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The Profile of Secondary School Informatics Teachers in the Autonomous Province of Vojvodina

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Abstract

This paper presents the research methodology and preliminary results aimed at forming the profile of informatics teachers in secondary schools in Vojvodina that could serve as a source of information for planning education modalities for informatics teaching staff. The research instrument used was a questionnaire designed to collect data on teachers' profile described by objective indicators (academic and permanent education), self-evaluation of teachers' own competency in Informatics and pedagogical-didactic domains, teachers' opinion on the importance of informatics and pedagogical and teaching methodology corpus in the university curriculum for informatics teachers, their opinion on the extent of the informatics domain knowledge in secondary education curriculum and preferred education modality for informatics teachers. The preliminary results indicate that there is an imbalance in the academic education of teachers while their self-assessment shows that their knowledge of more complex and contemporary aspects of Informatics, as well as the pedagogical and teaching methodology corpus is insufficient. Furthermore, the teachers' opinion is that many of the Informatics domain topics are not adequately represented in secondary school curricula in Vojvodina. The research also indicates a preference for specialized integrated studies as an education modality for informatics teachers.

Key words: *computer science; curriculum; informatics; secondary school; teacher; university.*

Introduction

The intensity of changes in the field of Informatics and their influence in other fields have caused an increasing need for frequent updating of higher education curricula for Informatics teachers and continuing professional development of teachers, but also for constant adjustment of elementary and secondary school Informatics curricula to contemporary trends. Special attention should be given to the necessity that curricula at all levels of education be in accordance. The outcome of Informatics education of elementary school students must be in accordance with secondary school Informatics curricula so as to equip the students with adequate knowledge and skills required for secondary school Informatics classes. Upon graduating from secondary school, the student must be educated enough to be able to attend Informatics courses within an appropriate study program of a higher education level. Similarly, the competencies of Informatics teachers who have graduated from university must be in accordance with the current elementary and secondary school Informatics curricula.

Even though references (Hazzan et al., 2010; Stephenson et al., 2005; Eurydice, 2004) point to the importance of designing contemporary Computer Science (CS) secondary school and teacher curricula, at the same time taking into account the specificity of the field of CS which requires creating a special curriculum for CS teachers (Ragonis et al., 2010), certain countries still have not developed separate study programs for CS/Informatics teachers (Armoni, 2011; CSTA, 2008; Ragonis et al., 2011). Consequently, in many secondary schools Informatics and CS is taught by teachers who do not have formal education in the field of computer science, such as math teachers or teachers from other scientific disciplines (Ragonis et al., 2011; Deek & Kimmel, 1999). According to Gal-Ezer and Stephenson (2010), there are two key factors which are considered the cause of this current crisis in CS teacher certification:

- insufficient clarity, understanding and consistency of the current CS teachers certification demands,
- an absence of a close tie between the existing teacher certification demands and current CS discipline contents.

Research in the United States has shown that there is a confusion among CS teachers regarding the necessary prerequisites for that profession, above all because, among those who are responsible for creating and implementing CS teachers certification rules, there is a lack of understanding of this scientific discipline, and its theoretical, practical and pedagogical basis, as well as the problem of confusing the CS fields with other disciplines such as educational technology, industrial and instructional technology, information systems management or even computer support in other thematic fields (Gal-Ezer & Stephenson, 2010). In the absence of clear and precise conditions for teaching CS in schools, the number of institutions for higher education that have special curricula for teachers is smaller. Inadequate education of secondary school teachers may cause a decline in the interest of students for CS oriented higher education study programs, an insufficient CS competency in students and less readiness for later professional engagement (Mishra & Yazici, 2011), as well as, according to Yardi and Bruckman (2007), a negative general attitude towards computer sciences. According to Dagdilelis et al. (2004), teaching CS in secondary school does not ensure an understanding of deeper conceptual levels of CS content, but a mere memorization of software details. Creating professional organizations like CSTA (Computer Science Teacher Association) is an indicator that the academic society is aware of the importance of this problem (Ragonis et al., 2011). The CSTA report (Stephenson et al., 2005) suggests the need for adopting standards for the education of CS teachers, i.e. defining the details of the specific content that is to be included in the study programs for educating CS teachers. The CSTA places great emphasis on the importance of permanent professional development of CS teachers already employed in schools. Informatics and computing is a specific scientific discipline the dynamic nature of which may be reflected in the slight changes in the curricula, like introducing new technology within the same paradigm (switching from Pascal to C) or in much more "dramatic" ones, such as changing the paradigm of programming itself (switching from procedural to Object-oriented programming). This means that teachers, for any of the possible changes, must be ready for professional development whether it is "organized or independent"(Armoni, 2011).

As suggested by Gal-Ezer and Stephenson (2010), every CS teacher preparatory program should contain four basic fields: Academic competency in the field of Computer Sciences, Academic competency in the field of education, Teaching Methodology courses and practice and General pedagogical knowledge. A comparative analysis of German, Turkish, Austrian, Dutch, Estonian and Israeli CS teacher curricula allows for a categorization of the courses into the four previously mentioned fields, taking into account that some of the analyzed curricula also cover courses such as mathematics, foreign languages etc., which could be classified as general knowledge and skills category. A proposed NCATE (National Council for Accreditation of Teacher Education) CS teacher education standard is given by East et al. (2011). The standard, basically, consists of four principles: Knowledge of CS content; Efficient teaching and learning; Efficient learning environments and Professional knowledge and skills. Taking into account the PISA rating that Finnish students have, studying the concept of educating secondary school teachers in this country is very important. The structure of Finnish secondary school teacher curricula generally, regardless of the subject being taught, according to Niemi and Jakku-Sihvonen (2009), consists of the following: basic academic disciplines, research studies, pedagogical studies (educational psychology, sociology of education, didactics, practice in "normal" schools during college) and a field that encompasses communication, ICT skills and foreign languages. Therefore, according to the available references and the analysis of the current world curricula, knowledge which contemporary curricula for education of CS/Informatics teacher should provide can be divided into 5 categories:

- Informatics domain knowledge,
- General pedagogical knowledge (educational psychology, didactics, etc.),
- Knowledge of Informatics teaching methods,
- Knowledge of teaching practice,
- General knowledge and skills (foreign languages, mathematics, applying ICT to teaching process).

In the context of secondary school CS curriculum standardization, the most comprehensive approach is represented by the ACM K12 proposed standard for all levels of education, up to higher education. The ACM K12 also provides an adequate description of computer sciences intended for secondary school teachers: computer sciences are neither programming nor computer literacy, but a study of computers and algorithmic processes, including their principles, hardware and software design, computer applications and their effect on society (Tucker et al., 2004; Gal-Ezer & Stephenson, 2010). Computer sciences are defined as a scientific discipline intended for problem solving, primarily within the algorithmic way of thinking and, sometimes, implementing solutions using certain programming languages (Armoni, 2011). Computer Sciences in secondary schools, according to Tucker et al. (2004), include: programming, databases and information retrieval, hardware design, computer networks, graphics, the algorithmic way of thinking, artificial intelligence, levels of abstraction, various programming paradigms (procedural and Object-oriented, primarily), logics, limitations of a computer, Information Technology application and "social" questions (Internet safety, privacy, intellectual property, etc.).

Before the ACM K12 proposal, the UNESCO/IFIP secondary school ICT education curriculum appeared (UNESCO, 2000). The ACM K12 proposal is considered to be more updated and comprehensive, considering the fact that it proposes a curriculum based on computer sciences, defined in such a way that they represent a more complete, appropriate and contemporary scientific discipline than ICT and Informatics described by UNESCO (2000).

In the Republic of Serbia and the AP of Vojvodina there are several study programs in a number of university programs that provide education for Informatics teachers. At the moment, in Vojvodina, future Informatics teachers can obtain education within integrated studies as graduate teachers of two study fields – master studies (Geography-Informatics) and bachelor and master studies for Informatics and Technical Studies teachers. Secondary school Informatics curricula mainly differ depending on the school. In elementary school Informatics and computing as a subject is an elective course, so even though a mandatory Technical and Informatics Education course partially involves the study of Informatics concepts, a scenario where the student does not take the Informatics and Computing course in elementary school and comes to secondary school with little or no knowledge of Informatics is highly possible. Creators of current secondary school Informatics curricula must be aware of this possibility.

Even though in the work of Ragonis et al. (2011) and Van Diepen et al. (2011) we are able to find research results of teachers' opinions regarding secondary school CS curricula, a detailed research, looking into teachers' opinions of CS/Informatics curricula that depends on the educational profile of those they teach, is rare. Nevertheless, contemporary references for secondary school Informatics curricula that contain general standards such as described by Tucker et al. (2004) and UNESCO (2000) do exist, while in the case of Informatics teacher curricula, that is not the case. There are also relatively few papers on Informatics teacher curricula based on research. In most cases, they are actually descriptive papers, which include recommendations for certain courses, "based on the experience and expertise of leading CS educators" (Armoni, 2011), or papers which describe one particular curriculum. That is the case with Armoni (2011) and Gal-Ezer and Stephenson (2010), who present a review of the current state and general suggestions of necessary teacher competencies divided into broader fields. However, East et al. (2011) provide us with a list of thematic fields within the proposed curriculum. In the work of Ragonis et al. (2010) we are provided with quality descriptive research on the Israeli academic society regarding the model of the CS teacher curriculum in that country. Hazan et al. (2008) suggest a model, whereas in the work of Gal-Ezer et al. (2007) we have a complete curriculum used in the Israeli Open University. Micheuz (2008) presents research which was done on the opinion of Austrian teachers, primarily, in comparison with ECDL and thematic fields of the ninth grade, while in Grgurina (2008) we are given a description of the Informatics teacher curriculum provided by the University of Groningen. Papers that cover this field in more detail are mostly outdated (Poirot et al., 1985; Statz & Miller, 1975; Taylor, 1997).

This paper is based on the research on the opinions of Informatics teachers regarding relevant thematic fields of curricula of all levels of education, taking into account the type of university study programs that have been completed and the type of school they teach in. This is a part of a broader research which deals with the problem of educating Informatics teachers in the Republic of Serbia, with the objective of defining an educational frame for secondary school Informatics teachers which would ensure that during their professional career teachers possess the following: (1) necessary general and specific knowledge within the domain field (Informatics) which is in accordance with the current state of that same field; (2) necessary general knowledge within the pedagogical and teaching methodology corpus, as well as specific knowledge pertaining to the field of Informatics teaching methods, which are in accordance with the demands of the current teaching methods and educational technologies.

Methods

Research Aim

The primary research aim of this paper was to define methodology for creating an Informatics teacher profile that would serve as a source of information for planning an education modality, not only of the current, but also of the future Informatics teaching staff. To do this, research was carried out on the objective indicators linked to academic and permanent education, teachers' subjective opinions regarding the significance of domain and pedagogical and teaching methodology corpus and its presence in Informatics teacher education curriculum, along with self-evaluation of Informatics field competencies.

- The teacher profile is described using the following attributes:
- Teaching experience (years of service, educational profile of students – 3 profiles),
- Academic education,
- Evaluation of competency within the domain field of Information and Communication Technology,
- Evaluation of competency within the pedagogical and teaching methodology corpus,
- Permanent education,
- An opinion regarding the importance of domain (Informatics), and pedagogical and teaching methodology corpus in the Informatics teacher education curriculum,
- An opinion regarding the representation of domain knowledge in the secondary school education curriculum,
- An opinion regarding Informatics teachers' education modalities.

