

The Use of Computer Modeling and Simulation Systems for Measurement Using Computers in School Laboratories at Czech Schools

Radek Nemeč, Andrea Berková, Stepan Hubalovský

Abstract — This article describes results of the phone interviews across the Czech Republic and of personal interviews with 4 teachers. The use of modelling and simulation measurement systems using computers in a school science laboratory at primary and lower secondary schools in the Czech Republic was analysed through the phone interviews. The results show that there is general knowledge of such systems. However, only 13 % of schools use these systems. The results of the use of systems, frequency of the use and the effect on the popularity of physics are part of the personal interviews.

Keywords—modelling, simulation, DAQ, measurement system, system SMPSL, phone interview.

I. INTRODUCTION

MEASUREMENT system using a computer is used to improve the attractiveness of science subjects due to a graphic display of natural phenomena. This view helps to increase interest in clarifying and deepening knowledge. The analysis was to determine whether teachers in primary schools in the Czech Republic know about these systems, whether these systems are available at schools, if they are used and in what subjects they are used. Subjective teachers' opinion regarding acquiring more knowledge and understanding of pupils was inspected. The personal interview clearly represents the use of these systems at four specific schools. The frequency of the use of these systems for measurement using a computer was determined. Furthermore, the frequency of demonstrations of experiments using systems for measurement and how often frontal demonstrations of experiments are performed using systems for measurements with the help of a computer, was determined.

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II. SYSTEMS FOR MEASUREMENT WITH COMPUTER

Measurement systems using the computer are systems that enable collection, management and processing of data obtained with the measuring device that is connected to a computer. [1] (See Figure 1). Such experiments are also called computer-aided experiments. [2], [3]

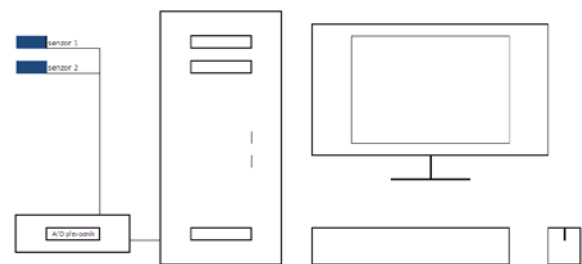


Fig 1 – Schematic picture of the computer and sensors

III. NATURAL SCIENCE LABORATORIES

Natural science laboratories offer a way to observe, document, set hypotheses, draw conclusions and finally gain knowledge about a phenomenon. It is a way how to actively acquire knowledge. [4]

In natural science laboratories when carrying out science experiments, the observations and experiments themselves are conducted. This will enrich all science learning and work of pupils and students in the classroom is activated. Students get practical skills for understanding the natural aspects of the world. At the same time, scientific observation and experiment is a strong motivator of teaching and it strongly contributes to the development of pupils' interests in science. [5], [6]

IV. NATURAL SCIENCE LABORATORY USING SYSTEMS FOR MEASURING WITH COMPUTER

The above mentioned aspects of the science observation and experiment can be realized also by means of a computer. For such experiments and measurement, systems are used for measurement using a computer in a school science lab. [7]

There are many reasons why a measurement is carried out using a computer. The main reason is the possibility of obtaining large amounts of data without manual recording, which is done by the connected computer. The processing may be immediately performed on the computer without overwriting previous readings. [8]

Thanks to the systems for measurement using the computer, the above described observations and experiments can be carried out with the use of computers, which is a major advantage in the rapid collection of large amounts of data and real processing in the form of graphs. Graphical representation helps easier understanding of a phenomenon, which is our purpose. [9]

V. THE METHOD OF THE ANALYSIS OF USING MEASUREMENT SYSTEMS

Analysis was performed using a telephone interview at randomly selected primary schools in each region of the Czech Republic. The list of schools was selected from the register of schools of the Ministry of Education, Youth and Sports. [10]

For each region 5 schools were randomly selected.

If the selected school was a special or practical school, it was replaced by the next school from the list.

The school selected in the sixth place served as a substitution in case of phone unavailability of the previous five schools.

