TEACHERS’ ATTITUDES ON THE IMPLEMENTATION OF INFORMATION AND COMMUNICATION TECHNOLOGIES IN BIOLOGY TEACHING

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Abstract
During the exponential scientific and technological development, and the development of the society of knowledge in which intellectual capital has become a major factor of progress, the quality of education is a priority strategic objective of many countries. Education Development Strategy in Serbia until 2020 has recognized the importance and the role of the didactic paradigm. The mission of the education system in Serbia in the 21st century is to ensure the basic foundation of life and development of every individual, society and state based on knowledge. According to education research in the world, the quality of teachers is a key factor in the quality of education. These findings are a standpoint for the definition of a specific strategy of teacher education in Serbia. It is directed to flexibility of teachers in terms of successful adaptation to new trends in education and advanced training aimed at developing competencies that are required in future. One of the tendencies in improving education is the application of information and communication technologies in teaching (ICT). Consequently, the number of training seminars for teachers, which aim is to train teachers to properly use the benefits of ICT in teaching, has increased in the Republic of Serbia in the last ten years. The effects of the application of new technologies in teaching depend on several parameters. One of these parameters is the teachers’ perception on their application in the teaching process. Therefore, the focus of this paper is aimed at examining the level of ICT application by biology teachers and their attitudes towards the ICT application in teaching. The paper also analyzes the influence of the level of skills and levels of ICT application on attitudes of biology teachers concerning their application in teaching. The research items were considered on a sample of 101 biology teachers who work in elementary schools in the Republic of Serbia.

The main findings of the research show that biology teachers have a positive attitude towards the ICT application in the teaching process, that they have a high level of skills concerning the use computers and computer tools, and that they often apply them the teaching process. Pearson’s coefficient has shown that there is a medium positive correlation among the level of skills and ICT application, and the teachers’ attitudes.

Keywords: attitudes, biology teachers, ICT, elementary school.

1 INTRODUCTION

1.1 Theoretical framework
The learning environments of today’s classrooms are becoming more diverse and teachers are facing higher and more complex expectations to help students reach their full potential and become valuable members of 21st century society. The initial concept of literacy, which goes considerably beyond a simple ability to read and write, has been complemented in recent decades by ‘skill-based literacy’, concepts developed to deal with information of increasing complexity, and developing technologies [1]. These new demands require teachers to deviate from traditional teaching methods and to employ innovative teaching practices. Highly qualified and competent teachers are fundamental for equitable and effective education systems [2]. Education Development Strategy in Serbia until 2020 has recognized the importance of teacher education and it is directed to successful adaptation of new trends in education and advanced training aimed at developing competencies that are required in future. One of the tendencies in improving education is the application of information and communication technologies in teaching [3].

Computer technologies are becoming increasingly effective components off education. Science teaching has benefited from the development of computers more than other fields [4]. Engagement in
computer-based modelling could help students develop a sense for some systematic processes that are fundamental to science and help them to develop epistemological awareness of the way knowledge is constructed in science [5]. Computer supported teaching increases student achievement in science education compared to traditional teaching methods, in addition, some studies revealed that computer supported science education positively affects students’ attitudes toward science education [6] and increases students’ motivation and their achievement on tests of knowledge [7-11]. Educators have commenced to use computer supported teaching methods to increase participation of students to the learning activities and to promote access to learning material [12].

The potentials of information and communication technologies at the disposal and how these resources will be utilized depends primarily on the ability of teachers to use ICT and effective integration of ICT in the teaching process. Teacher training for the implementation of active learning methods, using information and communication technologies is done through a system of initial education and training of teachers. Consequently, in the last ten years in the Republic of Serbia the number of professional seminars for teachers who aim to train teachers to properly use the benefits of ICT in teaching has increased. However a number of factors influence the application of ICT in teaching. Three categories of factors (personal, professional and organizational) that influence teachers in applying computers in their classroom practices were identified [13].

The survey on preschool teacher attitudes shows that the length of work experience and previous computer education, as well as attending technical training courses are positively correlated with the application of computers in preschools. Modern technology is still not widely applied in preschools, primarily due to insufficient funds and unsatisfactory IT skills of teachers [14]. Analysis of questionnaires for teachers of secondary schools in Slovenia on the implementation of ICT in the teaching of biology, according to which teachers have a positive attitude also showed that the opportunities of ICT are not used due to the burden of the curriculum, lack of equipment and lack of training [15]. Previous research in Serbia showed that elementary school biology teachers have a positive attitude toward the application of computer assisted learning and that they would like it have more opportunities to apply computers in school [16]. Science teachers tend to use computers more often as their level of computer literacy increases. Positive correlation was found between science teachers’ level of computer use and the integration of computer applications as an instructional tool at primary school level [17].