Sample

The research was conducted in May and June of 2012, with a representative sample of 49 Informatics teachers employed in 23 secondary schools throughout Vojvodina. For the purposes of this paper, secondary schools, taking into account the scope, research level and importance of Informatics courses in their curricula, were divided into three types: grammar schools, technical vocational schools and other vocational schools. The term "other vocational schools" refers to all other schools which are neither technical nor grammar schools (schools of economy, medicine, agriculture, etc.). The research encompassed 6 grammar schools, 6 technical vocational schools, and 11 other vocational schools in such a way that the representation of each type of school in the sample is proportional to the number of that type of school on the territory of Vojvodina. This research paper included all School Administrations in the territory of Vojvodina (Sombor, Zrenjanin and Novi Sad).

Research Instruments

The research instrument was a questionnaire, distributed by electronic mail. The teachers could choose the way in which they would fill out the questionnaire: electronically or by filling out the printed questionnaire form. The questionnaire used, in accordance with the attributes used to describe the teacher profile, was divided into sections, in such a way that the section titles were the same as the attribute titles.

The thematic fields of the curriculum, teachers' competency regarding these fields, the importance of the fields and representation in the secondary school curriculum were chosen on principles of references mentioned in the introduction of this paper and the existing curricula in the Republic of Serbia.

For the processing of the collected data, the following statistical methods were used: descriptive statistical measures (measures of central tendency, measures of variability, parameters of a distribution), and measures of statistical conclusion (chi-squared test, Fisher's exact test, univariate analysis of variance - ANOVA).

Results

Result grouping was done in accordance with the described profile, while the results regarding the questions which were statistically significantly different (determined by using Fisher's test or ANOVA) were marked by a star.

Academic Degree

Table 1.

Teacher structure in relation to academic degree and type of school in which they teach

		Type of school						Total	
		Grammar school		Technical vocational schools		Other vocational schools			
		N	%	N	%	N	%	N	%
Study program	Informatics teacher	13	76.5 %	2	20.0 %	9	40.9 %	24	49.0 %
	(business) Information systems	2	11.8 %	1	10.0 %	10	45.5 %	13	26.5 %
	Technical sciences	2	11.8 %	7	70.0 %	3	13.6 %	12	24.5 %

Fisher's exact test 16.905, Exact Sig. (2-sided): 0.001

Table 2.

Knowledge of methodology and skills acquired during university studies

		Type of school						Total	
		Grammar schools		Technical vocational schools		Other vocational schools			
		N	%	N	%	N	%	N	%
Acquired knowledge of school processes during university studies	Yes	4	23.5 %	3	30.0 %	5	22.7 %	12	24.5 %
	No	13	76.5 %	7	70.0 %	17	77.3 %	37	75.5 %
Acquired knowledge of school management during university studies	Yes	1	5.9 %	2	20.0 %	1	4.5 %	4	8.2 %
	No	16	94.1 %	8	80.0 %	21	95.5 %	45	91.8 %
Acquired knowledge of teaching methodology during university studies: homeroom teacher duties	Yes	5	29.4 %	2	20.0 %	8	36.4 %	15	30.6 %
	No	12	70.6 %	8	80.0 %	14	63.6 %	34	69.4 %
Acquired knowledge of Informatics methodology during university studies (observation of the teaching process)*	Yes	13	76.5 %	2	20.0 %	10	45.5 %	25	51.0 %
	No	4	23.5 %	8	80.0 %	12	54.5 %	24	49.0 %

* Fisher's exact test 8.395, Exact Sig.(2-sided): 0.016

Teacher Competency Evaluation

Table 3.

Self-evaluation mean values divided into fields and type of graduate studies completed

Thematic field	Type of graduate studies completed						Total	
	Informatics teacher		Information systems		Technical sciences			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Informatics basics	4.42	.565	4.32	.751	4.29	.582	4.36	.605
Operating systems basics, software, hardware and Internet basics	4.78	.323	4.64	.408	4.68	.439	4.72	.372
Software applications for text, charts and presentations	4.88	.338	4.91	.302	4.86	.332	4.88	.322
Mathematical basis of computers and hardware design	4.25	.643	3.86	1.398	4.17	.615	4.14	.864
Computer networks*	4.63*	.448	3.82*	1.168	4.00*	.640	4.28*	.793
Computer graphics*	4.63*	.711	3.82*	1.250	4.58*	.515	4.43*	.878
Multimedia*	4.71*	.690	3.82*	1.250	4.42*	.669	4.43*	.903
E – learning (LMS, e-learning standards, educational computer games)*	3.67*	.811*	2.82*	.923*	2.53*	.627	3.18*	.935
Data types, structures and algorithms	4.63	.532	4.21	1.138	4.14	.658	4.40	.761
Procedural programming	4.60	.707	4.09	1.158	4.08	.875	4.35	.890
Object-oriented programming	3.94	.866	3.12	1.393	3.42	1.016	3.62	1.081
Modeling and simulation and artificial intelligence basics*	3.06*	1.035	2.50*	.806	2.17*	.749	2.70*	.982
Databases*	4.58*	.602	4.41*	.801	3.54*	1.054	4.28*	.883
Advanced Internet and static and dynamic web page programming*	3.79*	1.062	2.82*	.923	3.00*	.667	3.36*	1.028
Educational psychology*	4.33*	.816	3.09*	1.136	3.75*	.754	3.89*	1.005
Didactics*	4.42*	.654	3.36*	1.286	3.67*	.651	3.98*	.944
Pedagogy, personalized learning and sociology of education*	3.90*	.975	3.00*	1.256	3.42*	.740	3.57*	1.045
Foreign languages	4.21	.721	3.91	.831	3.83	.937	4.04	.806
Mathematics*	4.63*	.495	4.00*	.894	4.67*	.492	4.49*	.655
Applying new technology in the teaching processes (educational technology, LMS/CMS, social software)*	4.10*	.705	3.33*	1.247	3.22*	1.122	3.70*	1.031
Informatics teaching methods	4.15	.896	3.61	1.340	3.44	.956	3.84	1.056
Everyday teaching practice engagement	4.28	.612	4.43	.686	4.08	.581	4.27	.621

* marks fields for which the ANOVA test measurements show statistically significant differences among groups

Permanent Professional Development

Table 4.

Ways of acquiring knowledge after formal education

Ways of acquiring additional knowledge	Field							
	Informatics (domain) field		General pedagogical field		Informatics teaching methods field		Teaching practice field	
	N	%	N	%	N	%	N	%
No additional knowledge acquired	1	2.1 %	3	6.5 %	9	19.6 %	12	26.1 %
Additional knowledge acquired by attending workshops/ seminars	32	68.1 %	31	67.4 %	19	41.3 %	21	45.7 %
Additional knowledge acquired by attending scientific and professional conferences	14	29.8 %	2	4.3 %	2	4.3 %	4	8.7 %
Additional knowledge acquired by reading professional literature	45	95.7 %	35	76.1 %	32	69.6 %	26	56.5 %
Additional knowledge acquired by attending special courses	28	59.6 %	21	45.7 %	11	23.9 %	4	8.7 %

Opinions on the Importance of Domain and Pedagogical-Methodological Corpus in the Informatics Teacher Education Curriculum

Table 5.

Significance of thematic fields in the Informatics teacher education curriculum

Teaching significance	Type of school						Total	
	Grammar schools		Technical vocational schools		Other vocational schools			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Informatics basics	4.44	.583	4.15	.784	4.08	.629	4.23	.656
Software applications for text, charts, and presentations	4.90	.283	4.53	.670	4.89	.315	4.82	.426
Operating systems basics, software, hardware and Internet basics	4.62	.323	4.62	.494	4.32	.608	4.50	.506
Mathematical basis of computers and hardware design*	3.88*	.574	4.05*	.832	3.18*	1.169	3.63*	.974
Computer networks	4.21	.639	4.30	.537	3.84	1.106	4.08	.856
Computer graphics	4.41	.618	4.10	.738	4.11	1.049	4.22	.841
Multimedia	4.53	.514	4.30	.483	4.21	.713	4.35	.604
E – learning (LMS, e-learning standards, educational computer games)	3.92	.722	3.83	.707	3.42	.777	3.70	.763
Data types and structures and algorithms*	4.63*	.576	4.20*	1.021	3.61*	1.167	4.12*	1.038
Procedural programming*	4.68*	.585	4.25*	1.034	3.08*	1.216	3.92*	1.211
Object-oriented programming*	4.55*	.634	3.97*	.909	2.98*	1.288	3.78*	1.213

Teaching significance	Type of school						Total	
	Grammar schools		Technical vocational schools		Other vocational schools			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Modeling and simulation and artificial intelligence basics*	3.76*	.710	3.65*	.914	2.74*	1.019	3.32*	1.002
Databases	4.56	.659	4.25	1.034	3.82	1.397	4.18	1.122
Advanced Internet and static and dynamic web page programming*	4.24*	.695	3.93*	.750	3.35*	1.136	3.80*	.980
Educational psychology	4.24	.752	4.40	.699	4.26	.806	4.28	.750
Didactics	4.29	.772	4.20	.789	4.37	.761	4.30	.756
Pedagogy, personalized learning and sociology of education	4.29	.576	4.27	.750	4.21	.931	4.25	.761
Foreign languages	4.76	.437	4.70	.483	4.74	.562	4.74	.491
Mathematics*	4.82*	.393	4.30*	.823	4.21*	.855	4.46*	.751
Applying new technology in the teaching processes (educational technology, LMS/CMS, social software)	4.22	.824	4.07	.927	3.81	.723	4.01	.810
Informatics teaching methods*	4.66*	.324	4.43*	.598	4.13*	.665	4.39*	.585
Everyday teaching practice engagement	4.56	.768	4.05	.762	4.16	.883	4.28	.828

* marks fields for which the ANOVA test measurements show statistically significant differences among groups

Opinions on the Representation of Domain Knowledge in the Secondary School Curriculum

Table 6.

Representation of domain knowledge in the high school curriculum

Representation in the curriculum	Type of school						Total	
	Grammar schools		Technical vocational schools		Other vocational schools			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Informatics basics	3.79	.730	3.70	.422	3.68	.869	3.73	.728
Operating systems basics, software, hardware and Internet basics	4.42	.429	4.38	.629	4.06	.743	4.26	.629
Software applications for text, charts, and presentations	4.94	.13´	4.50	.707	4.53	.731	4.67	.602
Mathematical basis of computers and hardware design	3.24	1.002	3.60	.937	2.84	1.143	3.15	1.069
Computer networks	3.71	.792	3.65	1.001	3.29	.933	3.52	.900
Computer graphics*	4.71*	.588	3.80*	1.229	3.11*	1.524	3.85*	1.366
Multimedia*	4.53*	.717	4.20*	.789	3.42*	1.170	4.00*	1.054
E – learning (LMS, e-learning standards, educational computer games)	2.06	.775	2.20	.613	2.32	1.003	2.20	.839
Data types and structures and algorithms*	4.22*	.881	3.43*	1.458	2.58*	1.105	3.37*	1.313

Representation in the curriculum	Type of school						Total	
	Grammar schools		Technical vocational schools		Other vocational schools			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Procedural programming*	4.44*	.917	3.25*	1.477	2.11*	.937	3.22*	1.474
Object-oriented programming*	3.82*	.826	2.97*	1.222	2.09*	.942	2.92*	1.224
Modeling and simulation and artificial intelligence basics	1.79	.936	2.10	.775	1.92	1.071	1.91	.950
Databases	3.94	.933	3.55	1.066	3.08	1.465	3.50	1.243
Advanced Internet and static and dynamic web page programming	3.16	1.119	2.47	.757	2.28	1.172	2.64	1.127

*marks fields for which the ANOVA test measurements show statistically significant differences among groups

Teacher Education Modality

Table 7.
The most suitable concept of teacher education

	Academic master studies focused on pedagogical aspects and aspects of Informatics teaching methods		Academic master studies focused on Informatics (domain) aspects		Integrated academic basic and master studies	
	N	%	N	%	N	%
Teacher education modality	9	17.8 %	9	17.8 %	29	64.4 %

Discussion

Teaching Experience

Out of the 49 secondary school Informatics teachers who participated in this survey, 17 teach in grammar schools, 10 are employed in technical vocational schools, while 22 are employed in other vocational schools (see Table 1). The average teaching experience of these teachers is 12.88 years (*SD*=8.42), taking into account the fact that there is no statistically significant difference in terms of where they teach. This accounts for the possibility of conducting teaching both in secondary school and elementary school.

