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BIOLOGY STUDENTS' TEACHER OPINIONS ABOUT THE INTEGRATION OF ICT INTO THE LEARNING AND TEACHING PROCESS

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Abstract

Biology laboratory work can be performed in various ways, even using information and communication technologies (ICT). Whether a teacher incorporates it into laboratory work is related to different factors, but educators can influence students' beliefs about the value of ICT through their pedagogical practice. In our study, student teachers of biology gave opinions on how successfully university professors use ICT in the classroom, where they acquired most knowledge about ICT and their attitude towards using of ICT in laboratory work. Student teachers were critical about the knowledge and usage of ICT of university professors in class. During their student teachers mostly failed to acquire knowledge about ICT and practice in incorporating it into daily routines. These results will be presented to our university professors, at which time we will suggest how they could use ICT more effectively in daily practice because, on the one hand, they are responsible for students teacher attitudes and for the level of student teacher knowledge, while, on the others, they precipitate indirectly in forming the pupils' attitudes and determining the level of the pupils' knowledge of ICT. The study was done on 85 student teachers of biology. Attitudes toward ICT are statistically significant by gender.

Key Words: gender studies, information and communication technology (ICT); media in education.

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Introduction

Laboratory exercises are included in the learning process for many reasons. The basic purpose is the direct acquisition of knowledge that students will be able to use in further studies, the workplace (Eschenhagen et al. 1998: 496) or in everyday life. Laboratory work also has greater impact than traditional lecture teaching.

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One factor that determines educational development and innovation in general is teachers, since they are the ones who use the ICT investment for educational development (Selwyn, 1999). Technology does not have educational value in itself. It becomes important when teachers use it in the learning-teaching process. Integration of ICT into the biology teaching process depends largely on the biology teachers. Teachers employ a different methods and forms of work, of ICT use and integration of various ways of working, deciding how best to transfer knowledge to learners (Ertmer, 1999) and only they decide how and why use ICT (Williams, 2000; Pelgrum, 2001). Pickersgill (1997) claimed that using ICT in the classroom makes the teaching-learning process more productive than without ICT. The decision to apply ICT can significantly affect the learning environment, the method of teaching (Niederhauser and Stoddart, 2001) and student attitudes towards computers. However, teachers need to be given an example and inspiration to work with ICT in the classroom, and this is the reason for our study of knowledge transfer and the influence of various factors on the use of ICT in education-vertically, from university professors to students in primary school (Figure 1).

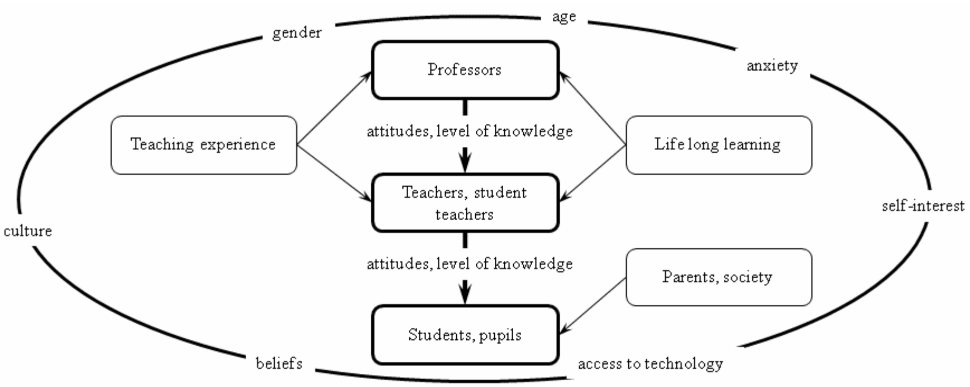

Figure 1: The transfer of knowledge and the impact of various factors on ICT attitude

What kind of skills in and attitudes toward ICT students and pupils have is related to teachers' and professors' attitudes and levels of knowledge (Pelgrum, 2001; Torkzadeh et al., 2006; Zhang, 2007; Paraskeva et al., 2008). Individual characteristics (gender, age) (Hartley and Bendixen, 2001) self-interes (Torkzadeh et al., 2006; Paraskeva et al., 2008), anxiety (Hong and Koh, 2002) culture (Torkzadeh et al., 2006; Albirini, 2006; Li and Kirkup, 2007) beliefs (Lim and Chan, 2007; Teo et al. 2008)

