have no idea how I would employ ICT for experiments. Necessary devices or applications are not available to me. The results are presented in Figure 3 below.

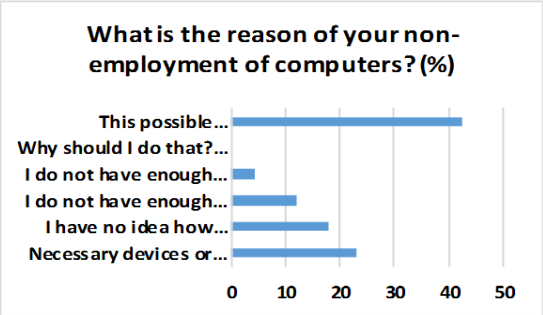

Figure 3: Reasons for non-use of computers for experiments by basic and secondary school teachers.

When looking at the results, the dominance of the response "This possible use does not relate to my subject" is striking: 43 per cent of teachers selected this option. The lack of equipment of schools manifests as well, since some teachers state that the necessary devices or applications are not available to them.

5 EXTENT OF COMPUTER USE FOR EXPERIMENTS IN TEACHING BY BASIC SCHOOL TEACHERS

We will now focus on basic schools. All teachers included in our sample taught at schools where the so-called Framework Educational Programme (in Czech: *Rámcový vzdělávací program*) is in force, which is the basic curricular document at the national level. Teaching can be compared generally across all schools.

A similar research assumption was stated again: *more than 50 per cent of basic school teachers use computers for experiments*. The obtained data were classified and processed. Their summary is presented in Figure 4 below.

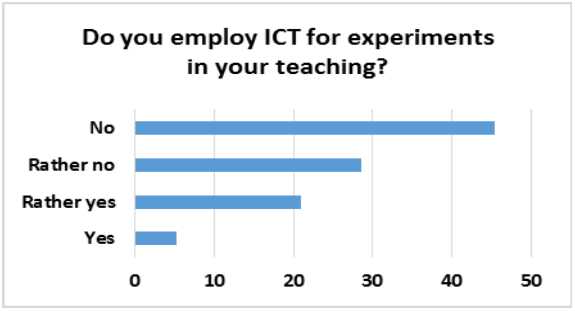

Figure 4: The extent of computer use for experiments (basic school teachers).

At first sight, it is obvious that the results are statistically significantly similar to the total results including secondary school teachers. We can conclude from the results that we again ***reject the research assumption that "more than 50 per cent of basic school teachers employ computers for experiments"***.

An important question connected to the teachers' qualifications came to light, i.e., the subject taught. We thought that the use (or non-use) of computers might be influenced by teachers' qualifications. Therefore, we performed a classification that might enable us to capture possible differences.

However, since there were too many different types of teachers' qualifications, transcoding into three groups was performed: 1) science-based and technical subjects, mathematics and information sciences (physics, chemistry, geography, natural history, mathematics, information science , technical education, technical works); this group is therefore called *science-based subjects*); 2) humanities, art-based, and sports-based subjects (Czech language, foreign language, civics, music education, art education, physical education); this group is thus called *social science subjects*); and 3) first stage of basic school (primary school).

During the classification, a problem emerged when a teacher mentioned his or her qualifications overlapped in categories. In this case, it was not clear from which qualification's perspective they were commenting. Therefore, those cases were rejected. The results are presented in Table 1 below.

Table 1: Frequency of responses classified according to teachers' qualifications (percentages).

	Science-based subjects	**Social science subjects**	**First stage of basic school**
Yes	10	4	3
Rather yes	20	10	22
Rather no	10	33	31
No	60	53	44

Upon analysing the obtained data, we see differences mainly in frequencies that might be called positive or rather positive. In the case of the response *Rather yes*, we see a double value. The surprising fact at first sight is, however, not evaluated as significant, which might be seen in Figure 5 below. It is apparent that this difference is negligible – individual results correlate.

The results can be called remarkable. It is generally thought that teachers of science-based and technical subjects and mathematics (concerning experiments) have a closer relation to IT than the teachers of social science subjects. The results discovered through research basically challenge this idea considerably. It is possible to state that there are no differences between individual teachers' qualifications from the point of view of frequency of use of computers for experiments in their teaching.

