UDK 372.83./.85:004
Original scientific paper
Prihvaćeno: 23. svibnja 2014.

Vesna KOSTOVIĆ-VRANJEŠ*
Nikolina TOMIĆ**

TRAINING TEACHERS FOR THE USE OF INFORMATION COMMUNICATION TECHNOLOGY IN SCIENCE

Summary: *Although the importance of ICT at all levels of education is mentioned in professional literature, especially at the beginning of primary school education, the application of ICT for educational purposes depends primarily on individual ambitions and characteristics of a teacher. Based on the fact that teachers' qualifications are the reason for applying or not applying ICT in teaching, the goal of our research is to determine how class teachers use ICT in preparation for, implementation and evaluation of teaching Science at the beginning of primary education, how much they expose students to various computer sources of knowledge and what the reasons for not applying ICT for educational purposes are. The research results indicate inadequate training of primary school teachers for the use of ICT in teaching Science, but also imply general situation in our schools. The results of the empirical research should serve as a starting point for modernization of existing teacher training curricula and designing professional development programs for teachers that will enable them to acquire and develop new competences for work with computer, with the purpose of training teachers for the application of ICT in teaching, which will thus create conditions for development of student's computer competence from the beginning of primary education.*

Keywords: *computer literacy, information literacy, initial teacher education, primary education, teachers' professional training.*

1. Introduction

In the time of a sudden technical and technological development, Information and communication technology (ICT) has a special impact on all

spheres of human activity. Therefore, today we can speak about information society, a society where ICT has a dominant and significant role in the life of modern humans. Besides the term information society, in everyday use there have entered terms such as: new media, networks, cyber culture and networked computers, email, Internet, online databases, online browsers, online discussions, electronic publications, electronic conferencing and digital libraries, which are just some of the trends that have significant social, political and cultural influence on our lives (Kostović-Vranješ, 2012).

We witness the development of new technology in changing society, lifestyle, communication and business, but also in changing our way of teaching and learning. Educational systems faced with strong pressure of the technological revolution are gradually changing and contemporary classes are oriented toward student, who is surrounded with resources for learning to develop her/his computer literacy (Hus, 2011; Kostović-Vranješ, 2011). In the process of modernization of teaching and designing student-oriented scenarios for learning, the application of ICT has a major role (Šorgo, 2010) and a variety of online content (various graphical representations, audio and video recordings, 3-D models, multimedia presentations, interactive electronic textbooks, educational programs, animations or simulations) allows a fuller understanding and adoption of teaching content as well as application in new situations (Peat and Taylor, 2005; Faure, 2002).

Information and communication technology plays an important role in modern education because it allows a wide range of different activities for teachers and students, with the purpose of improving the quality of teaching and achieving better learning outcomes (Cvjetičanin et al., 2013). Various aspects of the use of ICT in education allow the use of various forms of e-learning, and depending on the intensity and the way of ICT use, we can distinguish several forms of e-learning. Apart from traditional instruction in classroom (*face-to-face*, F2F), presence of technology aimed at improving teaching and talking about teaching with ICT (*supported teaching and learning*) is increasing. Often teachers, in their direct work with students, resort to a combination of the two above-mentioned types of teaching, a combination of conventional teaching and ICT-supported teaching, in which case we can talk about hybrid or mixed classes (*hybrid, mixed mode, blended learning*). A demanding and rarely used form of teaching are online classes, where teaching is completely organized remotely using ICT (*fully online*).

Because of ICT's importance for achieving educational goals, many studies were conducted related to the use of ICT in teaching at all levels of education (Balanskat et al., 2006; UNESCO, 2005; Hus, 2011; UNICEF, 2011). All these studies highlight the positive impact of ICT on educational attainment in educational

process, indicating that the use of ICT has strong motivational effects, positive impact on behavior, develops communication skills, thinking skills and has many other positive characteristics. However, the report stresses the fact that teachers' habits have not changed and that they mostly use ICT when it fits into their traditional way of teaching. Due to the previously mentioned and due to the fact that the application of ICT in teaching process depends primarily on individual ambitions and qualities of teachers, authors conducted a research which aimed to determine how much and in what ways teachers use ICT at the beginning of primary education in their preparation for classes and during implementation and evaluation of teaching Science. Furthermore, the goal of the empirical research was to determine how much and in what ways teachers include students in ICT-based activities, *apropos* what is the frequency of taking the initiative for teachers using ICT in teaching Science, and to determine the reasons for possible not applying ICT for educational purposes. Results of the empirical research should be used for critical thinking and adapting curricula of teacher's professional development programs to acquire the new and develop the already acquired computer skills. If class teachers are trained to work with Information and communication technologies (*Fluent with Information Technology*, FIT), ICT will be used in teaching practice as a teaching tool, and thus will create conditions for the development of students' computer competence and train them from the beginning of their primary education for life and work in information society.