Academic Degree

The average grade of the participant Informatics teachers, on all academic levels, was 7.99 (*SD*=0.63), without any statistically significant differences regarding the type of school where they teach. The majority (76 %) of Informatics teachers have completed the basic level of academic studies (4 years), 16 % have a master's degree and about 8 % have a degree of Master of Science. Apart from this, there have not been any statistically significant differences in the level of education completed and the school where they teach. Approximately half of the teachers have graduated from some type of Informatics teacher study program, while the other half has acquired an almost equal level of academic education in the field of Information systems and technical sciences (see Table 1). The teachers entered into the questionnaire the name of the study program and the faculty within the university they had graduated from, as well as the list of the academic subjects they had passed, divided into fields (Informatics, general pedagogic field, teaching methodology field and general knowledge and skills). Therefore, with a detailed analysis of the collected data, it can be concluded that the "Informatics teacher" group, apart from the study program with this very same name, also attended the following study programs: Informatics graduates from the Faculty of Sciences (this study program provided, at the time the participant teachers attended them, courses in Informatics teaching methods as well as general pedagogical knowledge), "Informatics Teaching Methods" and "Informatics in Education". Graduates in "Information Systems" group belong to the study group under the same name at the Faculty of Economy and the Faculty of Organizational Sciences. The "Technical Sciences" graduates' group refers to study programs such as: electronics and telecommunications, automatics and computer techniques, microcomputer electronics, etc. Table 1 shows that the majority of grammar school teachers have undergone some type of Informatics teacher study program; nearly half of Informatics teachers in "other vocational schools" have graduated in Information Systems, while the majority of teachers in technical vocational schools have graduated in Technical Sciences. Fisher's test points out that we cannot rule out the existence of a statistically significant difference such as the completed study programs in regard to the type of school the teachers are employed at. These results were to be expected, and to a large degree, the type of the completed studies coincides with the educational profile the teachers work with. In "other vocational schools" group, a large number of teachers work in secondary schools of economics and their formal education is, most frequently, in the field of (business) Information Systems. With a more detailed analysis of the structure and content of Information Systems and Technical Sciences studies programs, it is noticeable that they do not provide the courses in general educational studies and Informatics teaching methods. The results in Table 2, which show the knowledge of methodology and the skills that the teachers had the opportunity to acquire during their university studies, also point out to this (the majority of teachers did not acquire knowledge in the field of school operations, hardly any of them acquired knowledge and skills within the field of school management, while most of the teachers did not get acquainted with the duties of a homeroom teacher). A statistically significant difference related to the type of school was not established here. As for the acquired knowledge of methodology of Informatics teaching (teaching observation), the situation is slightly more favorable. Nevertheless, there is a statistically significant difference here between the type of the school the teachers work at (Fisher's exact test 8.93, $p = 0.02$), which was to be expected, taking into account the already mentioned fact that the largest number of Informatics teachers who have had the opportunity to acquire knowledge within this field during their university studies now work in grammar schools. The research points out that the majority of the teachers in technical schools and slightly more than half of teachers who work in other vocational schools have not acquired knowledge within this field, which is also a worrisome fact.

Teacher Competency Evaluation Grade for the Domain of Information and Communication Technology and the Pedagogical and Methodological Corpus

The questionnaire contained 64 thematic fields divided into 5 aspects, in accordance with the analysis presented in the introduction to this paper: the Informatics (domain) aspect, the general pedagogical aspect, general knowledge and skills, the Informatics teaching methods aspect, and the teaching practice aspect. The teachers rated their knowledge in these fields from 1-5 (1 – "I didn't know this field existed", 2 – "I know the field exists but I know nothing about it", 3 – "I know the basic concepts of the field but I don't understand its core", 4 – "I am familiar with and understand all the basic concepts", 5 – "I have gained practical experience in this field/I apply it in my teaching"). A number of 47 teachers answered this group of questions. In Tables 3 and 5 all thematic fields have been grouped into 22 related groups for the purposes of this paper, and the group grade was obtained by calculating the mean score of the thematic fields which belong to it. The teachers' self-evaluation regarding the selected fields is shown in Table 3 which provides the mean values and standard deviations of calculated scores in relation to the type of the study program completed. It is noticeable that teachers rated their knowledge with lower scores in the fields of contemporary CS like: e-learning (particularly e-learning standards, LMS/CMS administration), Object-oriented programming, Modeling and simulation and artificial intelligence basics, Advanced Internet and static and dynamic web page programming. High scores were not given to knowledge in the fields of educational psychology, pedagogy, personalized learning and sociology of education, the application of new technology in teaching processes and Informatics teaching methods. This would appear in a more distinctive fashion if we were to compare the acquired knowledge with the type of the study program completed, and for this purpose we applied the ANOVA (univariate analysis of variance). Statistically significant differences exist in the e-learning field, where teachers who have graduated in Information Systems and Technical Sciences have rated their knowledge below 3.00. A higher grade in this field was given by Informatics teachers who had studied some fields that encompassed e-learning during their university level education. Statistically significant differences also appear in the field of multimedia, computer graphics and computer networks, which were studied less within the Information Systems study programs. In the field of modeling and simulation and artificial intelligence, as well as databases and advanced Internet and programming static and dynamic web pages, a statistically significant difference in grades can also be found. Informatics teachers also rated their knowledge of these fields with the highest grades. The ANOVA test has shown statistically significant differences that refer to the knowledge of these three groups of teachers regarding highly important fields of educational psychology and didactics. Even though the mean score for all the teachers relating to these two fields was at a satisfactory level, when we look at the distribution of grades according to the type of the study program completed, significant differences are noticeable in terms of higher grades in the group of Informatics teachers when compared to the other two groups of teachers. The reason for this could be the structure of Information Systems study programs and different departments of technical sciences which do not encompass general pedagogic fields. Similar conclusions might be drawn in regards to the field of applying new technologies in the teaching process and the field of pedagogy, personalized learning and the sociology of education. A statistically significant difference also exists among the groups of teachers, and Informatics teachers rate their knowledge with the highest grades. A statistically significant difference appears in the field of mathematics, bearing in mind that the teachers who had finished Information Systems university study programs rated their knowledge within this field with slightly lower grades.

Permanent Professional Development

Table 4 shows the results which refer to the continuing professional development of teachers. The majority of teachers have accomplished some kind of additional knowledge acquisition within the field of Informatics after graduating from university (Table 4). Multiple answers were possible here, and the majority of teachers acquired additional knowledge by studying professional literature at least, most of them have attended workshops and seminars, while every third teacher has attended scientific and professional conferences. Nearly 60 % of teachers attended special courses. Most often the teachers attended some of the basic (ECDL and Archimedes) courses which provide the study of computer hardware, software applications for text, presentations and charts, basics of the Internet, operating systems, as well as multimedia, computer networks, database basics courses. It is exactly these fields of knowledge that were rated with the highest grades by teachers in the self-evaluation process (Table 3). Teachers attended courses in the field of contemporary Informatics domain to a slightly lower extent and rated their knowledge of these fields with lower grades (Table 3). Teachers who attended additional courses that covered Object-oriented programming, Moodle LMS, SCORM standard or "cloud computing" rated their knowledge of these fields with higher grades in their self-evaluation. These results point to the need for organizing additional courses in the lower rated fields, especially in those fields teachers were least educated in, as well as to the need for stimulating teachers to attend these courses. In comparison with the Informatics domain, where only one teacher did not acquire any additional knowledge, a slightly higher percentage of teachers did not acquire any knowledge in the general pedagogical field, while results in the field of Informatics teaching methods and the teaching practice field point to a significantly lower continuing professional development. For these three aspects, the majority of teachers acquired knowledge by studying professional literature and to a lower extent by attending scientific and professional conferences. Taking into account the significant number of teachers who had finished studies which did not encompass the aspect of pedagogical fields, Informatics teaching methods and teaching practice, the results which point to the fact that these teachers did acquire additional knowledge within these fields are encouraging. Moreover, a significant number of teachers acquired additional knowledge by attending special courses, especially in the general pedagogical field. Fisher's test did not point to a statistical difference in the acquisition of additional knowledge within the Informatics field, the general pedagogical field, Informatics teaching methods and the teaching practice field with regard to the type of school they teach at. In the part of the questionnaire where the teachers were asked to list software technologies offered by additional courses they thought would be most needed for the teaching process, they largely expressed the need for those technologies they rated with the lowest grades in the self-evaluation, and for those which they did not have a chance to get acquainted with via additional courses. The following fields were most frequently listed: Object-oriented programming, static web page programming, UML, advanced Internet technology, "cloud computing", Moodle and, generally, Learning Management Systems (LMS, CMS). A lower number of teachers expressed that computer networks, multimedia, computer graphics and databases courses would also be useful in the teaching process.

The Opinion of Teachers on the Importance of Domain, and Pedagogical and Teaching Methodology Corpus in the Informatics Teacher Education Curriculum

Table 5 shows the opinion of teachers regarding university level curriculum content for Informatics teachers, i.e. how important it is that each of the suggested fields be present in higher education curricula enabling teaching Informatics in secondary schools successfully. Teachers rated the importance in relation to the educational profiles of those they teach. The questionnaire comprised 64 thematic fields the importance of which was rated in the following way: 1 – "no importance whatsoever", 2 – "very low importance", 3 – "medium importance", 4 – "high importance", 5 – "of the utmost importance". A number of 46 teachers answered this group of questions. Teachers had the possibility of adding a thematic field which was not offered in the questionnaire, but which they considered to be significant for the teaching process. However, teachers felt no such field exists. Thematic fields were also grouped here in the same way they were grouped in the self-evaluation of teachers and the results of the significance scores are shown in Table 5. It is noticeable that teachers rated the importance of almost every field highly (the minimum grade was 3.32). For the majority of those fields the importance of which had lower rates in teaching, the univariate analysis of variance, the ANOVA test, pointed to statistically significant differences with regard to the type of school the teachers work at. Thus, even though the total importance score for the mathematical basis of computers and hardware design is slightly lower, grades for this field differ with regard to the type of school teachers work at (in technical schools it is the highest, while in other vocational schools it is the lowest), and the ANOVA test result points to a statistically significant difference with regard to the type of school. Similarly, the importance of procedural programming and Object/oriented programming in teaching was rated high in grammar and technical schools, while in other vocational schools the grade was significantly lower. Also, the importance of the modeling and simulation and artificial intelligence basics aspect was, on average, rated relatively low, firstly because the importance of this area was rated below 3.00 in other vocational schools. A statistically significant difference is also shown among the three types of schools with regard to the following fields: data types and structures and algorithms, advanced Internet and static and dynamic web page programming. It is noticeable that a difference in the importance of themes regarding the type of school affects contemporary and/or more complex Informatics field concepts. Teachers in grammar schools and technical vocational schools consider these fields to be more significant for the teaching process than teachers in other vocational schools. Of course, contents and the number of Informatics subjects which cover these fields, as well as the level which they are studied at, is different when compared to the current curricula of the three types of schools. Table 5 shows that there is no statistically significant difference between the type of school in relation to the relevance of the field of databases, which would have been expected. A detailed sample analysis of the participating schools suggests a possible conclusion that the importance of this field in other vocational schools is at a higher level, possibly due to the relatively high number of secondary schools of economics among them, where the field of databases represents a highly important part of Informatics curricula. Statistically significant differences obtained by the ANOVA test were found in mathematics and Informatics teaching methods fields. Their importance was also rated highest among grammar schools and lowest in other vocational schools.

