Computer based science laboratory at high schools in Slovenia

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Abstract – Many high schools in Slovenia possess basic equipment for computerised school science laboratory including data acquisition system and sensors. A questionnaire for biology, chemistry and physics teachers from those schools has been prepared. A questionnaire was divided into 3 parts with 30 questions all together. Some of our main goals were to find out: (1) how frequently was the equipment in use at different schools, (2) are there any differences in usage of data acquisition system and sensors among teachers of biology, chemistry and physics and (3) potential difficulties in application of data acquisition system and sensors in teaching natural sciences. In this paper some results of our research are presented. These results were one of starting-points for ComLab group to improve equipment for computer based laboratory work and to prepare new courses for computerised school science laboratory.

Keywords - computer based laboratory, school science laboratory, science teaching, physics, chemistry, biology

1. INTRODUCTION

Many scientists and other people recognise decline of interest in natural sciences and natural sciences careers as a world phenomenon [1]. Slovenia is not an exception from this observation. Students’ attitudes toward science subjects are even more negative in Slovenia than in the other parts all over the world [2]. Many educators all over the world are trying to find out the way to make natural sciences more interesting without losing or even raising the quality of them. Based on results of many studies [3,4,5,6,7,8], it is possible to summarize that a switch from teacher-centered to student-centered methods of school work is one possible approach to raise the quality of teaching and learning of natural sciences. The increase of students interest in natural science might be an sine effect of such school work. Increasing of and a . The paper should consist of a title, author’s name(s), affiliation, full address, abstract, introduction, main text with section titles and subheadings (if any), conclusion, acknowledgment (if any) and references. If all authors belong to the same institution, do not use superscripted numbers. The length of the paper is limited to six one-sided pages including illustrations. Discovery and inquiry methods of work allow process-oriented instruction [9, 10] with fully engaged students, so these methods should more often replace traditional, lecture-based teaching. From this perspective, laboratory and experimental work should be considered as one of the cornerstones in teaching Science, because through such work it is simultaneously possible to achieve the highest cognitive levels of knowledge, to acquire many skills (e.g., manipulative skills) unlikely to be achieved with other methods, and students generally have positive attitudes toward laboratory work [11].

2. PROBLEM

Between years 2001 and 2004 eighty-eight Slovene high schools were equipped with minimal equipment for computerised school science laboratory including data acquisition system and sensors. The underlying idea of our research was that computer-based laboratory (CBL) is only an upgrade of classical laboratory, so it may be possible that obstacles have its roots much deeper. It is known, that computer, data acquisition system and sensors are just the condition for application but not assurance for application of CBL. In autumn of 2005 Computerised Laboratory in Science and Technology Teaching – PART 2 (ComLab2) project have been started. At the beginning we made some needs analysis as one of the starting-points of our work in project.

Some of main goals of our research were to find out: - how frequently was the equipment in use at different schools; - are there any differences in usage of data acquisition system and sensors among teachers of biology, chemistry and physics; - potential difficulties in application of data acquisition system and sensors in teaching natural sciences.

We assume that:
- the equipment is rarely in use,
- the physics teachers use data acquisition system and sensors more often than chemistry and biology teachers,
- there are many potential difficulties in application of data acquisition system end sensors, e.g.: time for preparation, not enough sensors for group work, …

2.1 Structure of the questionnaire

A questionnaire for biology, chemistry and physics teachers from schools that possess equipment has been prepared. A questionnaire was divided into 3 parts with 30 questions all together. From different parts of the questionnaire we can get information about: use of computers in classroom and in private life, laboratory work (sources of teachers’ manuals, which style of laboratory work prevails, how often teachers include laboratory work
in their teaching, the way in which exercises are performed and teacher's attitudes toward such work) and CBL. In this paper we are focused on the third part of the questionnaire where the answers to the following questions were included:

1. Where and when did you get to know CBL?
2. What is the purpose (testing the equipment, demonstration in the classroom, working in pupils’ research groups, laboratory work in classroom, etc.) and frequency of application of equipment for CBL?
3. How many sensors of each kind teachers should have for effective CBL?
4. What is the best way for gain knowledge about CBL?
5. What are the teachers’ attitudes toward CBL?
6. Why they do not use CBL more often?
7. Do pupils like to work in CBL?