2. Information and computer literacy

The seventies and the Industrial Age were followed by the information age characterized by rapid development of Information and communication technologies (ICT), whose influence is evident in all spheres of human life (Kostović-Vranješ, 2010; Milat, 2011). The greatest significance of rapid development of ICT, especially the rapid development of the Internet and the World Wide Web, is that they provide individuals with a direct exchange of ideas, thus providing new opportunities for learning (Hus, 2011; Kostović-Vranješ, 2011; Kovačević, 2011). The use of information technology has led to the introduction of the term *IT literacy*, but also the broader term *information literacy*, which are often equated, although these are two very different phenomena, both forming the basis for the development of modern society. While information literacy deals with content, information related to technology, infrastructure and technological know-how refers to the ability to use computers and computer programs, and is implemented through a certain level of use and operation of computer systems, networks and applications. To become an information literate person, especially

because of the amount of information available in electronic form, an individual must really be IT literate. However, today, except for the necessity of developing information literacy and IT literacy, we talk about the necessary development of digital culture as a new form of general culture conditioned by overarching influence of computers and networks (Jukes, 2008; Kostović-Vranješ, 2012).

Information literacy implies effective use of information and recognizing the need for information and the possession of knowledge on how to find, evaluate and use information that is available to solve a particular problem or make a decision. Therefore, the source of information should not be only a computer, as is usually thought, but it may relate to books, magazines, TV, film or any other source of information. Therefore, by the term information literate person, today we imply someone who has learned how to learn, who knows how to organize knowledge, to find the necessary information, how to recycle the found information and to use it. In addition, a characteristic of an information literate person is also the ability to understand the role of the individual in a successful search, and the ability to understand that success depends on her/him alone, and not on the technology used. To prepare each individual for life and work in modern information society, it is necessary to enable the primary education development of information literacy, while for increasing the development and availability of ICT, it is necessary to enable the development of computer literacy as a foundation for the application of modern technology. If an individual is offered basics of certain literacy, not only with regard to IT and information, through formal education, then s/he will be able for a lifelong learning. Today it is known that lifelong learning is realized only with the development of information literacy, which opens the way to solve problems and prepare everyone to select relevant information from the flood of available resources (Špiranec, 2003), thus enabling the development of other forms of literacy.

3. The role of Information and communication technology (ICT) in developing information literacy

Information and communication technology (ICT) includes a variety of technological tools and resources that are used for communication, but also for creation, storage and management of information. Therefore, it is one of the basic building blocks of modern education (Kostović- Vranješ, 2010; Hus, 2011; Milat, 2011). Due to the fact that the core of education, along with reading, writing and computing, today consists of understanding and possessing the skills and concepts of ICT, UNESCO set as one of its priorities the need to ensure access to educational resources needed to prepare young people to play an active role in modern society. To enable young people of today to live

and work in a technologically developed environment, it is necessary to enable them to develop skills applicable and adaptable to different situations, ICT skills needed for professional work, abilities to make decisions, to cope with dynamic situations, as well as to develop teamwork and effective communication skills (Kostović-Vranješ, 2012). However, as ICT is changing rapidly, educators are facing the difficult task of preparing students for such a dynamic environment where the ultimate goal is lifelong learning and entry into a knowledge society. The document *Strategy on Information and Communication Technology, Croatia in the 21st Century* (2002) pointed out the purpose of education is to enable students to acquire knowledge, skills, abilities and attitudes needed for life, work and lifelong learning, which is a necessary precondition for successful functioning in the future knowledge society. Accordingly, in the *National Curriculum Framework* for pre-school education and general compulsory and secondary education (NOK, 2011), a special emphasis is given to the necessity of training for the use of ICT in learning, work and daily life, and development of algorithmic way of thinking, skills and abilities to apply computers to solve problems in different fields of application (Brođanac, 2011).