The Opinion of Teachers Regarding the Representation of Domain Knowledge in the Secondary School Curriculum

Table 6 shows the opinions of teachers regarding the representation of Informatics thematic fields in the curriculum they teach. Thus, here they rated secondary school Informatics curricula with regard to the proposed thematic fields. This group of questions was answered by 46 teachers. Here the thematic fields were divided into related groups by calculating the mean score and their representation was rated on a 1-5 scale (1 – "doesn't exist", 2 – "insufficient", 3 – "acceptable", 4 – "represented well", and 5 – "adequately represented"). Teachers did not think that any other fields, which did not find their place in the questionnaire, should be represented in the curriculum here either. Regarding some fields that were rated lower here, the application of the

ANOVA test pointed to statistically significant differences with regard to the type of school. This especially refers to three fields: data types and structures and algorithms, procedural programming and Object-oriented programming. Thus, even though the data types and structures and algorithms field mean score was sligthly lower, the representation of this aspect was scored above 4.00 in grammar schools, but below 3.00 in "other vocational schools". A similar mean ratio of representation, with regard to procedural programming and object-oriented programming, was noticeable. Thus, the representation of procedural programming and object-oriented programming field had the highest score in grammar schools. Moreover, grades for these fields in grammar schools were significatly higher than the total average score. Taking into account the differences in the curricula of these three types of schools, such results are not surprising and the representation of programming field aspects was, compared to "other vocational schools", expectedly higher in grammar schools, while their representation in technical vocational schools is not appropriate; the representation of object-oriented programming was, for instance, rated below 3.00 in technical schools. Statistically significant differences with regard to the type of school also apply to the fields of computer graphics and multimedia; their representation was rated highest in grammar schools, while the rate of their representation was lowest in "other vocational schools". Satisfactory mean scores (equal to or greater than 3.50) of representation in secondary school curricula were given to seven aspects (out of 14) by the teachers: Informatics basics, Software applications for text, charts and presentations, OS basics, software, hardware and Internet basics, computer graphics, multimedia, computer networks and databases. Nevertheless, out of these 7 aspects only 3 have the mean score equal to or higher than 4.00. Likewise, even though the representation score for Informatics basics was not low, a detailed analysis of the questionnaire points out that the representation of the thematic field of "computer ethics, safety and data protection" which Informatics basics cover, was rated very low, whilst the significance of that thematic field in teaching got high ratings. A particularly low grade was given in all types of schools with regard to the following four fields: e-learning, modeling and simulating and artificial intelligence basics; advanced Internet and programming static and dynamic web pages; the mathematical basis of computers and hardware design. Even though it has been recognized that these four fields were rated with the lowest grades when the rating criteria was their importance in teaching, and that the representation of the programming field (with the differences in secondary school curricula this was to be expected) was significantly different with regard to the type of school (with its representation rated highest in grammar schools), the results still point to the teachers' opinions that many important fields (once again, those referring to more complex and contemporary concepts, especially object-oriented programming, advanced Internet technologies, standards and e-learning technologies) are not adequately represented in secondary school Informatics curriculum.

Opinions Regarding the Informatics Teacher Education Modality

The majority of Informatics teachers who participated in this research consider integrated basic and master academic studies, which would provide them with an opportunity for studying Informatics and pedagogical aspects simultaneously, the most adequate modality for the education of the future Informatics teachers (Table 7). Teachers who find education modality with basic academic studies separated from the master studies to be more adequate for the future Informatics teachers' education are equally distributed in terms of whether they prefer basic academic studies in Informatics followed by master's studies in pedagogical subject, or in reverse order, with basic academic studies in pedagogical subject followed by master studies only in Informatics domain.

Conclusion

This research indicates that a significant number of the secondary school Informatics teachers in Vojvodina, who participated in this research, do not possess adequate formal education and that during university studies the majority of them did not have the opportunity to acquire knowledge and skills within the teaching practice field. Likewise, self-evaluation has shown that a significant number of the teachers who participated in the study and who do not have adequate academic education, lack knowledge in the general pedagogical fields (such as educational psychology and didactics), as well as in the field of applying new technologies to the teaching process. The mean score for teachers' self-evaluation of knowledge of Informatics teaching methods was also relatively low. The majority of the respondents tend to acquire additional knowledge in various fields, but the least in contemporary and complex aspects of Informatics and computing (i.e. object-oriented (OO) programming, advanced Internet concepts or standards, and e-learning management systems). The teachers also expressed the highest need for additional courses in fields in which they rated their knowledge with the lowest grades. All Informatics teacher curriculum fields offered in the questionnaire were rated high in terms of their importance for the teaching profession, and no new field was added. Apart from that, results point to statistically significant difference in importance of some fields (the mathematical basis of computers and hardware design, procedural and OO programming, data types and structures, etc.) with regard to the type of school. These results were expected because the importance of, for example OO paradigms for grammar schools differs substantially from the importance of the same paradigms for other vocational schools (for instance, secondary school of agriculture). The results related to the representation of Informatics fields in secondary school Informatics curricula have shown that it is necessary to update the secondary school curricula (even though the representation of these fields with the lowest rates is more favorable in grammar schools, a large number of significant fields were rated as insufficiently represented). The majority of the respondents consider integrated master's degree program, which would simultaneously cover all informatics and pedagogical aspects, to be the most adequate Informatics teacher's education concept.

Even though the research shown in this paper is of a preliminary type (the research was conducted on a sample that included only the employed Informatics teachers in Vojvodina selected in accordance with the secondary school structure), its results could be of value to two target groups: to amenable ministries and to universities which provide Informatics teacher education. Based on the results of this research, recommendations for the identified target groups are as follows:

- The ministries should give priority to integrated studies for Informatics teachers; ensure secondary school curriculum adaptation and continual updating so that all current thematic Informatics fields are represented; ensure quality continuing professional development for teachers by changing accreditation systems for this type of education which applies to regular study courses.
- University programs for the education of teachers should provide a teaching modality within specialized integrated basic and master studies for Informatics teachers; create study program curricula in such a way that they anticipate future secondary school students' needs, taking into account the opinion of teachers as well; offer quality professional development for teachers, especially in those fields whose knowledge teachers rated with lower grades and fields in which they expressed a need for additional courses.

Further research should have two directions. The first one would be aimed at ensuring a greater coverage in terms of including the existing and future teacher population. Therefore, research is planned which will increase the number of secondary school teachers, include elementary Informatics teachers and Informatics teacher graduate study program students. The second direction aims at providing software tools which could be used for assessing compatibility and adjusting Informatics teacher curricula and programs for their permanent education to the current state of the Informatics field, the general and specific Informatics teaching pedagogical and teaching methodology corpus, as well as elementary and secondary school curricula.

References

Armoni, M. (2011). Looking at secondary teacher preparation through the lens of computer science. *ACM Transactions on Computing Education, 11*(4), 1-38.

CSTA (2008). *Ensuring Exemplary Teaching in an Essential Discipline: Addressing the Crisis in Computer Science Teacher Certification* /online/. Retrieved on 25th July 2012 from http://www.csta.acm.org/Communications/sub/DocsPresentationFiles/CertificationFinal.pdf

Dagdilelis, V., Satratzemi, M., & Evangelidis, G. (2004). Introducing secondary education students to algorithms and programming. *Education and Information Technologies*, *9*(2), 159–173.

Deek, F. P., & Kimmel, H. (1999). Status of computer science education in secondary schools: One state's perspective. *Computer Science Education*, *9*(2), 89-113.

East, P., Bentley, C., Kmoch, J., Rainwater, S., & Stephenson, C. (2011). NCATE standards for preparation of secondary computer science teachers. In *Proceedings of SIGCSE 2011 - The 42st ACM Technical Symposium on Computer Science Education* (pp. 243-244). New York: ACM New York.

Eurydice (2004). *Key Data on Information and Communication Technology in Schools in Europe*. /online/. Retrieved on 25th July 2012 from

http://eacea.ec.europa.eu/education/eurydice/documents/key_data_series/048EN.pdf

Gal-Ezer, J., & Stephenson, C. (2010). Computer science teacher preparation is critical. *ACM Inroads*, *1*(1), 61-66.

Gal-Ezer, J., & Zur, E. (2007). Reaching out to CS teachers: Certification via distance learning. *Mathematics and Computer Education, 41*(3), 250–265.

Grgurina, N. (2008). Computer Science Teacher Training at the University of Groningen. *Lecture Notes in Computer Science, 5090*, 272 - 281.

Hazzan, O., Gal-Ezer, J., & Blum, L. (2008). A model for high school computer science education: the four key elements that make it! *ACM SIGCSE Bulletin - SIGCSE 08, 40*(1), 281–285.

Hazzan, O., Gal-Ezer, J., & Ragonis, N. (2010). How to establish a Computer Science teacher preparation program at your university? – The ECSTPP Workshop. *ACM Inroads magazine*, *1*(1), 35-39.

Micheuz, P. (2008). Some findings on informatics education in Austrian academic secondary schools. *Informatics in Education*, *7*(2), 221–236.

Mishra, A., & Yazici, A. (2011). An assessment of the software engineering curriculum in Turkish Universities: IEEE/ACM guidelines perspective. *Croatian Journal of Education*, *13*(1), 188-219.

Niemi, H., & Jakku-Sihvonen, R. (2009). *Teacher Education Curriculum of Secondary School Teachers*. Helsinki: University of Helsinki /online/. Retrieved on 25th July from http://www.ince.mec.es/revistaeducacion/re350/re350_08ing.pdf

Poirot, J., Luerhmann, A., Norris, C., Taylor, H., & Taylor, R. (1985). Proposed curriculum for programs leading to teacher certification in computer science. *Communications of the ACM, 28*(3), 275–279.

Ragonis, N., Hazzan, O., & Gal-Ezer, J. (2010). A survey of Computer Science teacher preparation programs in Israel tells us: Computer Science deserves a designated high school teacher preparation! In *Proceedings of SIGCSE 2010 - The 41st ACM Technical Symposium on Computer Science Education* (pp. 401-405). New York: ACM New York.

Ragonis, N., Hazzan, O., & Gal-Ezer, J. (2011). A Study on Attitudes and Emphases in Computer Science Teacher Preparation. In *Proceedings of SIGCSE 2011 - The 42st ACM Technical Symposium on Computer Science Education* (pp. 559-564). New York: ACM New York.