According to Becta (British Educational Communications and Technology Agency) barriers to integration of ICT into education can be grouped as teacher-level barriers, if they relate to the individual or as school-level barriers, if they relate to the institution [18]. Bingimlas has pointed out three teacher-level barriers: lack of teacher confidence, lack of teacher competence and resistance to change and negative attitudes [19]. Research has shown that in the developing countries lack of technological competence is a main barrier to acceptance and adaptation of ICT in education. Empirica reports on the use of ICT in European schools show that teachers who do not use computers in classrooms see lack of skills as constraining factor [20]. Studies showed that teachers’ computer competence is a significant predictor of their attitudes toward use of computer in classroom [21-22]. It was also found that their attitudes vary with their years of experience and levels of knowledge [23]. Considering teachers’ attitude to integrating new technologies into educational settings is important because teachers’ beliefs influence the way they manage teaching and learning in classroom. Important aspect of teachers’ attitudes is their understanding of how new technologies and their implementation will benefit their teaching and their students’ learning. It seems that the current beliefs and attitudes towards ICT are not only the backbone of the information society, but also an important catalyst and a tool for provoking educational reforms [24].

1.2 Study purpose

This study aims to investigate the level of ICT application by biology teachers in Serbia with regard to their attitudes towards the ICT application in teaching. The paper also analyzes the influence of the level of skills and levels of ICT application on attitudes of biology teachers concerning their application in teaching.

2 METHODOLOGY

The study adopted a survey design. Data was collected from selected sample of 101 biology teacher using questionnaire. The instrument used in this study consisted of four parts. The first part of questionnaire contains unstructured (open-ended) items devoted to addressing demographic
characteristics of the subject and brief introduction with purpose of the study. Second part was devoted to perceptions of the level of skills of using ICT, the third part was related to the frequency of the use of ICT in the teaching of biology and the fourth part was related to the attitudes of teachers of biology on the application of ICT in the teaching process. These parts of the questionnaire were made up of structured (Likert-type) items. Participants were expected to rate items on a five-point Likert-type scale.

Based on the analysis of literature and research objectives following hypotheses are defined:

- H1 – Biology teachers perceive high level of computer skills.
- H2 – Work experience and perception of the level of computer skills and years of work experience are in negative correlation.
- H3 – Biology teachers perceive high level of frequency of computers skills use in the teaching process.
- H4 – Years of work experience and frequency of computer use are in negative correlation.
- H5 – Biology teachers have positive attitude towards the application of ICT in biology teaching.
- H6 – There is positive correlation between the attitudes of teachers, level of computer skills and the frequency of computer use in biology teaching.

Quantitative data processing includes the calculations of frequencies and percentage, chi-square test of statistical difference and Pearson correlation coefficient.

3 RESULTS AND DISCUSSION

The results of the research have indicated that the biology teachers perceive high level of ICT skills, M = 4.01, SD = 1.04. According to special categories that have been tested in this research the results are the following: high level of basic computer skills (M = 4.43, SD = 0.78), browsing the Internet (M = 4.26, SD = 0.96), use of text processing software (M = 4.20, SD = 0.92) and use of presentation tools and software (M = 3.89, SD = 1.11). Slightly lower value has been obtained for table calculations software use (M = 3.36, SD = 1.09) which is explained as being medium, whereas for the Internet page design only basic skills level has been perceived (M = 1.84, SD = 0.91).

The obtained values of the perceived computer skills level (M = 4.01; SD = 1.04) point out that the respondents perceive high computer skills level which confirms the hypothesis H1.

Chi-square test indicates statistically significant impact of the number of experience years on the perception of the ICT skills level, $\chi^2(20, n=707) = 221.68, p = 0.000, \text{fi} = 0.56$, where the impact of fi, according to Cohen criteria [25] has been characterised as large. With the aim of establishing the correlation direction for both features, Pearson correlation coefficient has been applied. Negative moderate correlation has been obtained $r = -0.46, p = 0.000$. Negative value of correlation indicates that the teachers with less years of experience (up to 10) have perceived high level of ICT skills, whereas the teachers with more years of experience (over 20) have perceived lower level of ICT skills. The obtained data are comprehensible due to the fact that computers became widely used only in 1986. However, under poor financial circumstances it was not before the year 2000 when the computers gained wider use in schools, both public and private in the country. As cited in the research on ICT application in the Republic of Serbia [26], in the year 2006, only 26.5% respondents owned a computer at home, whereas in the year 2014 the percentage increased to 63.2% respondents, where 80% respondents had only one computer at home. Yet, 29.7% respondents had never used a computer and the percentage of computer users in 2010 was 43.7%. Simultaneously, 62.8% respondents specified that either they personally had the Internet access or a family member had it. In the year 2006 such possibility was available to only 18.5% respondents, whereas 33.1% respondents had never used the Internet. In the year 2010 the percentage of respondents with the Internet access was 54.1%. The listed data indicate that there is still high percentage of population which neither had a personal computer or the Internet access which impacts their computer literacy as well as their attitudes on ICT application. The same research displayed that 37.9% respondents did not have the Internet access at home due to expensive equipment, 34.8% respondents thought the Internet access was too expensive, and 26% respondents said it was due to the lack of skills. The obtained data show that earlier there were small possibilities for the teachers to be introduced to computer skills, compared to their younger colleagues whose development ran parallel to the development of information technologies during their education. Moreover, positive results of the research that dealt
with instructional efficiency of multimedia application in natural science teaching [27-29] are an additional motive for the teachers to start applying this type of teaching instruction in their work.