A random analysis was conducted in MS Office Excel. The function selected was =RANDBETWEEN(1, XXX). Where 1 is the lower limit and the upper limit is XXX. The upper limit is equal to the number of schools in the region.

The number beside the region indicates the number of schools in the region. The table listing the regions, the number of schools in the region and a randomly generated number can be seen in Table 1.

Table 1. – The list of regions and randomly generated number

Region / Number of school	Quantity/RND
Prague	267
1	220
2	16
3	184
4	39
5	47
6	74
Central Bohemian Region	536
1	332
2	281
3	494
4	133
5	9

6	121
South Bohemian Region	257
1	196
2	10
3	191
4	94
5	6
6	145
Pilsen Region	221
1	216
2	134
3	143
4	185
5	75
6	156
Karlovy Vary Region	110
1	43
2	54
3	42
4	96
5	96
6	99
Usti Region	279
1	185
2	97
3	179
4	44
5	217
6	20
Liberec Region	208
1	153
2	17
3	167
4	52
5	98
6	31
Hradec Kralove Region	269
1	47
2	9
3	258
4	133
5	11
6	52
Pardubice Region	253

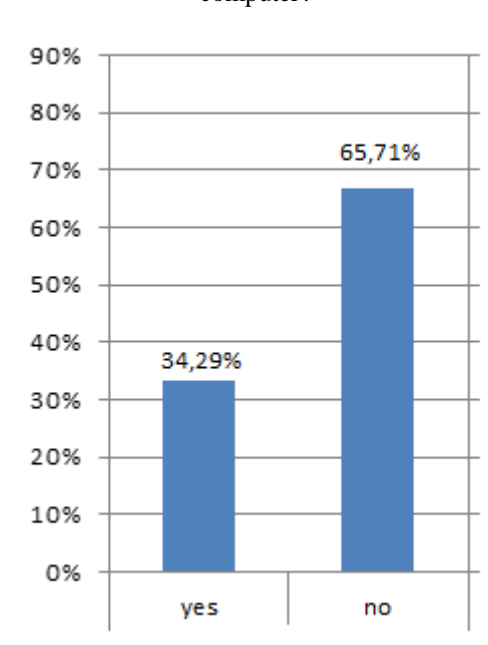
	1	157
	2	200
	3	216
	4	231
	5	179
	6	195
Vysočina Region		265
	1	106
	2	241
	3	255
	4	96
	5	73
	6	1
South Moravian Region		481
	1	344
	2	103
	3	76
	4	416
	5	34
	6	60
Olomouc Region		303
	1	209
	2	4
	3	112
	4	34
	5	95
	6	288
Zlin Region		261
	1	199
	2	196
	3	216
	4	209
	5	147
	6	6
Moravian-Silesian Region		446
	1	361
	2	247
	3	12
	4	80
	5	234
	6	402

VI. THE RESULTS OF THE ANALYSIS OF THE USE OF MEASUREMENT SYSTEMS USING COMPUTERS AT PRIMARY SCHOOLS IN THE CZECH REPUBLIC

The first question was concerning the knowledge of these systems, whether teachers know about these systems (Table 2).

Table 2. – The knowledge of the systems

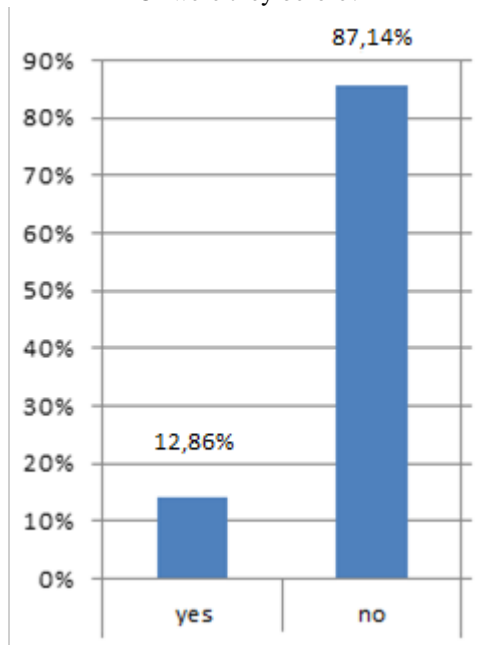
Do you know the measurement systems using a computer?