2.2 Sample

207 teachers (64 biology teachers, 64 chemistry teachers, 63 physics teachers and 16 teacher of other subjects) from 52 high schools have filled in the questionnaire. The sample included almost 40 % of the Slovenian natural science teachers and 40 % of the Slovenian high schools. Most of teachers are females (70 %). There is a statistically significant difference in gender between teachers of different subjects, \(\chi^2(2) = 53.374, \ p = 0.000\). There are 90 % females among biology and chemistry teachers, while there are just 61 % females among physics teachers.

In all other parameters (age, degree of education, number of years being employed, years employed in education) there are no statistically significant differences among teachers of different subjects.

3. RESULTS

Studies groups, fellow-workers and workshops were the most common source for 78 % teachers to come into contact with CBL. Physics teachers have got to know CBL much more years ago than chemistry and biology teachers \((F(2,126) = 11.651, \ p = 0.000)\).

<table>
<thead>
<tr>
<th>YEAR</th>
<th>NUMBER of teachers</th>
<th>f(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before 2001</td>
<td>30</td>
<td>23.3</td>
</tr>
<tr>
<td>2001-2004</td>
<td>85</td>
<td>65.9</td>
</tr>
<tr>
<td>2005-2006</td>
<td>14</td>
<td>10.9</td>
</tr>
</tbody>
</table>

Table 1. Year of the first information about CBL

More than one third of the teachers (37.5%) that have answered on question about purpose and frequency of application of equipment for CBL have never used equipment for CBL in spite of that the equipment is at their school at least 1.5 years. Third part of them have tried to work with equipment by themselves and one thirds of them have also tried to make some demonstrations or even laboratory work with pupils. Thed did this only ones or twice.

Less than 20 % of teachers that have answered to that question have ever tried to stimulate pupils to do their own problem-based exercise in CBL. It is very obvious that physics teachers use equipment for CBL much more often and for all purposes (see Table 2).

77.5 % of testees have stated their opinion about ideal number of sensors for CBL at school:
- 41.9 % of them mean, that 8 sensors is the minimum for effective work in CBL,
- 47.9 % that 4 -6 sensors are enough.

75.5 % of testees that have answered to this questions means that practical seminars for teachers are the best way to learn more about CBL, and 11,0 % of them would be satisfied with book for self-studying. Others options are almost useless.

Most of testees have positive attitude toward use of computer in laboratory work even they have not use it yet. They believe that computer in CBL can help them to work faster, more accurate and to get opportunity to do some experiments that could not be done in traditional science laboratory.

Teacher have mentioned many obstructions for using CBL more often:
- not enough time for preparation,
- no room with prepared equipment,
- more equipment for work in groups or even in pairs,
- more prepared instruction for exercises in CBL,
- more practical seminars to learn more about CBL,
- more simple data acquisition system (there is too many connections and the acquisition system is not compatible to new computers’ connections (USB)).
Less than a half of testees have filled in the part of the questionnaire about concrete exercises and experiences with them. Physics teachers have statistically significant more experiences with CBL than chemistry and biology teachers, $\chi^2 (2) = 35.885, \ p = 0.000$ (see Table 3).

<table>
<thead>
<tr>
<th>Subject</th>
<th>N</th>
<th>f(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td>45</td>
<td>71.4</td>
</tr>
<tr>
<td>Chemistry</td>
<td>27</td>
<td>42.2</td>
</tr>
<tr>
<td>Biology</td>
<td>11</td>
<td>17.2</td>
</tr>
</tbody>
</table>

Table 3. Number of teachers that have filled in the last part of the questionnaire with regard to the subject

All pupils have been satisfied during experimentation in CBL and they didn’t have almost no trouble to deal with equipment.

4. CONCLUSION

The results of our research confirmed that the physics teachers are more willing to use data-loggers then chemistry and biology teachers. They use CBL for demonstrations and exercises in laboratory from all fields of physics (movement, waves, sound, forces, sound, electricity and magnetism, etc.). Chemistry teachers also use CBL in different ways and in all parts of chemistry. But they have difficulties to find a lot of experiments that are interesting to show dependence on time (most reactions are to quick or to slow – those are useful to observe for a long period with computer monitoring).

Our research also confirmed some major advantages of the computer-based laboratory and opened up several new possibilities for future work in ComLab-2 project.

Results of ComLab-2 project group that came out as a result of needs analysis were:

- new seminars for science teachers
- development of new data acquisition system especially for science CBL (eProDas-SC2 with USB connection)
- new courses for exercises in science CBL
- incorporation of some computer based exercises in an e-workbook for natural sciences for vocational education etc.

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REFERENCES