Roberts, E., & Halopoff, G. (2005). *Results of the 2005 CSTA National Secondary Computer Science Survey: 2005 Survey Analysis* /online/. Retrieved on 25th July from http://csta.acm.org/Research/sub/Projects/ResearchFiles/CSTASurveyResAnaly.pdf

Statz, J., & Miller, L. (1975). Certification of secondary school computer science teachers: Some issues and viewpoints. In *Proceedings of the Annual Conference of the ACM - ACM'75* (pp. 71–73). New York: ACM New York.

Stephenson, C., Gal-Ezer, J., Haberman, B., & Verno, A. (2005). *The new educational imperative: Improving high school computer science education.* New York: CSTA Curriculum Improvement Task Force /online/. Retrieved on 25th July 2012 from http://csta.acm.org/Communications/sub/DocsPresentationFiles/White_Paper07_06.pdf

Taylor, H. G. (1997). The evolution of standards for accrediting computer science teacher preparation programs. *ACM SIGCSE Bulletin, 29*(1), 67–71.

Tucker, A., Deek, F., Jones, J., McCowan, D., Stephenson, C., & Verno, A. (2004). *A Model Curriculum for K-12 Computer Science*. The ACM K-12 Education Task Force /online/. Retrieved on 25th July 2012 from http://csta.acm.org/Curriculum/sub/CurrFiles/K-12ModelCurr2ndEd.pdf

UNESCO (2000*). Information and Communication Technology in Secondary Education / online/*. Retrieved on 25th July 2012 from http://wwwedu.ge.ch/cptic/prospective/projets/unesco/en/curriculum2000.pdf

Van Diepen, N., Perrenet, J., & Zwaneveld, B. (2011). Which Way with Informatics in high schools in the Netherlands? The Dutch dilemma. *Informatics in Education*, *10*(1), 123–148.

Yardi, S., & Bruckman, A. (2007). What is computing? Bridging the gap between teenagers' perceptions and graduate students' experiences. In *Proceedings of the 3rd International Workshop on Computing Education Research - ICER'07* (pp. 39–50). New York: ACM New York.

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Profil srednjoškolskih nastavnika informatike u Autonomnoj pokrajini Vojvodini

Sažetak

Ovaj rad prikazuje metodologiju koja je korištena u istraživanju i preliminarne rezultate istraživanja s ciljem stvaranja profila nastavnika informatike u srednjim školama u Vojvodini koji bi mogao služiti kao izvor informacija pri planiranju modela obrazovanja nastavnika informatike. Instrument korišten u istraživanju bila je anketa oblikovana tako da bi se prikupili podaci o profilu nastavnika na temelju objektivnih pokazatelja (akademsko i trajno obrazovanje); samovrednovanja nastavničkih kompetencija u područjima informatike, pedagogije i didaktike; mišljenju nastavnika o važnosti informatike i pedagoško-metodičkog aspekta u sveučilišnom kurikulu za obrazovanje nastavnika informatike; njihova mišljenja o zastupljenosti znanja iz područja informatike u srednjoškolskom kurikulu i prikladnom modelu obrazovanja nastavnika informatike. Preliminarni rezultati pokazuju da postoji nesklad u akademskom obrazovanju nastavnika, dok njihova samoprocjena pokazuje da je njihovo znanje o složenijim i suvremenim aspektima informatike, kao i znanje u području pedagogije i metodike nedostatno. Mišljenje nastavnika je da mnoge informatičke teme nisu prikladno zastupljene u srednjoškolskom kurikulu u Vojvodini. Istraživanje također ukazuje na potrebu specijaliziranih integriranih studija kao modela obrazovanja nastavnika informatike.

Ključne riječi: *informatika; kurikul; nastavnik; računalne znanosti; srednja škola; sveučilište.*

Uvod

Intenzitet promjena u području informatike i njihov utjecaj na ostala područja uzrokovali su sve veću potrebu za čestim nadograđivanjem kurikula visokog obrazovanja za nastavnike informatike i trajnog stručnog usavršavanja nastavnika, no i stalnu prilagodbu kurikula informatike u osnovnim i srednjim školama suvremenim trendovima. Posebna bi se pažnja trebala posvetiti potrebi da se kurikuli na svim stupnjevima obrazovanja usklade. Obrazovni ishodi u području informatike u osnovnoj školi moraju biti u skladu s kurikulom informatike u srednjoj školi, da bi učenici mogli steći adekvatno znanje i vještine potrebne za nastavu informatike u srednjoj školi. Nakon završetka srednje škole učenici bi morali biti dovoljno obrazovani u području informatike da bi mogli pohađati kolegije iz informatike unutar odgovarajućeg studijskog programa na stupnju visokoškolskog obrazovanja. Slično tome, kompetencije nastavnika informatike koji steknu visokoškolsko obrazovanje moraju biti u skladu s aktualnim kurikulom informatike u osnovnoj i srednjoj školi.

Iako literatura (Hazzan i sur. 2010; Stephenson i sur. 2005; Eurydice, 2004) ukazuje na važnost stvaranja suvremenih kurikula za srednje škole i za obrazovanje nastavnika u području računalnih znanosti, istodobno uzimajući u obzir posebnost područja računalnih znanosti koje zahtijeva izradu posebnog kurikula za nastavnike računalnih znanosti (Ragonis i sur. 2010), u nekim zemljama još nisu izrađeni posebni studijski programi za obrazovanje nastavnika računalnih znanosti/informatike (Armoni, 2011; CSTA, 2008; Ragonis i sur. 2011). Posljedica toga je da u mnogim srednjim školama informatiku i računalne znanosti predaju nastavnici koji nisu stekli formalno obrazovanje u području računalnih znanosti, kao što su, npr. nastavnici matematike ili nastavnici drugih znanstvenih disciplina (Ragonis i sur. 2011; Deek i Kimmel, 1999). Prema Gal-Ezeru i Stephensonu (2010) postoje dva ključna čimbenika koja se smatra odgovornima za trenutnu krizu u obrazovanju nastavnika računalnih znanosti:

- Nedovoljna jasnoća, razumijevanje i dosljednost postojećih zahtjeva za certificiranje nastavnika računalnih znanosti
- Nepostojanje tijesne povezanosti između postojećih zahtjeva za certificiranje nastavnika i trenutnih sadržaja discipline računalnih znanosti.

Istraživanje u SAD-u je pokazalo da među nastavnicima računalnih znanosti postoje nejasnoće u vezi s potrebnim preduvjetima za to zanimanje, najviše zbog toga što oni koji su odgovorni za stvaranje i provođenje pravila za certificiranje nastavnika računalnih znanosti ne razumiju dovoljno dobro tu znanstvenu disciplinu, kao ni njezinu teorijsku, praktičnu i pedagošku osnovu. Drugi je problem u tome što se polje računalnih znanosti miješa s drugim disciplinama poput obrazovne tehnologije, industrijske ili nastavne tehnologije, upravljanja informacijskim sustavima ili čak računalnom podrškom u drugim tematskim područjima (Gal-Ezer i Stephenson, 2010). U nedostatku jasnih i preciznih uvjeta za predavanje računalnih znanosti u školama, broj institucija visokog obrazovanja koje imaju posebne kurikule za obrazovanje nastavnika je manji. Neadekvatno obrazovanje srednjoškolskih nastavnika informatike može dovesti do smanjenog interesa učenika za sveučilišne studijske programe u području računalnih znanosti, nedostatnih kompetencija učenika u području računalnih znanosti i nespremnosti da se kasnije profesionalno bave računalnim znanostima (Mishra i Yazici, 2011). Kako navode Yardi i Bruckman (2007), ono također može dovesti i do stvaranja općeg negativnog stava prema računalnim znanostima. Prema Dagdilelisu i suradnicima (2004), nastava u području računalnih znanosti u srednjim školama ne vodi razumijevanju dubljih konceptualnih sadržaja računalnih znanosti, već podrazumijeva puko memoriranje detalja vezanih uz računalne programe. Osnivanje strukovnih organizacija kao što je CSTA (eng. *Computer Science Teacher Association* – Udruženje nastavnika računalnih znanosti) ukazuje na činjenicu da je akademska zajednica svjesna težine toga problema (Ragonis i sur. 2011). Izvješće koje je pripremila CSTA (Stephenson i sur. 2005) upućuje na potrebu usvajanja standarda za obrazovanje nastavnika računalnih znanosti, tj. na potrebu određivanja detalja posebnih sadržaja koji bi se trebali uključiti u studijske programe za obrazovanje nastavnika računalnih znanosti. CSTA posebno naglašava važnost trajnog stručnog usavršavanja nastavnika računalnih znanosti koji su već zaposleni u školama. Informatika i računalstvo pripadaju posebnoj znanstvenoj disciplini čija se dinamična priroda može odraziti na male promjene u kurikulu, kao što je uvođenje nove tehnologije u istoj paradigmi (prijelaz s Pascala na C) ili na dramatičnije promjene, kao što je mijenjanje same paradigme programiranja (prijelaz s proceduralnog programiranja na objektno orijentirano programiranje). To znači da nastavnici moraju biti spremni na stručno usavršavanje zbog svih promjena, bez obzira na to bilo ono „organizirano ili samostalno" (Armoni, 2011).

Kako su predložili Gal-Ezer i Stephenson (2010), svaki pripremni program za nastavnike računalnih znanosti trebao bi se sastojati od četiri osnovna polja: akademskih kompetencija u području računalnih znanosti, akademskih kompetencija u području obrazovanja, metodike nastave i prakse i općega pedagoškog znanja. Komparativna analiza kurikula za obrazovanje nastavnika računalnih znanosti u Njemačkoj, Turskoj, Austriji, Nizozemskoj, Estoniji i Izraelu pokazuje da se kolegiji mogu klasificirati u četiri spomenuta polja, uzimajući u obzir činjenicu da neki analizirani kurikuli također uključuju kolegije matematike, stranih jezika itd., a koji bi se mogli svrstati u kategoriju općeg znanja i vještina. East i sur. (2011) prikazuju standard za obrazovanje nastavnika računalnih znanosti koji je predložilo Nacionalno vijeće za akreditaciju obrazovanja nastavnika (eng. *NCATE - National Council for Accreditation of Teacher Education*). Standard se, u osnovi, sastoji od četiri principa: poznavanja sadržaja računalnih znanosti, učinkovitog poučavanja i učenja, učinkovite okoline za učenje i profesionalnog znanja i vještina. Uzimajući u obzir PISA rezultate finskih studenata, proučavanje koncepta za obrazovanje srednjoškolskih nastavnika u toj je zemlji bitno. U Finskoj struktura kurikula za obrazovanje srednjoškolskih nastavnika općenito, bez obzira na predmet koji nastavnik predaje, kako navode Niemi i Jakku-Sihvonen (2009), uključuje slijedeće: osnovne akademske discipline, istraživačke studije, pedagoške studije (psihologija obrazovanja, sociologija obrazovanja, didaktika, praksa u školama tijekom visokoškolskog obrazovanja) i polje koje obuhvaća komunikaciju, informacijsko-komunikacijske vještine i strane jezike. Stoga, prema dostupnoj literaturi i analizi suvremenih svjetskih kurikula, znanje koje bi suvremeni kurikul za obrazovanje nastavnika računalnih znanosti/informatike trebao pružiti može se svrstati u 5 kategorija:

- znanje u području informatike
- opće pedagoško znanje (psihologija obrazovanja, didaktika itd.)
- poznavanje nastavnih metoda informatike
- poznavanje nastavne prakse
- opće znanje i vještine (strani jezici, matematika, primjena informacijsko-komunikacijske tehnologije u nastavnom procesu).