The second asked question was about the occurrence of these systems, whether these systems are available at schools (Table 3).

Table 3. – Occurrence in schools

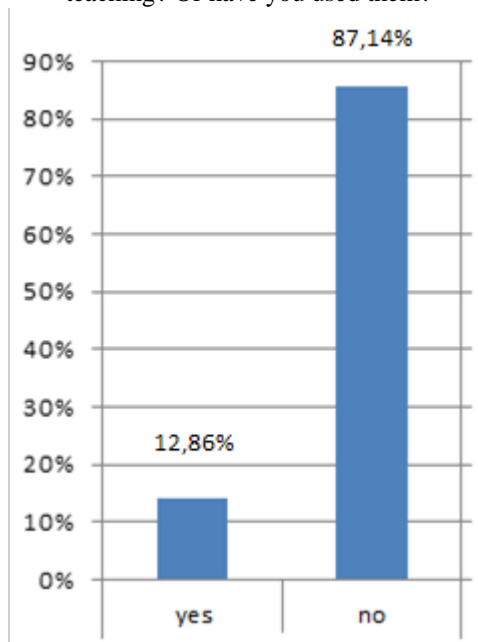
Are such systems available at school?
Or were they before?



The third question dealt with the use of these systems, whether teachers use these systems (Table 4).

Table 4. – The usage of the systems

Do you use these systems in
teaching? Or have you used them?



Subsequently, the teachers were asked about subjects in which they use the systems. Replies were clear that in science subjects, which is understandable. The most frequent subject was Physics, partly also chemistry and technical subjects.

Another question examined the frequency of using these systems. It was from several times a week to a year after the unit was applied.

The penultimate question was: "Do you have experience that teaching, where systems are used for measurement using computers, leads to increased knowledge and expertise in the field of sciences?" Here teachers answered as follows. The systems led and entertained students, the system helps primarily due to an increased interest, clarification and knowledge of the subject.

The last question was focused on the used systems. These were mainly systems from Vernier, sometimes from Pasco.

VII. THE METHOD OF THE PERSONAL INTERVIEW

This personal interview was conducted as a semi-structured interview.

Semi-structured interview was conducted at four primary schools in Hradec Kralove region in the Czech Republic. The interview was conducted using a Dictaphone to record and subsequently transcribe the answers.

Some questions for the semi-structured interview were based on a research project KOF UWB: "A thorough analysis of the state of physics teaching in elementary and secondary schools to new approaches in training physics teachers" [11], and by courtesy of doc. Gerhard Hofer, PhD., some questions of his research were used.

These issues represented measuring systems using a computer was detected:

- The type of measurement system using a computer
- The frequency of use of systems for measurement using a computer
- The frequency of measurement using these systems during demonstrations of experiments and pupils experiments.
- An opinion, if the use of systems for measurement using a computer leads to an increased popularity and interest in the subject of physics.

The personal interview was determined as: "Questions for semi-structured interview with Physics teachers of primary schools in the Hradec Kralove region of the Czech Republic." Interview includes the following questions:

Are there the systems for measurement using a computer in the school?

The following suggestions can also be used:

- Do you know what measurement systems using computers are?
- Why are not they presented?

What systems for measurement using a computer at school do you have?

Case supplementation can use the following suggestions:

- Vernier [12]
- Pasco [13]
- ISES [14]
- IP Coach [15]
- SMPSL [16]
- Other

How often do you perform demonstration experiments using the measurement systems using a computer?

Case supplementation can use the following suggestions:

- never, almost never, ..., almost always, always
- how many times per week / month / per semester

How often do you perform the frontal demonstrations with the use of measurement systems using a computer?