Today it is unnecessary to prove the desirability and necessity of ICT in education, therefore it remains only to devise ways, methods and work programs based on ICT, and train teachers and encourage them to find ways of applying modern technologies as they are essential for achieving changes in education systems. Of course, to accomplish this assumption, it is necessary to satisfy the objective factors and provide infrastructure and material conditions in schools, but it is even more important to have practicing teachers trained. Therefore it is necessary to have good study programs and ongoing professional training that will enable training of future teachers and practicing teachers, particularly those with longer tenure, and who could be empowered during initial education to use ICT in their everyday teaching process. When talking about IT literacy of educators, we must also mention teachers' initial education and training organized by Agency for Education and CARNet (Croatian Academic and Research Network), which offer a variety of educational programs, while CARNet's educational center *Edupoint* serves the purpose of systematic raising the level of computer literacy in the Croatian academic community (Seljan and Stančić, 2010).

4. ICT in teaching Science

A child needs to start working on the computer when s/he shows an interest for it, regardless of her/his age, because computer provides her/him with auditory, visual and sensory stimuli that s/he can control. Although we often hear

that the pillar of education is a teacher, which indicates that there are concerns that computer and computer facilities could become a substitute for the teacher, there is no basis for such fear because teachers can use computer facilities in teaching like any other learning material. If a teacher goes from the fact that children of early school age accept computer as a means of entertainment, and in doing so develop creativity and pioneering spirit of solving different problems, appropriate for them, then creative teachers can apply computer to all forms of work in all stages of education as a means for acquiring knowledge, but also as an instrument through which students can practice, repeat or examine the adopted content (Stankov et al., 2006; Tomaš, 2006; Hus, 2011; Tomaš and Marinković, 2012; Cvjetičanin et al., 2013).

Although each teacher develops best teaching scenarios and didactic materials depending on the structure of students in her/his class, still a teacher can find a variety of online teaching materials that can be applied directly or after being modified: PowerPoint presentations, interactive multimedia posters, digital comics, web presentations, web manuals, interactive animations and interactive quizzes. Particularly important for teachers are the following repositories or collections of digital teaching materials: *Suradnici u učenju* (<www.ucitelji.hr>), *Udruga Zvono* (<udruga-zvono.weebly.com>), *Zlatna djeca* (<zlatna-djeca.blogspot.com>), *Učilica* (<http://ucilica.carnet.hr>), *Nacionalni portal za učenje na daljinu Nikola Tesla*, *E-learning akademija*, etc.

5. Research methodology

Scientific literature emphasizes the importance of Information and communication technologies (ICT) at all levels of education, especially at the beginning of primary education. However, the application of ICT in teaching process depends on individual ambitions and qualities of a teacher (subjective factors) and on school infrastructure and material conditions (objective factors). Based on the fact that subjective factors are the most common reasons for lack of applying ICT in teaching, the goal of our empirical research was to establish the extent to which teachers use ICT in teaching Science at the beginning of primary education. In order to achieve the endpoint, there were set tasks which seek to determine the extent to which class teachers use available ICT resources during their preparation for teaching, processing of teaching content and evaluation of students' achievement as well as tasks to determine what the frequency of taking the initiative for teachers using ICT in teaching Science was.

In accordance with the tasks of the empirical research, we set a general hypothesis (Hg) on how teachers rarely use available ICT resources in preparing

for, teaching and evaluating teaching Science, and the starting point for a set of working hypotheses was stated:

- H1− teachers rarely use ICT in preparing Science lessons.
- H2 − teachers rarely use ICT during the processing of teaching content in Science.
- H3 − teachers rarely use ICT in the evaluation of students' achievement in the domain of Science.
- H4 − there is no significant statistical difference in the frequency of the use of ICT in teaching Science with regard to the type of school where teachers are employed, their qualifications and length of educational service.
- H5 − there is a low frequency of taking the initiative for teachers using ICT in teaching Science.

6. Sample of respondents

Testing was conducted on a sample of 50 primary school teachers in two primary schools in Makarska, one school in Vrgorac and their associated local schools in Dusina, Mijaci, Stilje, Veliki Prolog, Orah and Ravča (table 1).

Table 1 − *The structure of the sample*

			F	%
school in which respondents work	2 urban schools		35	70
	1 rural school	10 rural schools	6	12
	9 regional school		9	18
sex of respondents	female		49	98
	male		1	2
qualifications of respondents	higher education		20	40
	university degree		30	60
years of work / experience of the respondents	<10		14	28.0
	10 − 20		17	34.0
	20 − 30		12	24.0
	>30		7	14.0
total			50	100

The structure of the sample with respect to gender is almost homogeneous because 98% of respondents were female, while with respect to a completed university degree it was found that 40% of respondents had a higher education and 60% university degrees. Out of the total number of respondents, two thirds worked in urban schools, and one third of respondents worked in rural and regional schools. In the statistical analysis, the variables of rural and regional schools are connected in a variable of rural schools, due to the fact that a local school is always located in places that do not have a city status. Respondents were of different age and different direct educational work experience, with only 14% of them being involved in the educational process for more than 30 years.