Observed by certain categories of computer skills, there is a strong negative correlation between perceived level of skills and browsing the Internet content (r = -0.62, p = 0.000), knowledge of basic computer skills (r = -0.64, p = 0.000), text processing software (r = -0.52, p = 0.000) and years of work experience. Negative correlation of mean impact has been obtained between the perceived level of computer skills for preparing presentations (r = -0.49, p = 0.000) and years of work experience which confirms the hypothesis H2.

The results have shown that 50% of teachers with over 20 years of work experience perceive their basic computer skills ranging from low to medium level, whereas all their colleagues with up to 10 years of experience perceive their basic computer skills ranging from high to extremely high level. Also, 65% of teachers with over 20 years of work experience perceive very low to medium level skills in browsing the Internet, whereas all their colleagues with up to 10 years of work experience perceive high or extremely high level skills in browsing the Internet content. The obtained data is in concordance with the previously collected data that the teachers who obtained certain work experience prior to wider computer use in teaching did not have the opportunity to improve their ICT knowledge and skills.

The second part of the research refers to the investigation of the level of ICT application by biology teachers in their teaching process. The obtained results have pointed out the high frequency of ICT use in biology teaching (M = 3.88, SD = 1.14). The following categories stand out: browsing the Internet content (M = 4.42, SD = 0.89) using basic computer skills (M = 4.43, SD = 0.84), whereas the following categories are under-represented: use of tabular calculation software (M = 2.86, SD = 1.01) and the Internet page design (M = 1.59, SD = 0.87). The obtained results point out that the respondents (biology teachers) are interested in application of modern didactic tools that contribute to achieving higher obviousness and raising interest of school children in learning process. The results of the questionnaire show that 88% of the teachers (two thirds of whom have up to 10 years of experience) browse the Internet on a regular basis or frequently in order to improve their teaching and prepare higher quality material for the classroom. Over 60% of the respondents (two thirds of whom have up to 10 years of experience) regularly or frequently use presentation design tools and software to enhance their teaching or make it more interesting. Low use of tabular calculation software is understandable since the preparation of teaching material in biology does not need such programme quite contrary to other natural science disciplines, e.g. physics. However, the application of this programme facilitates certain administrative work of teachers.

The obtained value (M = 3.88, SD = 1.14) indicates that the respondents perceive high frequency of computer use in the teaching process which confirms the hypothesis H3.

Similarly to the first part of the research, chi-squared test has shown statistically significant impact of the number of the years of experience on frequency of ICT application in teaching, \( \chi^2(20, n=707) = 116.47, p = 0.000, \phi = 0.41 \). Coefficient \( \phi \) indicates the mean impact, whereas Pearson coefficient indicates negative correlation between these two features which confirms the hypothesis H4. The value of the coefficient shows the mean impact, \( r = -0.30, p = 0.000 \). Observed by categories, there is negative correlation between browsing the Internet (\( r = -0.53, p = 0.000 \)), use of basic computer skills (\( r = -0.47, p = 0.000 \)), use of presentation design tools and software (\( r = -0.40, p = 0.000 \)) and the years of work experience.

The results demonstrate strong positive correlation between the perceived level of skills and frequency of ICT application in teaching, \( r = 0.75, p = 0.000 \). The obtained data imply that, in case the teachers can use ICT tools, such skills are frequently used for preparation of their own teaching materials. Extremely high correlations have been prevalent for the categories: use of presentation design tools and software (\( r = 0.81, p = 0.000 \)), use of basic computer skills (\( r = 0.73, p = 0.000 \)) and browsing the Internet (\( r = 0.71, p = 0.000 \)).