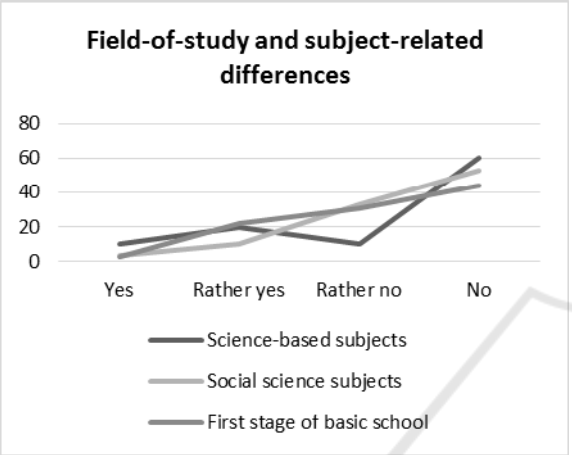

Figure 5: Extent of use of computers for experiments (basic school teacher according to their qualifications).

If we select responses concerning basic schools only and in relation to the question concerning the reasons for the use of computers, we obtain the results presented in Figure 6 below.

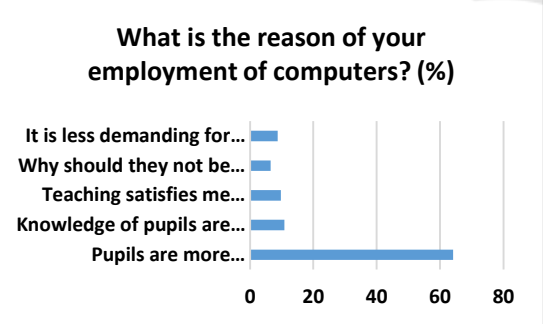

Figure 6: Motivation of basic school teachers to use computers for experiments.

Again, we have to state that the results do not show statistically significant differences from the responses that include secondary school teachers as well.

The possible similarities or differences interest us as well in the case of reasons for non-use of computers. Figure 7 (see below) was formed from that reason.

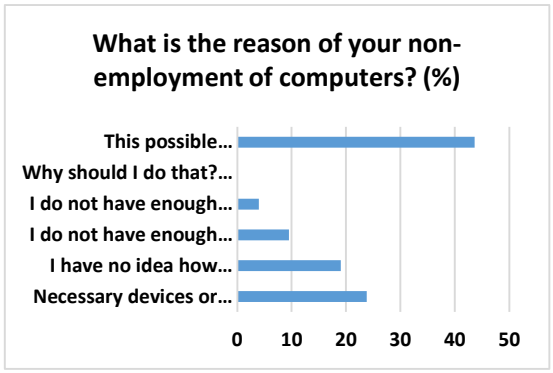

Figure 7: Reasons of non-use of computers for experimenting by basic school teachers.

Upon comparing the frequencies including both basic and secondary school teachers with the frequencies including only basic school teachers, we reach the conclusion that there are no statistically significant differences between those two groups.

6 EXTENT OF USE OF COMPUTERS FOR EXPERIMENTS IN TEACHING BY SECONDARY SCHOOL TEACHERS

Similar to basic school teachers, secondary school teachers answered the question, "*Do you employ computers (information and communication technology) in your teaching for experiments?*" It is necessary to mention that the experiments realized by pupils often have a more complex nature, and they also might have a more considerable application nature according to the focus of the branch of study. The employment of specific ICT is based on this fact.

To perform research, the following assumption was stated: *more than 50 per cent of secondary school teachers use computers for experiments*. The obtained data were classified and processed. Their summary is presented in Figure 8 below.

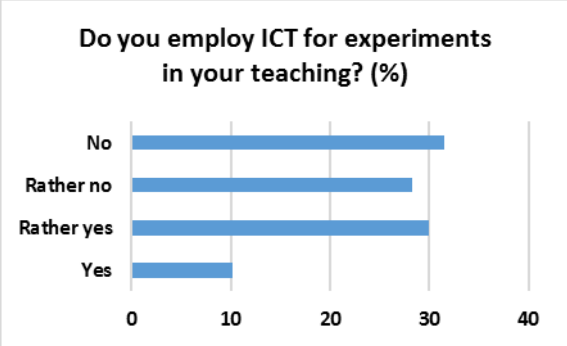

Figure 8: Extent of use of computers for experiments (secondary school teachers).

Upon comparing the values stated in Figure 8 with the values stated in Figure 4, we will mention differences. The frequencies for *No* responses are not lower than those for basic school teachers. This is the reason why we present the results in the form of a graph, since the correlation of both groups' results is obvious.