7. Instrument of testing

In accordance with the established problem, objective and goal, and in order to verify the hypotheses, an instrument was made which by structural forms represents a survey of 15 questions. Nine closed-ended questions were set to determine the frequency of use of ICT in teaching Science, and they were associated with responses to Likert scale, numbered from 1 to 4 (1 = lowest frequency, 4 = highest frequency). Six open-ended questions were asked in order to determine the general trends (sublimated personal dimension of respondents) that affected the frequency of application of ICT.

8. Methods of data processing

After the research variables were defined, the data were sorted, coded and entered into a computer program for statistical analysis SPSS 16. Then we carried out standardization and normalization of data and processing methods of factor analysis with component model (PCA), univariate frequency analysis, correlation analysis, t-test and multivariate analysis of variance (MANOVA).

9. Testing the reliability of the measurement instrument

We tested internal consistency reliability by the use of the instrument made of nine closed-ended questions, which sought to determine the frequency of application of ICT in teaching Science. Although the calculated high Alpha coefficient (0.806) indicated the homogenous structure of the scale, we analyzed all nine variables which were calculated and the mean intercorrelation of variables, which amounted to 0,316. The resulting value proved to be between 0.2 and 0.4, which is, according to Pallant (2005), quite satisfactory for repeatedly

performing the conclusion that this is a homogeneous measurement scale used to measure the same phenomenon, and the frequency of application of ICT in teaching Science.

Exploratory factor analysis on the dependent variables under the component model (PCA) was preceded by testing the adequacy of the correlation matrix factorization procedure. Preliminary analyzes determined the absolute fit of the data for process factor analysis (KMO = 0.731, $\chi 2 = 92.535$, $p = 0.00$). Since factor analysis was conducted on a relatively small number of variables (only 9), as well as switch-off criterion for extraction of components, we took Guttman-Kaiser (GK) criterion's characteristic values higher than 1 (Mejovšek, 2008). The analysis of principal components resulted in a two-component solution which explained 51.8% of the total variance, out of which 32.4% of the variance was explained by the first, and 19.4% by the second component.

Table 2 – *Matrix of factor saturation and correlation factors in the analysis of the main components with the direct oblimin rotation of a two-component solution*

	COMPONENT MATRIX *		**MATRIX ASSEMBLY ****		**STRUCTURE MATRIX *****		
	component		**component**		**component**		
variable ******	**1**	**2**	**1**	**2**	**1**	**2**	**commu-nality**
PRNS	0,631	-0,382	**0,753**	-0,198	**0,712**	-0,041	0,544
DMDN	0,607	-0,421	**0,750**	-0,242	**0,700**	-0,085	0,546
SUPI	0,667	-0,137	**0,667**	0,053	**0,684**	0,629	0,463
ERNS	0,602	-0,148	**0,615**	0,024	**0,678**	0,193	0,385
ONSA	0,722	0,094	**0,606**	0,296	**0,668**	0,422	0,530
PFSI	0,795	0,289	**0,578**	**0,508**	**0,620**	0,152	0,715
DSPP	0,612	0,000	**0,553**	0,172	**0,589**	0,288	0,375
OVNM	0,211	0,797	-0,193	**0,843**	-0,017	**0,803**	0,680
PTTP	0,474	0,447	0,213	**0,573**	0,333	**0,617**	0,425

* COMPONENT MATRIX − unrotated factor saturation of individual manifest variables;

** MATRIX ASSEMBLY − factor saturation of individual manifest variables after implemented direct oblimin rotation;

*** STRUCTURE MATRIX − correlation coefficients manifest variables and extracted factors;

**** Variables: PRNS − preparation for teaching; DMDN − digital materials of other teachers; SUPI – self-study via the Internet; ERNS – examination of acquired teaching content; ONSA – implementation of teaching content; PFSI − presentation video; DSPP − working with children with special needs; OVNM − publishing their own material; PTTP − making Power Point presentations.

In order to simplify the interpretation of the results, we applied direct oblique rotation, which established the existence of a simple structure by which the extracted components have high factor saturation and all the variables have high correlation with only one factor (table 2). Matrix assembly shows that the first component consists of variables related to preparation for teaching Science (PRNS), direct teaching and learning (ONSA, ERNS, DSPP and SUPI) and the use of ICT as teaching aids and equipment (PFSI, DMDN). The second component in manifested space represents related variables OVNM and PTTP, which refer to preparation and publication of teachers' own teaching materials. Based on the results of the factor analysis and extracted two-component results, it is opportune to conclude a sufficient level of reliability of the measurement instrument, so as to extract the latent dimensions in manifested space, represents a heterogeneous entity (application of ICT in teaching Science).