U kontekstu standardizacije srednjoškolskih kurikula najopsežniji je pristup prikazan ACM K12 predloženim standardom za sve stupnjeve obrazovanja, sve do visokog obrazovanja. ACM K12 također pruža prikladan opis računalnih znanosti za srednjoškolske nastavnike: računalne znanosti nisu ni programiranje ni računalna pismenost, već proučavanje računalnih i algoritamskih procesa, uključujući i njihove principe, dizajn računalnih programa i hardvera, računalne aplikacije i njihov utjecaj na društvo (Tucker i sur. 2004; Gal-Ezer i Stephenson, 2010). Računalne znanosti definirane su kao znanstvene discipline kojima je cilj rješavanje problema, ponajprije u sklopu algoritamskog načina razmišljanja te, ponekad, provođenje rješenja korištenjem određenih programskih jezika (Armoni, 2011). Računalne znanosti u srednjim školama, prema Tuckeru i sur. (2004), uključuju: programiranje, baze podataka i pronalaženje informacija, dizajn hardvera, računalne mreže, grafiku, algoritamski način razmišljanja, umjetnu inteligenciju, stupnjeve apstrakcije, razne programske paradigme (uglavnom proceduralno i objektno orijentirano programiranje), logiku, ograničenja računala, primjenu informacijske tehnologije i društvena pitanja (sigurnost na internetu, privatnost, intelektualno vlasništvo itd.).

Prije prijedloga ACM K12 pojavio se srednjoškolski kurikul za područje informacijsko-komunikacijske tehnologije od UNESCO/FIP-a (UNESCO, 2000). Smatra se da je prijedlog ACM K12 suvremeniji i opsežniji, uzimajući u obzir činjenicu da on predlaže kurikul uemeljen na računalnim znanostima, definiran tako da one predstavljaju potpuniju, odgovarajuću i suvremeniju znanstvenu disciplinu nego što je informacijsko-komunikacijska tehnologija i informatika koje je opisao UNESCO (2000).

U Republici Srbiji i Autonomnoj pokrajini Vojvodini postoji nekoliko studijskih programa u sklopu sveučilišnih programa obrazovanja nastavnika informatike. Trenutno u Vojvodini budući nastavnici informatike mogu steći obrazovanje u sklopu integriranih diplomskih studija kao nastavnici dvaju područja – master studija (geografija – informatika) i diplomskih i master studija za nastavnike informatike i tehničkih znanosti. Srednjoškolski kurikuli za informatiku mogu se razlikovati, ovisno o školi. U osnovnoj je školi informatika i računalstvo izborni predmet, tako da je, iako obvezni predmet „tehnički odgoj i informatika" djelomično uključuje i proučavanje pojmova informatike, čest scenarij u kojem učenik ne odabere informatiku i računalstvo kao predmet u osnovnoj školi i dođe u srednju školu sa slabim predznanjem ili bez znanja informatike. Ljudi zaduženi za izradu novih srednjoškolskih kurikula za informatiku moraju biti svjesni te mogućnosti.

Iako u radu Ragonisa i sur. (2011) i Van Diepena i sur. (2011) možemo pronaći rezultate istraživanja o mišljenju nastavnika o srednjoškolskim kurikulima za računalne znanosti, rijetka su detaljna istraživanja koja bi se bavila mišljenjima nastavnika o kurikulima računalnih znanosti/informatike koji ovise o obrazovnom profilu učenika. Međutim, postoje suvremene reference za srednjoškolski kurikul iz informatike koje sadrže opće standarde poput onih koje su opisali Tucker i sur. (2004) i UNESCO (2000). To, međutim, nije slučaj kod kurikula za obrazovanje nastavnika informatike. Također postoji i malo radova o kurikulima za obrazovanje nastavnika informatike koji se temelje na istraživanjima. U većini slučajeva to su pretežno deskriptivni radovi koji uključuju preporuke za određene kolegije, „utemeljene na iskustvu i stručnosti vodećih stručnjaka u području računalnih znanosti" (Armoni, 2001) ili radovi koji opisuju jedan određeni kurikul. To je slučaj s Armonijem (2011) i Gal-Ezerom i Stephensonom (2010), koji daju pregled trenutnog stanja i općenite prijedloge za potrebne nastavničke kompetencije, podijeljene u nekoliko širih područja. Međutim, East i suradnici (2011) daju popis tematskih područja unutar predloženog kurikula. U radu Ragonisa i suradnika (2010) vidimo kvalitativno deskriptivno istraživanje provedeno u izraelskom akademskom društvu o modelu kurikula za obrazovanje nastavnika računalnih znanosti u toj zemlji. Hazan i suradnici (2008) predlažu model, a Gal-Ezer i suradnici (2007) prikazuju potpuni kurikul na izraelskom Otvorenom sveučilištu. Micheuz (2008) prikazuje istraživanje koje je provedeno o mišljenju austrijskih nastavnika, o usporedbi ECDL-a i tematskih područja devetog razreda. Grgurina (2008) daje opis kurikula za obrazovanje nastavnika informatike koji se provodi na Sveučilištu u Groningenu. Radovi koji se detaljnije bave tim područjem uglavnom su zastarjeli (Poirot i sur. 1985; Statz i Miller, 1975; Taylor, 1997).

Ovaj rad utemeljen je na istraživanju o mišljenju nastavnika informatike o relevantnim tematskim područjima kurikula na svim razinama obrazovanja, uzimajući u obzir vrstu sveučilišnih studijskih programa koje su nastavnici završili i vrstu škole na kojoj podučavaju. Ovo je dio opsežnijeg istraživanja koje se bavi problemom obrazovanja nastavnika informatike na području Republike Srbije s ciljem definiranja obrazovnog okvira za srednjoškolske nastavnike informatike, što bi omogućilo nastavnicima da tijekom svoje profesionalne karijere posjeduju: (1) neophodno opće i posebno znanje u području informatike, koje je u skladu s trenutnim trendovima u tom području; (2) neophodno opće znanje o pedagogiji i metodici, kao i posebno znanje o nastavnim metodama koje se koriste u nastavi informatike, a koje su u skladu sa zahtjevima suvremenih nastavnih metoda i obrazovnih tehnologija.

Metode

Cilj istraživanja

Primarni cilj istraživanja u ovom radu bio je definirati metodologiju za stvaranje profila nastavnika informatike koji bi poslužio kao izvor informacija pri planiranju modela obrazovanja ne samo sadašnjih nego i budućih nastavnika informatike. Da bi se to omogućilo, provedeno je istraživanje o objektivnim pokazateljima koji su povezani s akademskim i trajnim obrazovanjem, subjektivnim mišljenjem nastavnika o važnosti područja i pedagoško-metodičkog korpusa, kao i njegove prisutnosti u kurikulu za obrazovanje nastavnika informatike, zajedno sa samovrednovanjem kompetencija u području informatike.

Profil nastavnika opisuje se sljedećim atributima:

- iskustvo u nastavničkom zanimanju (staž, obrazovni profil učenika – 3 profila)
- akademsko obrazovanje
- vrednovanje kompetencija u području informacijske i komunikacijske tehnologije
- vrednovanje kompetencija u području pedagogije i metodike
- trajno obrazovanje
- mišljenje o važnosti područja (informatike) i pedagoško-metodičkog korpusa u kurikulu za obrazovanje nastavnika informatike
- mišljenje o zastupljenosti znanja u srednjoškolskom kurikulu
- mišljenje o modelu obrazovanja nastavnika informatike.

Uzorak

Istraživanje je provedeno u svibnju i lipnju 2012. godine, na reprezentativnom uzorku od 49 nastavnika informatike zaposlenih u 23 srednje škole u Vojvodini. Za potrebe ovoga rada srednje škole su, uzimajući u obzir opseg, stupanj istraživanja i važnost informatike kao predmeta u njihovim kurikulima, podijeljene u tri vrste: gimnazije, tehničke strukovne škole i ostale strukovne škole. Termin „ostale strukovne škole" obuhvaća sve druge srednje škole koje nisu ni tehničke škole, ni gimnazije (ekonomske škole, medicinske škole, poljoprivredne škole itd.). Istraživanje je obuhvatilo 6 gimnazija, 6 tehničkih strukovnih škola i 11 ostalih strukovnih škola, i to na takav način da je zastupljenost svake vrste srednje škole u uzorku proporcionalna broju takve vrste srednje škole na području Vojvodine. Ovaj rad obuhvatio je sve školske uprave na području Vojvodine (u Somboru, Zrenjaninu i Novom Sadu).

Instrumenti istraživanja

Instrument istraživanja bila je anketa poslana elektroničkom poštom. Nastavnici su mogli birati način na koji će popuniti anketu: elektroničkim putem ili popunjavanjem ispisanog obrasca. Anketa koja je primijenjena, u skladu s atributima koji su korišteni da bi se opisao profil nastavnika, bila je podijeljena na odjeljke na takav način da su naslovi odjeljaka bili isti kao i naslovi atributa.

Tematska područja kurikula, kompetencije nastavnika u tim područjima, važnost područja i njihova zastupljenost u srednjoškolskom kurikulu bili su odabrani u skladu s referencijama navedenim u uvodu ovoga rada i s postojećim kurikulom u Republici Srbiji.

Za obradu prikupljenih podataka korištene su sljedeće statističke metode: deskriptivne statističke mjere (mjere središnje tendencije, mjerenje varijabilnosti, parametri distribucije) i mjere statističkog zaključivanja (Hi-kvadrat test, Fisherov egzaktni test, univarijatna analiza varijance – ANOVA).

Rezultati

Grupiranje rezultata provedeno je u skladu s opisanim profilom. Rezultati koji se odnose na pitanja koja su bila statistički drugačija (što je određeno korištenjem Fisherova testa ili ANOVA analizom) označeni su zvjezdicom.

Akademski stupanj

Tablica 1. i 2.

Vrednovanje nastavničkih kompetencija

Tablica 3.

Permanentno stručno usavršavanje

Tablica 4.

Mišljenja o važnosti područja i pedagoško-metodičkog korpusa u kurikulu za obrazovanje nastavnika informatike

Tablica 5.

Mišljenje o zastupljenosti znanja o području u srednjoškolskom kurikulu

Tablica 6.

Mišljenje o modelu obrazovanja nastavnika

Tablica 7.

Rasprava

Radni staž u nastavi

Od 49 srednjoškolskih nastavnika informatike koji su sudjelovali u ovom istraživanju 17 ih radi u gimnazijama, 10 ih je zaposleno u tehničkim strukovnim školama, a 22 u ostalim strukovnim školama (vidi Tablicu 1). Prosječni radni staž u nastavi iznosi 12,88 godina (SD = 8,42), uzimajući u obzir činjenicu da ne postoji statistički značajna razlika u tome gdje rade. To objašnjava mogućnost podučavanja i u srednjoj i u osnovnoj školi.