and access to technology (Hong and Koh, 2002) are certainly overall factors that affect ICT use in all groups: university professors, teachers, students teachers, students and pupils. Some factors are specific to each group: ICT attitudes, knowledge and use (Teo et al., 2008; Aydın, 2007) years of teaching experience (Hartley and Bendixen, 2001) experience in using ICT (Paraskeva et al., 2008; Bove´e, 2008) learning and teaching approach (Niederhauser and Stoddart, 2001; Teo et al., 2008a). Attitudes affect teachers' behaviours. Additionally, they have a considerable effect on openness to new experiences, as well as on reflecting and implementing change. Positive attitudes towards ICT, though limited in their effect, do support its use in classes. The effectiveness of ICT investment can be improved with their effective application in the classroom as part of the curriculum (Tezci, 2009).
In recent years, the teaching science subjects has increasingly involved computer-supported laboratory work, where a computer equipped with appropriate measuring equipment functions as a versatile measuring instrument with diverse applications. A computer equipped with an appropriate interface for data acquisition and control enabling a completely new and different dimension of education and the teaching of biology (Šorgo, 2006). Using the computer and the necessary accessory, students can do the following:

- carry out updated and more interesting current laboratory work,
- using an innovative combination of various measuring devices, benefit from new demonstration and independent laboratory work,
- enjoy improved visualization and
- gain a better idea of laboratory results, which can then be transferred to better understanding in situations of everyday life.

With ICT, pupils' learning achievements in science are better than without it (Chang, 2001; Tsai and Chou, 2002; Powell et al., 2003). Graff (2003) and Mikropoulos-Katsikis et al. (2003) consider that the use of ICT improves student's mental development and creativity. Meaningful and creative usage of ICT improves the processes of creative thinking (Wheeler et al., 2002). Cvjetićanin et al. (2013) reported that students who used computers have better knowledge than students who are not using computers in the learning process.

Wainwright (1989) and Morrell (1992) claimed some opposition to ICT usage in schools. They believe that traditional teaching methods are more beneficial than the usage of ICT, and that the use of computers has a negative impact on student behaviour and academic achievement. As noted by Ward and Parr [31] some teachers see no real need to use computers when "traditional practices continue to work" and hence see "no clearly recognised need to change".

The aim of the current study was to survey biology student teachers´ opinions on and attitudes to ICT usage in the biology laboratory. We wanted to find out what skills and knowledge they had missed during university study, and how satisfied they were with the ICT knowledge and usage of university professors.

Materials and Methods

The participants for this study were student biology teachers who volunteered for this study. They were from the 3th and 4th university years at the Faculty of Natural Sciences, University of Maribor in Slovenia. All participants had some pedagogical practice in schools. They completed a questionnaire prepared for the purpose of the study. They completed it in electronic form. We collected 85 questionnaires from 72 women (84.7 %) and 13 (15.3 %) men, between 22 and 25 years old.

The questionnaire contained three parts. The first part of the questionnaire solicited demographic data such as age and gender. The second part concerned student teacher attitudes about laboratory work and the use of ICT during laboratory work (see Table 1). The answers were measured by a 5-point Likert scale. The scale questionnaire was as follows: 1 = definitely disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = definitely agree. Student teachers were to formulate opinions about the quality of their university professors' usage of ICT during lectures. The scale questionnaire was as follows: 1 = they are outdated; 2 = poor; 3 = good; 4 = very good; 5 = excellent. Results are presented as means [M] and standard deviations [SD]. The third part was an open question about what knowledge they failed to acquire during university study. We grouped similar answers in to seven complexes which describe the same answers.

The reliability of the questionnaire was measured by the Cronbach coefficient. The Cronbach reliability coefficient was 0.69 for the 20-item scale, which can be considered satisfactory. Microsoft® Excel 2007 was used for data input. The analyses were performed with the statistical package SPSS 17.0, where we used descriptive statistics; One-way ANOVA was used to examine differences in opinions by student teacher's gender. The Chi-Square test ($\chi 2$) was used for comparison of differences between results from the student teachers opinions about the quality of university professors' usage of ICT during lectures.

The responses were analysed using main components analysis, and then the varimax rotation method was applied. The factor loadings and reliability of the items in the scale were re-calculated. The congruence of the data to the main components analysis was examined using the Kaiser–Meyer–Olkin (KMO) coefficients and Bartlett´s Sphericity test. That the value of the KMO was (0.70) and the result of the Bartlett test ($\chi^2_{(190)}$ = 394.76) was significant ($p < 0.01$) indicate that the data are appropriate for the analysis. The results of main components analysis reveal that the eigenvalue of 20 items concentrate on seven factors that are higher than one.