10. Research results and discussion

On the basis of calculating the measure of central tendency, especially the arithmetic mean of the results obtained in quantitative variables, it is possible to identify trends in the frequency of use of ICT in various aspects of the educational process of teaching Science. The results regarding relevant central values (table 3) indicate that respondents generally rarely use ICT resources in teaching process, the exception being the application of ICT in preparation for teaching (PRNS) and during implementation phase of teaching (ONSA). Although according to the central tendencies of the variables PRNS and ONSA respondents often use ICT, though from a more detailed consideration of the frequency distribution of these variables (table 3), it follows that ICT in the preparation for teaching (PRNS) are not used only by two respondents, 10 of them use ICT rarely, and almost three fourths use them frequently and regularly. Although analysis of frequency of use of ICT in implementation phase of teaching (ONSA) points to the conclusion

of common ICT use, these results are debatable. Therefore, the analysis of the summary categories *never* or *rarely* in the category of *not frequently* and categories *frequently* and *regularly* in the category *often* had about the same ratio, i.e. 42% of respondents would be classified in the first category of the summary category *not frequently*, and 58% in the second category *frequently*.

Table 3 – *Central values, standard deviations and the sum frequency of variable frequency application of ICT in teaching Science*

M	SD	Mod	$\sum_f$	var*	FREQUENCY							
					never		rarely		often		regularly	
					F	%	F	%	f	%	F	%
3,10	0,86	3	155,00	PRNS	2	4	10	20	19	38	19	38
2,64	0,77	3	132,00	ONSA	2	6	18	36	23	46	6	12
2,34	0,79	2	117,00	ERNS	6	12	25	50	15	30	4	8
2,00	0,78	2	100,00	PTTP	14	28	23	46	12	24	1	2
2,06	0,86	2	103,00	PFSI	13	26	25	50	8	16	4	8
2,33	0,85	2	114,00	DMDN	8	16,3	21	42,9	16	32,7	4	8,1
1,20	0,60	1	60,00	OVNM	44	88	3	6	2	4	1	2
2,27	0,86	2	102,00	DSPP	10	22,2	15	33,3	18	40	2	4,5
2,59	0,92	3	122,00	SUPI	6	12,8	15	31,9	18	38,3	8	17

M = Mean, SD = standard deviation, Mod = dominant value, Σf = sum frequency

* Variables: PRNS − preparation for teaching; DMDN − digital materials of other teachers; SUPI − self-study via the Internet; ERNS − examination of acquired teaching content; ONSA – implementation phase of teaching; PFSI − presentation video; DSPP − working with children with special needs; OVNM − publishing theachers' own material; PTTP − making Power Point presentations.

Mathematically speaking, the results of the variables relating to encouraging students (just) to learn the content available on the Internet (SUPI) recorded an average score *often* (M = 2.596). Previously applied frequency analysis in this case shows categories *frequent* and *often* represent less than one fifth of respondents.

At all other variables recorded not at all optimistic results because teachers rarely or never use ICT in teaching Science with regard to examination of acquired teaching content (ERNS), creating Power Point presentations (PTTP), presentation videos (PFSI) and using digital material of other teachers (DMDN) or publishing their own material (OVNM), even to working with children with special needs (DSPP). It is indicative that the respondents declare that they *frequently* use information and communication resources during preparation for teaching (PRNS) and implementation phase of teaching (ONSA), but they do not practice these during the evaluation of students' achievement. This result can be explained by the fact that it is still common practice to evaluate the achievements identified with the traditional playing of content that results in a particular grade. It is also possible to explain the results by the fact that the preparation and implementation facilities depend on a teacher and her/his competence, while evaluation of students' achievement emphasis depends on students' digital competence.

Although the indicators of the existence of teachers' initiatives for improving teaching and learning processes of Science can be seen as variables of making Power Point presentations (PTTP), presentation videos (PFSI), the use of digital material of other teachers (DMDN), publishing their own material (OVNM) and work with children with special needs (DSPP), it is for the purpose of further explanation of the space, while keeping in mind the arithmetic mean of these variables and with the inclusion of paradigmatic variables related to self-study via the Internet (SUPI), to calculate their range (Table 4). First ranked is the variable of self-study via the Internet (SUPI), which is determined in the previous analysis, but it is noteworthy that on the issue of teachers' initiative this variable was evident only declarative and does not require special teachers' effort because here teachers only encourage students to use the Internet content. By contrast, last ranked is the variable publishing teachers' own material (OVNM), which assumes the overall activity of teachers, thereby implying their competence. Remaining ranks suggest that teachers of Science are more likely to use simpler presentation programs and present their colleagues' videos or material than to create and publish their own multimedia creations.