Case supplementation can use the following suggestions:

- never, almost never, ..., almost always, always
- how many times per week / month / per semester

Do you believe that it is possible to increase the popularity and interest in the subject of Physics using the measurement computer systems?

VIII. THE RESULTS OF THE PERSONAL INTERVIEW

The appearance of measuring systems using computers was found at these four schools:

At school 1, the responses were as follows:

- *yes*

At school 2, responses were as follows:

- *lent*

At school 3, responses were as follows:

- *lent*

At school 4, the responses were as follows:

- *yes, 6 pieces*

Determining which systems for measurement using a computer are at school:

At school 1, the responses were as follows:

- *Vernier*

At school 2 responses were as follows:

- *SMPSL*

At school 3 responses were as follows:

- *SMPSL*

At school 4, the responses were as follows:

- *Pasco*

When detecting the frequency of demonstration trials using software for measuring answers were spoken in this way.

At school 1, the responses were as follows:

- *new*
- *only begins*

At school 2 responses were as follows:

- *only as an example*

At school 3 responses were as follows:

- *3-4 tasks for the exam*

At school 4, the responses were as follows:

- *use Data Logger*
- *directly to the computer is not available – it is necessary to go into IT classrooms*
- *Data Logger sees directly*
- *according to an area - if there is a sensor, then it is used*

Regarding the frequency of pupils' experiments using measurement systems using computer, the teachers answered as follows.

At school 1, the responses were as follows:

- *by the time*

At school 2 responses were as follows:

- *demonstration*

At school 3 responses were as follows:

- *no*

At school 4, the responses were as follows:

- *1/4 of tasks*
- *reading the display data logger*
- *does not see so much manual work as in the classic measurement*

Opinion on the increase of the popularity and interest in physics while using means of measurement systems using computers brought the following responses.

At school 1, the responses were as follows:

- *It will be more fun than to sit in class but if it affects the interest in the subject as such, I cannot estimate yet.*

At school 2, responses were as follows:

- *I think it should be done manually – I mean the measuring, weighing, assembling circuit.*
- *Concerning the computer, it also belongs to these days, but mechanic work is necessary, for example it is very difficult to use mechanical weighing machine. But it belongs here, time goes forward, it belongs here. I do not know.*

At school 3, responses were as follows:

• *I think so, because the clarity is important and they can see it, so I think certainly it's better for them to understand and to remember, it is more interesting and it is a proof of phenomena.*

At school 4, the responses were as follows:

• *I do not know. It is interesting, pleasant but I do not see some special benefit in the field of physics study. Both classic and modern approaches are necessary. Teaching material is easily forgotten when it is not in use.*

School 1 and School 4 have their own systems. At schools 2 and 3, the systems are lent. Two schools use system SMPSL. The other two use Vernier and Pasco. Schools 1-3 are getting acquainted with the systems for measurement using a computer and they use them for testing several tasks. At school 4, data logger is mainly used according to the area and the availability of sensors.

Pupil experiments using measurement systems using computers in schools 1-3, if performed, it depends on the topic or just as an example. At school 4, 1/4 in case of tasks due to the use of data loggers.

Opinions on increasing popularity and interest in physics while using means of measurement systems using computers differ. At most schools they do not know. At schools 1, 3 and 4 they think that students will have more fun, it's exciting, enjoyable and gripping. At school 2, they think it is essential to work manually, but this type of measurement belongs to the present.

IX. CONCLUSION

The analysis shows that only one third of teachers in the Czech Republic know the measurement systems and the systems are available only in 13 % of schools. If the systems are at teachers' disposal, they use them. Through the results of the interviews this paper also introduces the experiences and opinions of concrete teachers from four schools in Hradec Kralove region that use these systems. Despite the limitation of this research in the number of respondents the paper provides a comprehensive view of the use of the measurement system using a computer in the Czech Republic.