Results

For the purpose of the study, we asked student biology teachers where they had acquired most of their knowledge about ICT. There are statistically significant differences between results for where they acquired the most ICT knowledge is ($\chi^2_{(3)}$ = 43.80; ($p < 0.01$)). One student (1.2 %) answered that he / she still lacked such skills and knowledge. 12 (14.2 %) student teachers acquired their ICT knowledge from friends, relatives or acquaintances; 36 (42.3 %) student teachers acquired most of their knowledge about ICT by themselves, and similar results apply to students who acquired their ICT knowledge in primary or secondary school or in classes at university (N = 36; 42.3 %).

From the results we can see that students mostly learned about ICT in their leisure time and not in class time. We can conclude that they probably have only limited trust in teachers when it comes to ICT knowledge, because 80 (94.1 %) student teachers never took extra lecture courses about ICT and only 5 (5.9 %) student teachers used it ($\chi^2_{(1)}$ = 66.18; ($p < 0.01$)).

The student teachers rated the knowledge and usage of ICT among university professors ($\chi^2_{(3)}$ = 47.00; ($p < 0.01$)). They were quite critical, because 8 (9.4 %) student teachers claimed that the knowledge and usage of ICT among university professors was outdated; 31 (36.5 %) called it poor; 42 (49.4 %) good and 4 (4.7 %) very good. Not one student teacher expressed the opinion that university professors' knowledge and usage of ICT was excellent. These results indicate that our university professors lack sufficient knowledge of and skills in the digital competences that they should be transferring to students.

Table 1 represents the findings concerning student teachers' opinions – by gender – about the use of ICT for professional work. We can conclude that female student teachers are not as receptive to ICT in professional work as male student teachers, because there is a statistically significant difference between them on the statement, ˝Working with a computer cannot improve the quality of teaching˝. More male student teachers disagree to a statistically significant degree with this statement than do female students. Almost the same applies to the statement, ˝The amount of knowledge gained outweighs the work of preparation time using a computer˝ and, ˝Computer-supported laboratory does not achieve higher cognitive levels (application, analysis, evaluation) skills than the classical method of laboratory work performance˝ (Table 1). For other student teacher opinions, there are no statistically significant differences.

Table 1: Opinions, by gender, about laboratory work and usage of ICT in biology laboratory work

Opinion	gender	M	SD	F	*p*
Working with computers cannot increase the quality of my professional work.	m* f*	1.38 1.89	0.51 0.74	5.51	0.02
Working with a computer cannot improve the quality of teaching.	m f	1.38 1.76	0.51 0.68	3.65	0.06
Students should be involved in planning the laboratory experiments.	m f	3.85 3.79	0.90 0.71	0.06	0.81
The amount of knowledge gained outweighs the work of preparation time using a computer.	m f	2.08 2.85	0.64 0.91	8.44	0.01
Laboratory exercises constitute extra work and loss of time.	m f	1.38 1.44	0.51 0.69	0.09	0.77
The most effective method for implementating laboratory exercises is demonstration experiments.	m f	2.38 2.21	1.26 0.93	0.35	0.56
I would be embarrasseed in front of students if I did not know the final results of laboratory work.	m f	3.00 2.81	1.00 1.11	0.35	0.56
If a person who to offer technical assistance were available, I would use computers in the classroom more often.	m f	2.23 2.46	0.73 0.93	0.69	0.41
Computer-supported laboratory is not an appropriate lesson for students to work independently, because they have difficulty working with computerized gauges.	m f	1.23 1.75	0.60 0.85	4.42	0.04
Students copy a lot of information from the Internet; computers in schools should be prohibited.	m f	2.62 2.74	0.65 0.81	0.26	0.61
Computer-supported laboratory does not achieve higher cognitive level (application, analysis, evaluation) skills than the classical method of laboratory work performance.	m f	2.62 2.42	1.19 1.08	0.36	0.55
Classic laboratory work can be adequately replaced by computer simulation and animation.	m f	1.92 1.75	0.64 0.84	0.50	0.48
Skills gained in laboratory work are not important for students' future professional	m f	2.15 2.47	0.99 0.86	1.46	0.23

and academic performance.					
Computer use in laboratory work is currently popular because it results in better-quality laboratory work.	m f	2.23 2.56	1.01 1.03	1.10	0.30
Most of the tasks I can perform as effectively as a computer.	m f	3.23 2.94	1.36 1.01	0.80	0.38
Each new development in the school system is welcome and does not disturb stable and tested ways of working.	m f	1.77 2.11	0.83 0.87	1.74	0.19
The most efficient performance of laboratory work is computer-supported laboratory.	m f	2.54 2.46	0.88 0.84	0.10	0.75