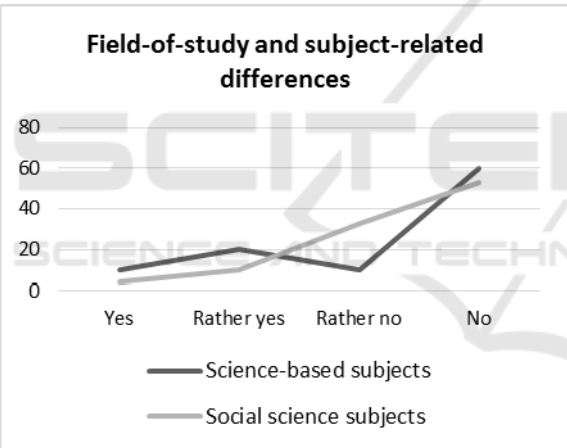

Figure 9: Extent of use of computers for experiments (secondary school teachers according to their qualification).

It turns out again that the teachers of science-based and technical subjects and mathematics (concerning experiments) do not have a closer relation to IT than the teachers of social science subjects. The extent of computer use is not statistically significantly different.
We can conclude from the results that we ***reject the research assumption that "more than 50 per cent of secondary school teachers employ computers for experiments"***.

Now, we ask whether there are differences in the motives for the use for experiments in teaching when comparing to basic school teachers. The frequencies of responses of secondary school teachers are presented in Figure 10 below.

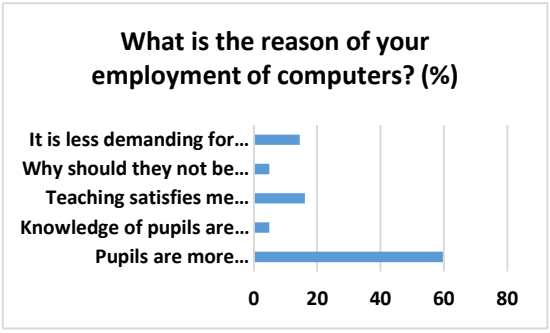

Figure 10: Motivation of secondary school teachers to use computers for experiments.

Compared to basic school, a larger number of teachers state that this is a less demanding type of teaching for them. Moreover, teaching with computers for experiments is more satisfying for teachers when they experience feelings of satisfaction and joy. Nevertheless, these differences are not statistically significant in any of these cases.

We compare the results with those concerning the reasons why the secondary school teachers do not employ computers for experimenting in their teaching; see Figure 11 below.

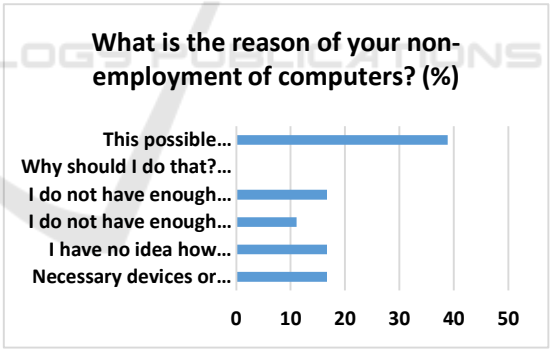

Figure 11: Reasons of non-use of computers for experiments by secondary school teachers.

We can conclude from the comparison that the results are statistically almost identical to the results for basic school teachers, which were presented in Figure 7. We find that teachers are limited by time to prepare for teaching and even the time devoted to teaching itself. Likewise, we often encounter the response that the experimenting does not relate to teaching the particular subject taught by the teacher.

7 CONCLUSIONS

Based on the realized research, it is possible to confirm the statement that teachers employ computers (or ICT) for experimenting their teaching on a merely limited scale. It is not possible to state that it is definitely a weakness; however, it is a surprising fact that in the case of science-based subjects, some teachers do not employ computers for experimenting, despite the current technological possibilities of computers.

The research of reasons to use computers for experiments in teaching at both basic and secondary schools unambiguously proves that the most common motive for computer use is higher motivations of pupils.

The majority of basic and secondary school teachers who do not employ the computers for experiments think that this possibility does not relate to their subjects. In this case, we are sceptical. Yes, there are subjects for which the extent of computer use in connection to pupils' experiments is lower, but the responses in this category might be found even among teachers of science-based branches, which is definitely inaccurate.

The remarkable finding was that no statistically significant differences between the teachers of science-based subjects, information science and mathematics, on the one hand, and social science subjects' teachers, on the other hand, were discovered. A similar conclusion was reached when comparing teachers of the first stage of basic school (primary school teachers): there was also no difference when comparing them to other groups of teachers.

However, we should note the fact that there is no rule that computers should be employed all the time. Pupils should encounter this possibility during their study as computers and modern technology (which is based on computers) become more and more integral to everyday life.

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