Akademski stupanj

Prosječna ocjena nastavnika informatike koji su sudjelovali u istraživanju na svim akademskim stupnjevima bila je 7,99 (SD = 0,63), bez ikakve statistički značajne razlike vezane uz vrstu škole u kojoj rade. Većina (76 %) nastavnika informatike završila je osnovno akademsko obrazovanje (u trajanju od 4 godine), 16 % ih ima master stupanj, a oko 8% ih ima stupanj magistra znanosti. Osim toga, nije bilo nikakvih statistički značajnih razlika u stečenom stupnju obrazovanja i škole u kojoj rade. Otprilike polovina nastavnika je diplomirala na nekom od studijskih programa za nastavnike informatike, dok je druga polovina stekla gotovo jednako akademsko obrazovanje u polju informacijskih sustava i tehničkih znanosti (vidi Tablicu 1). Nastavnici su u anketu upisali naziv studijskog programa i fakultet u sklopu sveučilišta na kojemu su diplomirali, kao i popis akademskih kolegija koje su položili, podijeljenih u polja (informatika, opća pedagogija, metodika, opća znanja i vještine). Stoga, potkrijepljeno detaljnom analizom prikupljenih podataka, možemo zaključiti da je grupa „Nastavnik informatike", osim studijskog programa istoga naziva pohađala i sljedeće studijske programe: *Diplomirani informatičar na Prirodno-matematičkom fakultetu* (taj studijski program je, kada su ga sudionici u istraživanju pohađali, uključivao kolegij o nastavnim metodama informatike i kolegij iz opće pedagogije); *Nastavne metode informatike* i *Informatika u obrazovanju*. Grupa nastavnika koji su diplomirali na „Informacijskim sustavima" pripada studijskoj grupi istoga naziva na Ekonomskom fakultetu i Fakultetu organizacionih nauka. Grupa nastavnika koji su diplomirali na „Tehničkim naukama" pohađala je studijske programe kao što su: elektronika i telekomunikacije, automatika i računalne tehnike, mikroračunalna elektronika itd. Tablica 1 pokazuje da je većina nastavnika koji rade u gimnazijama završila neki oblik studijskog programa za nastavnike informatike; gotovo polovina nastavnika informatike u „ostalim strukovnim školama" je diplomirala na Informacijskim sustavima, dok je većina nastavnika informatike na tehničkim strukovnim školama diplomirala na Tehničkim naukama. Fisherov test ukazuje na to da ne možemo isključiti postojanje statistički značajne razlike kao što je završen studijski program s obzirom na vrstu škole u kojoj su nastavnici zaposleni. Ti su rezultati bili očekivani, a u velikoj mjeri se oblik završenog studija podudara s obrazovnim profilom učenika s kojima nastavnici rade. U grupi nastavnika informatike koji rade u „ostalim strukovnim školama" velik broj nastavnika radi na srednjim ekonomskim školama. Njihovo je njihovo formalno obrazovanje, najčešće, stečeno u polju (poslovnih) informacijskih sustava. Uz detaljniju analizu strukture i sadržaja Informacijskih sustava i Tehničkih nauka kao studijskih programa vidljivo je da oni ne pružaju kolegije iz područja općih pedagoških znanosti i nastavnih metoda informatike. Rezultati prikazani u Tablici 2, u kojoj je prikazano poznavanje metodike i vještina koje su nastavnici imali priliku steći tijekom sveučilišnih studija, također upućuju na tu činjenicu (većina nastavnika nije stekla znanja i vještine u polju upravljanja školom, a veći se dio nastavnika uopće nije upoznao s dužnostima razrednika). Statistički značajna razlika povezana s vrstom škole ovdje nije uočena. Što se tiče stečenog znanja iz metodike nastave informatike (hospitacije studenata i promatranje nastavnog procesa), situacija je nešto povoljnija. Ipak, i tu postoji statistički značajna razlika između vrste škole na kojoj nastavnici informatike rade (Fisherov egzaktni test 8,93, $p = 0,02$), što je bilo očekivano, uzevši u obzir već spomenutu činjenicu da najveći broj nastavnika informatike koji su imali priliku steći znanje u tom polju tijekom sveučilišnog studija sada radi u gimnazijama. Istraživanje ističe činjenicu da većina nastavnika koji rade na tehničkim strukovnim školama i nešto malo više od polovine nastavnika koji rade u ostalim strukovnim školama nisu stekli znanje u tom području, što je zabrinjavajuće.

Ocjena nastavničke kompetencije u području Informacijske i komunikacijske tehnologije i pedagoško-metodičkog korpusa

Anketa se sastojala od 64 tematska područja podijeljena u 5 aspekata, u skladu s analizom prikazanom u Uvodu ovoga rada: informatički aspekt (područje), opći pedagoški aspekt, opće znanje i vještine, aspekt nastavnih metoda informatike i aspekt nastavne prakse. Nastavnici su ocjenjivali svoje znanje u tim poljima ocjenama od 1 do 5 (1 – „Nisam znao/znala da to polje postoji", 2 – „Znao/znala sam da to polje postoji, ali ne znam ništa o njemu", 3 – „Znam osnovne pojmove iz toga polja, ali ne razumijem njegovu srž", 4 – „Upoznat/upoznata sam i razumijem sve osnovne pojmove", 5 – „Stekao/stekla sam praktično iskustvo u tom polju/Primjenjujem ga u svojem nastavnom procesu"). 47 nastavnika odgovorilo je na tu grupu pitanja. U Tablicama 3 i 5 su sva tematska područja grupirana u 22 srodne skupine za potrebe ovog rada, a ocjena za skupinu dobivena je izračunavanjem srednjeg rezultata tematskih područja koja joj pripadaju. Samovrednovanje nastavnika u odabranim područjima prikazano je u Tablici 3, u kojoj se mogu vidjeti srednje vrijednosti i standardne devijacije izračunatih rezultata u odnosu na vrstu studijskog programa koji su nastavnici završili. Može se primijetiti da su nastavnici nižom ocjenom ocijenili svoje znanje u poljima suvremenih računalnih znanosti, kao što su: E-učenje (posebno standardi e-učenja, LMS/CMS administracija), Objektno orijentirano programiranje, Osnove modeliranja, simulacije i umjetne inteligencije, Napredni internet i statičko i dinamičko programiranje web- stranica. Visoke ocjene nisu dane ni znanju u polju psihologije obrazovanja, pedagogije, individualiziranog učenja i sociologije obrazovanja, primjene novih tehnologija u nastavnom procesu i nastavnih metoda informatike. To bi bilo puno uočljivije kada bismo uspoređivali stečeno znanje s vrstom završenoga studijskog programa. Za to smo se koristili univarijatnom analizom varijance – ANOVA. Statistički značajne razlike postoje u polju e-učenja. Nastavnici koji su diplomirali na Informacijskim sustavima i Tehničkim naukama ocijenili su svoje znanje ocjenom nižom od 3,00. Višu ocjenu u tom polju dali su si Nastavnici informatike koji su proučili neka polja koja uključuju e-učenje tijekom sveučilišnog obrazovanja. Statistički značajne razlike također su se pojavile u polju multimedije, računalne grafike i računalnih mreža, koje su bile manje proučavane u studijskom programu Informacijski sustavi. U polju modeliranja, simulacije i umjetne inteligencije, kao i u polju baza podataka i naprednog interneta i programiranja statičkih i dinamičkih web- stranica, također se može uočiti statistički značajna razlika u ocjenama. ANOVA analiza pokazala je statistički značajne razlike koje se odnose na znanje tih triju grupa nastavnika u izrazito važnim poljima psihologije obrazovanja i didaktike. Čak iako je srednji rezultat za sve nastavnike u ta dva polja bio na zadovoljavajućoj razini, kada pogledamo distribuciju ocjena prema vrsti završenog studijskog programa, možemo uočiti značajne razlike kada visoke ocjene u grupi Nastavnika informatike usporedimo s druge dvije grupe nastavnika. Razlog tomu mogla bi biti struktura studijskih programa Informacijski sustavi i različiti odsjeci tehničkih znanosti koji ne uključuju polje opće pedagogije. Slični zaključci mogli bi se donijeti i u vezi s poljem primjene novih tehnologija u nastavnom procesu i u polju pedagogije, personaliziranog učenja i sociologije obrazovanja. Statistički značajna razlika također postoji i između skupina nastavnika, a nastavnici informatike ocjenjuju svoje znanje najvišim ocjenama. Statistički značajna razlika javlja se i u polju matematike, imajući na umu da su nastavnici koji su završili sveučilišne studijske programe Informacijski sustavi ocijenili svoje znanje u tom polju nešto nižim ocjenama.

Permanentno stručno usavršavanje

Tablica 4 prikazuje rezultate koji se odnose na kontinuirano stručno usavršavanje nastavnika. Većina nastavnika stekla je nekakav oblik dodatnog znanja u području informatike nakon završetka sveučilišnog obrazovanja (Tablica 4). Ovdje su bili mogući višestruki odgovori, a većina nastavnika stekla je dodatno znanje barem proučavajući stručnu literaturu, dok je veći dio njih pohađao radionice i seminare. Svaki treći nastavnik pohađao je znanstvene i stručne konferencije. Gotovo 60% nastavnika pohađalo je posebne tečajeve. Najčešće su nastavnici pohađali neke od osnovnih tečajeva (ECDL i Arhimed) koji pružaju znanje o hardveru, računalnim aplikacijama za obradu teksta, prezentacija i tablica, osnovama interneta, operacijskim sustavima, kao i tečajeve o multimediji, računalnim mrežama i osnovama o bazama podataka. Upravo su ta polja znanja ona koja su nastavnici ocijenili najvišom ocjenom u procesu samovrednovanja (Tablica 3). Nastavnici su pohađali tečajeve u polju suvremenog informatičkog područja u nešto manjoj mjeri. Svoje su znanje u tom području ocijenili nižim ocjenama, što se može vidjeti u Tablici 3. Nastavnici koji su pohađali dodatne tečajeve koji su se bavili temama kao što su objektno orijentirano programiranje, Moodle LMS, SCORM standard ili „cloud computing", svoje znanje u tim poljima ocijenili su višim ocjenama u procesu samovrednovanja. Ti rezultati upućuju na potrebu organiziranja dodatnih tečajeva u onim poljima koja su nastavnici ocijenili nižim ocjenama, posebno u onima u kojima su nastavnici stekli najmanju izobrazbu. Rezultati također ističu potrebu za poticanjem nastavnika da pohađaju takve tečajeve. U usporedbi s poručjem informatike, u kojem samo jedan nastavnik nije stekao nikakvo dodatno znanje, nešto viši postotak nastavnika nije stekao nikakvo znanje u području opće pedagogije, dok rezultati u polju nastavnih metoda informatike i polju nastavne prakse upućuju na značajno nizak stupanj kontinuiranog stručnog usavršavanja. U ta tri aspekta većina nastavnika stekla je znanje proučavanjem stručne literature, a u manjoj mjeri i pohađajući znanstvene i stručne konferencije. Uzimajući u obzir značajan broj nastavnika koji su završili studije koji nisu uključivali kolegije iz polja pedagogije, nastavnih metoda informatike i metodike, rezultati koji pokazuju da su ti nastavnici ipak stekli dodatno znanje u tim poljima vrlo su ohrabrujući. Štoviše, značajan broj nastavnika stekao je dodatno znanje pohađajući posebne tečajeve, pogotovo u polju opće pedagogije. Fisherov test nije ukazao na statističku razliku u usvajanju dodatnog znanja u poljima informatike, opće pedagogije, nastavnih metoda informatike i metodike, s obzirom na vrstu škole u kojoj su nastavnici zaposleni. U onome dijelu upitnika u kojemu su nastavnici trebali navesti softverske tehnologije koje pružaju dodatni tečajevi, a za koje oni misle da su najpotrebniji za nastavni proces, nastavnici su uvelike izrazili potrebu za onim tehnologijama koje su ocijenili najnižom ocjenom u samovrednovanju, i za onima s kojima se nisu imali priliku upoznati putem dodatnih tečajeva. Sljedeća polja su najčešće navedena: objektno orijentirano programiranje, statičko programiranje web-stranica, UML, napredna internetska tehnologija, „cloud computing", Moodle i općenito sustavi za upravljanje učenjem (LMS, CMS). Manji broj nastavnika smatra da bi tečajevi o računalnim mrežama, multimediji, računalnoj grafici i bazama podataka također bili korisni u nastavnom procesu.