Because I lack adequate instructions for teachers or other literature for preparation of laboratory work by computer, I need substantially more time and energy than for preparation of classic laboratory work.	m f	2.62 2.99	0.65 0.91	1.96	0.17
The knowledge gained through laboratory work in one subject cannot be applied to another subject.	m f	2.00 2.29	0.41 0.83	1.53	0.22
No one has yet shown me how the computer can be used with additional equipment in the laboratory as a measuring instrument.	m f	2.77 3.14	1.48 1.35	0.81	0.37

*male = m, * f = female

With the KMO coefficients and a Bartlett Sphericity test, the results of main components analysis reveal that the eigen value of 20 items concentrates on seven factors that are higher than one (Table 2).

With the first component, we can describe 15.03 % of Variances, including student teachers who disagree with the following statements: Working with computers cannot increase the quality of my professional work; Working with a computer cannot improve the quality of teaching. Laboratory exercises constitute extra work and loss of time; Students copy a lot of information from the Internet; computers in schools should be prohibited. This component comprises student teachers who think that computer is a very good teaching tool that should be used in everyday teaching practice and those who see a positive value in laboratory work.

With the second component, we can explain 9.08 % of Variances, including student teachers who concur with these opinions: Computer-supported laboratory does not achieve higher cognitive level (application, analysis, evaluation) skills than the classical method of laboratory work performance; Skills gained in laboratory work are not important for students' future professional and academic performance.

This component includes student teachers who will not use the computer in the classroom often, although they have a person available who could offer technical assistance. This component comprises student teachers who think that computers in laboratory work are not as important for learners and those who probably will not use the computer in everyday teaching practice, regardless ICT capability and the presence of technical staff.

Table 2: Factor Analysis Rotated Component Matrix of teacher opinions

Opinion*	Component						
	1	2	3	4	5	6	7
1.	**0.83**	0.09	-0.15	0.10	-0.01	0.12	0.03
2.	**0.78**	0.21	-0.09	0.09	0.01	0.03	0.15
3.	0.05	-0.12	-0.03	-0.01	**0.78**	-0.13	-0.01
4.	0.18	-0.02	0.10	-0.04	-0.08	**0.77**	0.00
5.	**0.55**	-0.03	0.29	-0.27	-0.35	0.25	-0.04
6.	0.10	0.06	**0.78**	0.17	-0.10	0.08	0.05
7.	0.08	-0.09	0.06	**0.81**	0.00	0.00	0.05
8.	0.15	-0.69	0.06	**0.34**	-0.02	-0.23	-0.14
9.	0.25	-0.14	0.20	**0.26**	-0.46	0.18	0.16
10.	**0.56**	0.19	0.32	0.22	-0.06	0.22	0.31
11.	0.26	**0.69**	-0.17	0.12	-0.01	0.05	-0.24
12.	0.23	-0.32	0.26	-0.34	**0.27**	0.06	-0.60
13.	0.37	**0.60**	0.11	-0.06	-0.01	-0.33	0.16
14.	0.37	0.14	0.09	0.29	0.00	**0.53**	0.29
15.	0.08	0.29	0.14	0.37	**0.61**	0.36	0.04
16.	0.31	0.11	0.29	**0.37**	-0.36	0.05	-0.02
17.	-0.25	-0.30	**0.69**	-0.06	-0.01	0.00	-0.14
18.	**0.38**	-0.07	0.37	0.16	0.22	-0.46	-0.03
19.	0.24	-0.11	0.02	-0.09	0.04	0.09	**0.86**
20.	**0.45**	-0.21	0.13	0.39	0.06	0.00	-0.12

* See Table 1 for a list of the statements

With the third component, we can explain 8.64 % of Variances, including teachers who agree with these opinions: The most effective method for implementation laboratory exercises is demonstration experiments; the most efficient performance of laboratory work is computer-supported laboratory. In the third component, teachers address the effectiveness of different methods of laboratory work. This 8.64 % of Variance group think that demonstration experiments and computer-supported laboratory are more effective for implementation laboratory exercises than other methods of laboratory work: i. e. classic, simulation or animation.