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REFERENCES

- [1] NĚMEC R., TRÍSKA J., ŠEDIVÝ J. *System SMPSL*. In: The 4th NAUN International Conference on CIRCUITS, SYSTEMS, CONTROL, SIGNALS (CSCS '13). Valencia, 2013, ISBN: 978-960-474-318-6. P. 43-47.
- [2] NĚMEC R., BERKOVA A., HUBALOVSKY S., Demonstration of Gear Ratios Using Mathematical Software and the System SMPSL In: INASE International Conference on Systems (CSCC 2015), Zakynthos Island, Greece, Recent Advances in Electrical Engineering Series 52, p. 717-720, ISBN 978-1-61804-321-4.
- [3] NĚMEC Radek, HUBÁLOVSKÝ Štěpán. *Development of System SMPSL for Analog Communication*. Applied mechanics and materials. 2013, 475 - 476(9), s. 867-870. ISSN 1660-9336.
- [4] NĚMEC, Radek, TRÍSKA, Jan. *Natural experiments using ICT*. In: Circuits, systems, control, signals (CSCS 2013): proceedings of the 4th international conference. Athens: World scientific and engineering academy and society, 2013, s. 48-52. ISBN 978-960-474-318-6.
- [5] HOFREITER, M. *Parameter Estimate of Anisochronic Models Using Method of Moments*. In: Mathematics and Computers in Science and Industry. Berkeley, CA: European Society for Applied Sciences and Development (EUROPMENT), 2014, p. 62-65. ISSN 2227-4588. ISBN 978-1-61804-247-7.
- [6] HUBALOVSKY, S., HANZALOVA, P., *Modeling, simulation and visualization of automatic cryptanalysis of the short monoalphabetical substituted cipher text*. In: International Journal of Mathematics and Computers in Simulation. Issue 2, Vol. 7, 2013, p. 134-143. ISSN 1998-0159.
- [7] HUBALOVSKY, S., *Modeling and simulation of real experimental device - seven storey rectification column*. In: WSEAS International Conference on System Theory and Scientific Computation (ISTASC'11), Florence, WSEAS Press, 2011, p. 63 -68, ISBN 978-1-61804-027-5.
- [8] BERKOVA, A, *Approaches to learning and studying in mathematical analysis classes*. In 8th International Technology, Education and Development Conference, Valencia, Spain. 2014. ISSN: 2340-1079. Publisher: IATED. In print.
- [9] ŠPILKA, R., MANĚNOVÁ, M. *Screencasts as Web-Based Learning Method for Math Students on Upper Primary School*. 2013. In. Recent Advances in Information Science: Proceedings of the 4th European Conference of Computer Science (ECCS'13). France: Paris 2013. ISBN 978-960-474-344-5. ISSN 1790-5109. pgs. 246-250.
- [10] MŠMT. *Rejstřík škol a školských zařízení* [online]. 2015 [cit. 2015-01-09]. Available: <http://rejskol.msmt.cz/>.
- [11] HÖFER, Gerhard, Václav HAVEL, Karel RAUNER, Josef KEPKA, Josef PETŘÍK a Emanuel SVOBODA. *Západočeská univerzita v Plzni, Fyzikálně pedagogická sekce JČMF, Česká školní inspekce. Výzkumný projekt KOF: Důkladnou analýzou stavu výuky fyziky na základních a středních školách k novým přístupům ve vzdělávání učitelů fyziky*. [online]. Západočeská

univerzita v Plzni, Fakulta pedagogická, Oddělení fyziky,
2003 [cit. 2015-03-01]. Available:
www.kof.zcu.cz/vusc/pg/projekt/.

- [12] *Vernier Software & Technology Global Gateway* [online].
2015 [cit. 2015-08-20]. Available:
<http://www.vernier.com>.
- [13] *Pasco* [online]. 2015 [cit. 2015-08-20]. Available:
<http://www.pasco.com>.
- [14] *iSES - Internet School Experimental System* [online].
2015 [cit. 2015-08-15]. Available: <http://www.ises.info>.
- [15] *CMA* [online]. 2015 [cit. 2015-08-18]. Available:
<http://cma-science.nl/english/index.html>.
- [16] *SMPSL* [online]. 2015 [cit. 2015-08-21]. Available:
<http://smpsl.radeknemec.cz>.

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