Positive attitude of teachers on ICT application in teaching has been highly rated in the research (M = 4.26, SD = 0.99). The results are the following: 85% respondents completely agree or mainly agree on the statements, 7% respondents are indecisive, and only 8% do not agree with the statements. Observed by certain statements, high values have been obtained for the following statements: I want to fully use computer in teaching biology (M = 4.71, SD = 0.71), Teaching biology with the use of computer is fun (M = 4.49, SD = 0.73), Computers are efficient teaching tools (M = 4.46, SD = 0.78), Teachers should be enhanced to use computer in teaching biology (M = 4.44, SD = 0.80). The lowest value has been obtained for the following statement: Computers should be used for each lesson (M =
The obtained results reveal that although the teachers perceive positive features of computer use, part of the respondents would not use computers in each lesson. Application of other teaching tools is considered as more efficient for certain units.

Obtained value (M = 4.26, SD = 0.99) confirms the working hypothesis H5, that the respondents perceive positive attitude of teachers towards ICT application in biology teaching. Similar results have been obtained by other researchers [22-23], [30-32] whose research has revealed prevailing positive attitude of teachers towards application of ICT. According to this research the application of computers in teaching saves time, alleviates work, motivates students to work and facilitates their studying. In the research of Buabeng-Andoh it has been obtained that ICT advances the process of learning, and also the teaching style of the teacher [29]. Furthermore, the research has displayed that the Internet offers great opportunities for the teachers to get access to various resources invaluable for the preparation of the teaching process. However, this research also suggests the problems of adequate computer equipment in schools, the achieved level of computer skills among the teachers to use such equipment in the teaching process. The research [23] has obtained positive correlation between the work experience of the teachers and their ICT knowledge. High level of knowledge in using such technologies impacts their proper and efficient use in the teaching process.

Chi-square test measures statistically significant impact of the mean strength between attitudes of teachers on ICT application and the years of work experience $\chi^2(20, n=707) = 82.26, p = 0.000, \phi = 0.34$. Yet, 89% respondents who have up to 10 years of work experience agree with the statements. Also, the agreement with the statements is perceived by 72% respondents who have over 20 years of work experience. Pearson coefficient has displayed mean correlation between the attitudes of teachers and ICT skills ($r = 0.31, p = 0.000$) and between attitudes of teachers and frequency of ICT application ($r = 0.30, p = 0.000$). The obtained results confirm the hypothesis H6 and show that in case the teachers have been trained to use computers then their attitude towards the application of computers in the teaching process will be more positive.

4 CONCLUSION

Based on the obtained results in this research we may conclude that biology teachers in Serbia perceive their competencies in ICT skills application as high level skills. The analysis of the obtained data indicates that there is exceptionally high level of basic computer skills (M = 4.43, SD = 0.78), browsing content on the Internet (M = 4.26, SD = 0.96), using text processing software (M = 4.20, SD = 0.92) and presentation tools and software (M = 3.89, SD = 1.11). On the one hand, 50% of teachers with over 20 years of work experience presume that they have either low or medium level basic computer skills, and on the other, 65% of teachers have either very low or medium level skills in browsing the Internet. Also the results have shown that there is strong positive correlation between perceived level of skills and frequency of using ICT in teaching. This draws attention to the need for continuous computer training and up skilling of teaching staff with ICT skills, especially of senior teachers who did not have the full opportunity to be introduced to the computer activities during their formal education. Since the problem of teacher's computer literacy has been recognised there are six times more seminars that include introduction to computer skills for teachers, as well as computer application in teaching in the Republic of Serbia in the period from school year 2006/07 to school year 2013/14. This fact indicates that the significance of preparation for ICT in the teaching process has been recognised.

The attitudes of biology teachers towards ICT application in the teaching process have been ranked as highly positive (M = 4.26, SD = 0.99). Although the part of the respondents with more teaching experience has stated that they have insufficiently mastered computer skills, they also perceive positive features of using modern information and communication technologies which is also supported by the obtained values for the statements which indicate that computers are efficient teaching tools contributing to the quality of the teaching process. The obtained results yield a mild positive correlation between the attitudes of the teachers and frequency of the use of ICT. Teachers can be helped through appropriate actions to develop competences and more positive attitudes towards the use of ICT for teaching and learning by ensuring that teacher training incorporate the use of ICT and the provision of continuing professional development opportunities [33].

Numerous theories about professional development of the teachers distinguish the periods, i.e. phases in individual careers where each phase has an inherent developmental task. In each phase they may experience either a conflict or a crisis that is the key support to their further development and the overcoming of such a phase would lead to the development of certain qualities. In the same way
we may perceive the phases in professional development which characterise the teacher’s profession according to the presented theoretical models [34]. During the periods when high demands are set for the teachers and in the process of education, when teaching profession is characterised with faster and greater changes, it is necessary to have institutional stimulus and support to the professional development of teachers. Ministry of Education, Science and Technology Development of Serbia has invested immense efforts in equipping schools with sufficient number of computers for years now so it can be expected that ICT is going to get proper place in the Serbian educational system in the future. Such investments and team work should contribute to creating educational system with a clear vision of the future.

REFERENCES