Table 4 – *Ranks results of variables "initiative of teachers"*

variable*	M	rank
SUPI	2,59	1
DMDN	2,33	2
DSPP	2,27	3
PFSI	2,06	4
PTTP	2,00	5
OVNM	1,20	6

M = Mean

* Variables: DMDN − digital materials of other teachers; SUPI − self-study via the Internet; PFSI − presentation video; DSPP − working with children with special needs; OVNM − publishing their own material; PTTP − making Power Point presentations.

Although ICT have a lengthy tradition of application in education and it is not justified to speak of them as something new, they still present a progressive technology that continuously generates a wide range of innovations. Therefore, it seemed necessary to determine whether and to what extent personal characteristics of respondents affect the frequency of ICT use in teaching Science. Respondents' sex was excluded from the analysis because only one respondent was male.

By conducting the t-test (table 5), we did not establish the existence of statistically significant differences between subjects with regard to their qualifications, with the exception of the variable of publishing teachers' own material (OVNM), t (14.354) = 2.667, p = 0.02. However, the difference between mean values of this variable in groups is very small and amounts to 0.5714. Also, the calculated value of the size of the impact is insignificant in the range of influence, amounting to η2 = 0.12. However, one should not ignore the fact that, contrary to expectations, the employees in rural schools are more likely to publish their own teaching material than their colleagues in urban schools.

Table 5 – *Results of t-test on the influence of school (type of school) on the variable of application of ICT*

variable	type of school	N	M	SD	t	Df	p
PRNS	**urban**	35	3,1714	0,82197	0,892	48	0,377
	rural	15	2,9333	0,96115			
ONSA	**urban**	35	2,6571	0,80231	0,236	48	0,814
	rural	15	2,6000	0,73679			
ERNS	**urban**	35	2,3143	0,86675	-0,345	48	0,732
	rural	15	2,4000	0,63246			

PTTP	**urban**	35	1,9143	0,78108	-1.188	48	0,241
	rural	15	2,2000	0,77460			
PFSI	**urban**	35	2,0857	0,85307	0.317	48	0,752
	rural	15	2,0000	0,92582			
DMDN	**urban**	35	2,5294	0,74814	2,667	47	0,10
	rural	15	1,8667	0,91548			
OVNM	**urban**	35	1,0286	0,16903	-2.231	14,354	0,02
	rural	15	1,6000	0,98561			
DSPP	**urban**	35	2,3125	0,85901	0.554	43	0,582
	rural	15	2,1538	0,89872			
SUPI	**urban**	35	2,5152	0,93946	-0.916	45	0,365
	rural	15	2,7857	0,89258			

* N – number of respondents, M – mean, SD – standard deviation, t – t-value functions, df – degrees of freedom, p – statistical significance.

T-test for independent samples was used in order to establish the existence of significant differences in the frequency of ICT use with regard to the qualifications of the respondents. However, in this case the t-test has not found a statistically significant difference in any of the variables (table 6).

Table 6 – *Results of t-test on the impact of teachers' education (STSP) on the variable of ICT application in teaching Science*

variable	type of school	N	M	SD	t	Df	P
PRNS	**university degree**	20	3,2000	0,89443	0,664	48	0,509
	higher education	30	3,0333	0,85029			
ONSA	**university degree**	20	2,6500	0,93330	0,074	48	0,942
	higher education	30	2,6333	0,66868			

ERNS	**university degree**	20	2,3000	0,92338	-0,287	48	0,776
	higher education	30	2,3667	0,71840			
PTTP	**university degree**	20	1,8500	0,67082	-1,109	48	0,273
	higher education	30	2,1000	0,84486			
PFSI	**university degree**	20	2,2500	0,85070	1,273	48	0,209
	higher education	30	1,9333	0,86834			
DMDN	**university degree**	20	2,5000	0,76089	1,190	47	0,240
	higher education	29	2,2069	0,90156			
OVNM	**university degree**	20	1,2000	0,69585	0,000	48	1,000
	higher education	30	1,2000	0,55086			
DSPP	**university degree**	17	2,1765	0,72761	-0,542	43	0,591
	higher education	28	2,3214	0,94491			
SUPI	**university degree**	17	2,5294	0,94324	-0,367	45	0,716
	higher education	30	2,6333	0,92786			

N − number of respondents, M − mean, SD − standard deviation, t – t-value functions, df − degrees of freedom, p − statistical significance

The impact of work experience (RAST) on the frequency of application of ICT in teaching Science was investigated by the process of multivariate analysis of variance. Preliminary analysis indicated the homogeneity of variance and covariance matrix (M = 215.598; p = 0.07), and the Levene test showed equality of variances of all dependent variables. However, the multivariate test did not show any statistically significant difference between the combination of dependent variables and seniority (F = 2.009, Wilks' Lambda 0.247, p = 0.08).