With the fourth component, we can explain 8.51 % of Variances, including student teachers' beliefs on just one point: I would be embarrassed in front of students if I did not know the final results of laboratory work. Student teachers who agree with this statement are not very self-confident, because teacher should be adaptable to different laboratory work conditions. In any biology laboratory, some experiments will not be successful and the results may be unexpected, but the teacher should explain such situations in a reasonable way.

With the fifth component, we can explain 7.98 % of Variances, including student teachers who concur with these opinions: Students should be involved in planning the laboratory experiments. Most of the tasks I can perform as effectively as a computer. In this component student teachers are more dependent on human resources than on technical ones.

With the sixth component, we can explain 7.87 % of Variances, including student teachers who concur with these opinions: The amount of knowledge gained outweighs the work of preparation time using a computer; Computer use in laboratory work is currently popular because it results in better-quality laboratory work. In the sixth component, student teachers approve of laboratory work with computers but perhaps only until the next technical innovation.

With seventh and the last component, we can explain 7.30 % of Variances, including student teachers who disagree with these opinions: The knowledge gained through laboratory work in one subject can be applied to another subject. Classic laboratory work can adequately replace computers simulations and animations. From this statement, we can see that student teachers lack sufficient work practice, because in our previous study we confirmed that the contribution to pupils' knowledge was almost the same regardless of the method of laboratory work (Špernjak and Šorgo, 2010).

In the questionnaire we put one open question about what content they might have missed during their studies. Some student teachers gave more than one answer, so we got 91 answers. Biology student teachers mostly lack knowledge about using ICT in the classroom (N = 39; 42.9 %). They want more practice in the classroom (N = 12; 13.2 %); 8 student teachers (8.8 %) lacked knowledge of other Science disciplines (Chemistry, Physics) or foreign languages (English); 6 (6.5 %) want more didactic and psychology knowledge; 5 (5.5 %) student teacher want more practice and knowledge in communication (rhetorical knowledge), and 4 (4.4 %) student teachers lack current information and news about Science. The other 17 (18.7 %) answers belonged in some of these groups, so we called it Other Answers'. There are statistically significant differences between results ($\chi^2_{(6)} = 70.15$; ($p < 0.01$)).

Discussion

Teachers carry out laboratory work in various ways. Some even include ICT. Many factors influence teachers' usage of ICT in the classroom. One of the keys is the teachers' attitude towards and perspective on ICT usage in the classroom. Teachers may influence students' beliefs about the value of ICTs through their pedagogical practice (Veriki, 2010).

The results of this study suggest that student biology teachers will probably not make much use of ICT in teaching practice, because they were deprived such knowledge and experience during their studies. 46.1% of students believe that knowledge and use of ICT among university professors is poor. At the time of the study, student teachers generally lacked knowledge of computer literacy and knowledge about computer usage in the classroom and the laboratory. This can be corroborated by responses to the statement, ˝No one has yet shown me how the computer can be used with additional equipment in the laboratory as a measuring instrument ˝With such a lack of experience, student teachers will not inspire a positive attitude to ICT on the part of pupils, although our previous studies confirm that pupils prefer to carry out exercises with computer-supported laboratory (Špernjak and Šorgo, 2009).

We believe that only a few teachers will acquire further skills in the field of ICT in an already crowded curriculum. This is confirmed by the results, where only 5.9 % of student teachers took extra ICT training during study time. We can conclude that education in the field of ICT for most student teachers our testing group is completed, unless they should happen to use it during the working process.

Brosnan (1998) established that boys are more inclined to use computers than girls of the same age (Graff, 2003; Kubiatko and Haláková, 2009). We also confirm this on the basis of the statement; ˝Working with a computer cannot improve the quality of teaching˝, where males' student teachers disagreed, while female student agreed. There is a statistically significant difference between genders on this statement. This argument suggests that female student teachers are not as frequent users of ICT in teaching, and therefore will not develop a positive attitude towards the use of ICT by pupils. Consequently, the pupils will develop fewer digital skills and competences.

Conclusion

We can conclude that university professors are responsible for the development of digital literacy among biology students' teachers and the usage of ICT. University professors should set future teachers a better example of ICT usage in the classroom, so that they can foster knowledge, skills and attitudes in their pupils.

On the basis of the statement:˝Most of the tasks I can perform as effectively as a computer˝, we can conclude that student teachers of biology do not have positive attitudes toward computers and other ICT because most agreed with this statement.

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