The empirical testing and quantitative analysis enabled a comprehension of quantity of ICT use in teaching Science at the sample of respondents. Despite the

numerous advantages of quantitative analysis, it also has disadvantages, primarily in the field of education. First of all, educational domain is a heterogeneous space in which there are causal links, bearing in mind the individual characteristics of students and teachers are often not measurable, and quantitative analysis can be measured, but cannot determine the reasons for the established measures. Therefore, for the purpose of further explanation of the results, the qualitative analysis of responses to open-ended questions was applied. It should be noted that qualitative analysis was not conducted for the purpose of making a definitive statement, but rather to determine the possible reasons (subjective and objective factors) influencing the frequency of application of ICT in teaching Science.

The results of the qualitative analysis indicate that respondents used a very narrow opus of Internet sources, mostly for organizing Science lessons (e.g. *Razredna nastava, Učilica, Zlatna djeca*), and an inconsiderable number of respondents recommended same sources to students as an additional source of knowledge. It is an interesting, and at the same time worrying, fact that the small number of respondents do not differ software and hardware of computer. In their reply to the question *Which computer tools do you use to prepare the Science lessons?* respondents frequently cited programs from the group of MS Office software package (e.g. text editor Word and Power Point presentation tool), but frequent answers were also *projector* and *computer*. This indicates an insufficient level of computer literacy of not that small number of teachers and an insufficient IT teacher training during their studies and their lifelong training, especially for teachers with longer tenure, who had not had the possibility to gain computer literacy during their initial education.

The qualitative and quantitative analyses show that teachers do not create their own digital materials. Moreover, quantitative analysis of the results reported in the variable of publishing their own material (OVNM) indicated that three respondents frequently and regularly publish their own materials. However, in open-ended questions the same respondents did not specify which material was at stake, therefore it is reasonable to express doubts about the credibility of their previous answers.

The attitudes of respondents on the positive and negative aspects of the implementation of ICT in teaching Science tried to establish an analysis of the statements made about the reasons for (not) using ICT in teaching. A small number of respondents stated their reasons for (not) using ICT, therefore we cannot reach any conclusions. But a few respondents said reasons against the use of ICT could be interpreted as objective reasons and did not exist. However, there were recorded replies of two respondents who felt that using ICT is an important measure because educational process includes primarily social

interaction in which ICT can be an exclusive resource, asset and/or an aid, not an equal participant. At the same time, it should be noted that the majority of respondents believe the application of ICT makes teaching process more dynamic and interesting to students.

Qualitative analysis sought to determine the objective reasons why the respondents did not use ICT in teaching Science. Nearly a fifth of respondents pointed out insufficient material (IT) equipment in schools in which they worked. Although in the Republic of Croatia the process of computerization of schools encouraged by the respective Ministry began more than ten years ago, the current situation is still not favorable as evidenced by the results obtained. Although computerization of schools exceeds the contextual framework of this study, it seems appropriate to point out that only classrooms for teaching Informatics and administrative offices are equipped with computers. It is not surprising then that the most of respondents considered insufficient equipment of their classrooms a fundamental obstacle in the use of ICT in teaching Science.

The empirical part of this article started from the hypotheses that were used for validation of the general hypothesis. The conducted statistical analysis shows that it is not possible to accept only the first hypothesis, which started from the assumption that teachers rarely use ICT in preparing for teaching Science, because it was found that only two of the respondents did not use ICT. The following two hypotheses can be verified because the teachers really rarely use ICT in implementation phase of teaching and evaluation of students' achievement. The third and fourth hypothesis were confirmed because there was no statistically significant difference in the frequency of the use of ICT in preparing for Science lessons, implementation phase of teaching and evaluation of students' achievement with respect to the type of school where teachers were employed, their qualifications and work experience in education. There is a low frequency of taking the initiative for teachers using ICT in teaching Science, so the fifth hypothesis would be difficult to accept. Due to the verification of four hypotheses, which implies the fulfillment of the tasks set by empirical studies, it is justified to conclude that the verified and general hypotheses were tested, and that the goal was reached.

11. Conclusions

The relevant professional and scientific literature points out the importance of a large number of possibilities of ICT application at all levels of the educational process, but the results of the study among primary school teachers show a different reality. Although the aim of the research presented in this article was to

determine how and to what extent class teachers apply ICT resources in Science, the results do not imply general conditions in schools. Unfortunately, teachers often use available ICT resources only during their preparation for teaching, and underuse them during implementation phase of teaching and evaluation of students' achievement. At the same time, teachers rarely create their own digital teaching material, and are more likely to use already made digital material (made by their colleagues), which indicates their lack of computer proficiency. If we add the fact that teachers often use simple text editors and presentation programs, then this confirms the previously said and it is definitely possible to conclude that respondents' level of IT competence was very low. Teachers with a longer tenure can be justified in a way by the fact that they had not had the opportunity to acquire basic computer competency during their studies. However, general computer literacy of teachers leads to the conclusion that there is an insufficient level of IT training during professional training of teachers. The alarming fact is that there is poor computer literacy among younger class teachers who are obviously not sufficiently trained in the use of ICT in teaching during their initial education. Along with insufficient computer training of teachers it is necessary to emphasize the problem of the lack of IT equipment in schools as one of the objective factors that certainly, together with poor computer training for teachers, affects the motivation for the implementation of ICT in educational process. The results presented in this article indicate the necessity for modernizing the existing teachers' curricula, and professional training of teachers with the purpose of acquiring new or developing already acquired computer competences to train teachers for the use of ICT in teaching process, and thus enable students to develop their computer skills. In order to accomplish the above-mentioned, it is necessary to enable a complete computerization of schools, and computer networking in all classrooms, not just specialized IT classrooms and administrative offices. If we remove the fundamental obstacles in the use of ICT in teaching process and if teachers are trained to apply ICT, the process of teaching and learning will be directed in accordance with the aspirations of modern information society.

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Vesna Kostović-Vranješ*
Nikolina Tomić**

OSPOSOBLJAVANJE UČITELJA ZA PRIMJENU INFORMACIJSKO-KOMUNIKACIJSKE TEHNOLOGIJE U NASTAVI PRIRODE I DRUŠTVA

Sažetak: *Iako se u relevantnoj literaturi ističe važnost informacijsko-komunikacijske tehnologije na svim razinama odgoja i obrazovanja, a posebice na početku primarnog obrazovanja, ipak primjena IKT-a u obrazovne svrhe ovisi prvenstveno o individualnim ambicijama i osobinama učitelja. Vodeći se činjenicom kako je osposobljenost učitelja najčešći razlog ne/primjenjivanja IKT-a u nastavi, postavljen je cilj empirijskog ispitivanja kojim se htjelo utvrditi kako se i u kojoj mjeri učitelji razredne nastave koriste IKT-om tijekom pripremanja, realizacije i evaluacije nastave Prirode i društva na početku primarnog obrazovanja, koliko upućuju učenike na različite računalne izvore znanja te koji su razlozi za moguće neprimjenjivanje IKT-a u odgojno-obrazovne svrhe. Rezultati istraživanja ukazuju na nedovoljnu osposobljenost učitelja razredne nastave za primjenu IKT-a u nastavi Prirode i društva, ali ujedno upućuju i na opće stanje u našim školama. Dobiveni rezultati provedenog empirijskog istraživanja trebaju poslužiti kao polazište za osuvremenjivanje postojećih učiteljskih studijskih programa, ali i osmišljavanje stručnih usavršavanja učitelja koji će omogućiti stjecanje novih i razvijanje stečenih računalnih kompetencija, sve sa svrhom osposobljavanja učitelja za primjenu IKT-a u nastavi, a time i stvaranja preduvjeta za razvijanje učeničke računalne kompetencije već od početka primarnog obrazovanja.*

Ključne riječi: *informacijska pismenost, informatička pismenost, inicijalno obrazovanje učitelja, primarno obrazovanje, stručno osposobljavanje učitelja.*

* doc. dr. sc. Vesna Kostović-Vranješ,
Sveučilište u Splitu
Filozofski fakultet
vesna.kostovic-vranjes@ffst.hr

**Nikolina Tomić, dipl. učiteljica
nikolina323@net.hr

*Vesna Kostović-Vranješ,
assistant professor, PhD
University of Split
Faculty of Philosophy
vesna.kostovic-vranjes@ffst.hr

**Nikolina Tomić, graduate teacher
nikolina323@net.hr