Mišljenje nastavnika o važnosti područja i pedagoško-metodičkog korpusa u kurikulu za obrazovanje nastavnika informatike

Tablica 5 pokazuje mišljenje nastavnika o sadržaju sveučilišnog kurikula za obrazovanje nastavnika informatike, tj. koliko je važno da svako od predloženih polja njihove izobrazbe bude u kurikulu visokog školstva, tako da bi ti nastavnici mogli uspješno predavati informatiku u srednjim školama. Nastavnici su ocijenili važnost u vezi s obrazovnim profilom onih koje podučavaju. Anketa je sadržavala 64 tematska polja čija je važnost ocijenjena na sljedeći način: 1 – „uopće nije važno", 2 – „vrlo niska važnost", 3 – „srednja važnost", 4 – „visoka važnost", 5 – „najveća važnost". 46 nastavnika odgovorilo je na tu grupu pitanja. Nastavnici su imali mogućnost dodati tematsko polje koje nije bilo ponuđeno u anketi, a za koje su oni smatrali da je bitno za nastavni proces. Međutim, nastavnici nisu smatrali da takvo polje postoji. Tematska polja su ovdje također bila grupirana na isti način kao što su bila grupirana i u samovrednovanju nastavnika i rezultatima važnosti pokazanima u Tablici 5. Vidljivo je da su nastavnici važnost gotovo svakog polja ocijenili visokom ocjenom (najniža ocjena bila je 3,32). Za većinu polja čija je važnost u nastavnom procesu dobila niže ocjene, univarijantna analiza varijance, tj. ANOVA analiza pokazala je statistički značajne razlike s obzirom na vrstu škole u kojoj nastavnici rade. Stoga, iako je ukupna ocjena važnosti za matematičku podlogu računala i hardverski dizajn nešto niža, ocjene toga polja razlikuju se s obzirom na to u kojoj vrsti škole nastavnici rade (u tehničkim školama je ocjena najviša, a u ostalim strukovnim školama je najniža), a rezultati ANOVA analize pokazuju statistički značajne razlike s obzirom na vrstu škole. Slično tome, važnost proceduralnog programiranja i objektno orijentiranog programiranja u nastavi visoko je ocijenjena u gimnazijama i tehničkim školama, a u ostalim je strukovnim školama ocjena bila znatno niža. Također, važnost osnova modeliranja, simulacije i umjetne inteligencije bila je, u prosjeku, nisko ocijenjena, prije svega zato što je važnost toga područja u ostalim strukovnim školama ocijenjena ocjenom nižom od 3,00. Statistički značajna razlika također se može vidjeti između tri vrste škola s obzirom na sljedeća polja: vrste, strukture i algoritmi podataka; napredni internet, statičko i dinamičko programiranje web-stranica. Vidljivo je da razlika u važnosti tema s obzirom na vrstu škole utječe na suvremene i/ili složenije pojmove područja informatike. Nastavnici zaposleni u gimnazijama i tehničkim strukovnim školama smatraju da su ta polja važnija za nastavni proces nego što to smatraju nastavnici zaposleni u ostalim strukovnim školama. Naravno, sadržaj i broj informatičkih predmeta koje pokrivaju ta polja, kao i stupanj na kojem se ona proučavaju, različit je u usporedbi s postojećim kurikulima triju vrsta škola. Tablica 5 pokazuje da ne postoji statistički značajna razlika između vrste škole i važnosti polja baza podataka, što se moglo očekivati. Detaljnija analiza uzorka škola koje su sudjelovale u istraživanju nameće mogući zaključak da je važnost toga polja veća na ostalim strukovnim školama, vjerojatno zbog relativno velikog broja srednjih ekonomskih škola unutar te vrste škola, a u kojima polje baza podataka predstavlja bitan dio kurikula informatike. Statistički značajne razlike dobivene ANOVA analizom uočene su u poljima nastavnih metoda matematike i informatike. Njihova važnost također je visoko ocijenjena u gimnazijama, a nisko u ostalim strukovnim školama.

Mišljenje nastavnika o zastupljenosti znanja iz područja u srednjoškolskom kurikulu

Tablica 6 pokazuje mišljenje nastavnika o zastupljenosti tematskih polja informatike u kurikulu po kojemu podučavaju. Nastavnici su ocijenili srednjoškolski kurikul informatike s obzirom na predložena tematska polja. Na tu grupu pitanja odgovorilo je 46 nastavnika. Tu su tematska polja bila podijeljena na srodne skupine izračunavanjem srednje ocjene, a njihova zastupljenost ocijenjena je ocjenom od 1 do 5 (1 – „ne postoji", 2 – „nedovoljno", 3 – „prihvatljivo", 4 – „dobro zastupljeno" i 5 – „adekvatno zastupljeno"). Nastavnici nisu smatrali da bi neka druga polja, koja nisu bila uključena u anketu, trebala biti zastupljena u kurikulu. Što se tiče polja koja su ovdje ocijenjena nižom ocjenom, primjena ANOVA analize pokazala je statistički značajne razlike s obzirom na vrstu škole. To se posebno odnosi na tri polja: vrste, strukture i algoritme podataka; proceduralno programiranje i objektno orijentirano programiranje. Stoga, iako je srednja ocjena za polje „vrste, strukture i algoritmi podataka" bila nešto niža, zastupljenost tog aspekta ocijenjena je ocjenom višom od 4,00 u gimnazijama, ali ocjena u ostalim strukovnim školama bila je ispod 3,00. Također se može uočiti i sličan srednji omjer zastupljenosti, s obzirom na proceduralno programiranje i objektno orijentirano programiranje. Stoga je zastupljenost proceduralnog programiranja i objektno orijentiranog programiranja dobila najviše ocjene u gimnazijama. Štoviše, ocjene za ta polja u gimnazijama su bile značajno veće od ukupne prosječne ocjene. Uzimajući u obzir razlike u kurikulima između te tri vrste škola, takvi rezultati ne iznenađuju. Zastupljenost polja programiranja je, u usporedbi s ostalim strukovnim školama, očekivano veća u gimnazijama, dok je njegova zastupljenost u tehničkim strukovnim školama neadekvatna. Zastupljenost objektno orijentiranog programiranja bila je, na primjer, ocijenjena ocjenom nižom od 3,00 u tehničkim školama. Statistički značajne razlike s obzirom na vrstu škole također se mogu vidjeti i u poljima računalne grafike i multimedije. Njihova zastupljenost ocijenjena je najvišom ocjenom u gimnazijama, a njihova je zastupljenost u ostalim strukovnim školama bila najniže ocijenjena. Zadovoljavajuće srednje ocjene (jednake ili više od 3,50) zastupljenosti u srednjoškolskim kurikulima nastavnici su dali za sedam (od 14) aspekata: osnove informatike; programske aplikacije za tekst, tablice i prezentacije; osnove operacijskih sustava, računalnih programa, hardvera i osnove interneta; računalna grafika; multimedija; računalne mreže i baze podataka. Međutim, samo 3 od 7 aspekata imaju srednju ocjenu jednaku ili višu od 4,00. Stoga, čak iako srednja ocjena zastupljenosti osnova informatike nije bila niska, detaljna analiza ankete pokazuje da je zastupljenost tematskog polja „računalna etika, sigurnost i zaštita podataka", koju polje „osnove informatike" pokriva, dobila vrlo nisku ocjenu, a važnost toga polja u nastavi dobila je visoke ocjene. Posebno nisku ocjenu u svim vrstama škola dobila su sljedeća četiri polja: e-učenje; osnove modeliranja, simulacije i umjetne inteligencije; napredni internet i statičko i dinamičko programiranje web-stranica i matematičke osnove računalnog i hardverskog dizajna. Usprkos tome što je uočeno da su ta četiri polja ocijenjena najnižim ocjenama kada je kriterij ocjenjivanja bila njihova važnost u nastavi, a da je zastupljenost polja programiranja (što se, s obzirom na razlike u srednjoškolskim kurikulima mogloa očekivati) bila značajno drugačija s obzirom na vrstu škole (njegova zastupljenost ocijenjena je najvišom ocjenom u gimnazijama), rezultati još uvijek upućuju na mišljenje nastavnika da mnoga važna polja (još jednom, ona koja se odnose na kompleksnije i suvremene pojmove, posebno objektno orijentirano programiranje, napredne internetske tehnologije, standarde i tehnologije e-učenja) nisu adekvatno zastupljena u srednjoškolskom kurikulu informatike.

Mišljenje o modelu obrazovanja nastavnika informatike

Većina nastavnika informatike koji su sudjelovali u ovom istraživanju smatra da bi integrirani osnovni i master akademski studij, koji bi im pružio priliku studiranja informatike i pedagoškog aspekta istodobno, bio najadekvatniji model obrazovanja budućih nastavnika informatike (Tablica 7). Nastavnici koji smatraju da je model obrazovanja s osnovnim akademskim studijem odvojenim od master studija prikladniji za obrazovanje budućih nastavnika informatike raspoređeni su jednako s obzirom na to smatraju li da bi iza osnovnog akademskog studija informatike trebao slijediti master studij u području pedagogije, ili obrnutim redoslijedom, da bi osnovni akademski studij pedagogije trebao prethoditi master studiju isključivo u području informatike.

Zaključak

Ovo istraživanje pokazuje da znatan broj srednjoškolskih nastavnika informatike u Vojvodini, a koji su sudjelovali u ovom istraživanju, ne posjeduje odgovarajuće formalno obrazovanje i da tijekom sveučilišnog studija većina njih nije imala priliku steći znanje i vještine u nastavnoj praksi. Isto tako, samovrednovanje je pokazalo da značajan broj nastavnika koji su sudjelovali u istraživanju, a koji nemaju odgovarajuće akademsko obrazovanje, ne posjeduje znanje u polju pedagogije (kao što je psihologija obrazovanja i didaktika), kao ni znanje u polju primjene novih tehnologija u nastavnom procesu. Srednja ocjena samovrednovanja nastavnika o poznavanju nastavnih metoda informatike bila je također prilično niska. Iako je većina ispitanika uglavnom stekla dodatno znanje u različitim poljima, to je najmanje slučaj u poljima suvremenih i kompleksnih aspekata informatike i računalstva (npr. objektno orijentirano programiranje, standardi i pojmovi naprednog interneta, sustavi upravljanja e-učenjem). Nastavnici su također izrazili veliku potrebu za dodatnim tečajevima u poljima u kojima su svoje znanje ocijenili najnižim ocjenama. Sva polja kurikula za obrazovanje nastavnika informatike koja su bila ponuđena u anketi bila su ocijenjena visokom ocjenom s obzirom na njihovu važnost u nastavničkom zanimanju i nije dodano nijedno novo polje. Osim toga, rezultati pokazuju statistički značajne razlike u važnosti nekih polja (matematičke osnove računalnog i hardverskog dizajna; proceduralno i objektno orijentirano programiranje, vrste i strukture podataka itd.) s obzirom na vrstu škole. Ti rezultati bili su očekivani jer se važnost, na primjer paradigme objektno orijentiranog programiranja u gimnazijama značajno razlikuje od važnosti te iste paradigme u ostalim strukovnim školama (na primjer u poljoprivrednoj školi). Rezultati koji pokazuju zastupljenost različitih polja informatike u srednjoškolskim kurikulima informatike upućuju na to da je potrebno modernizirati srednjoškolske kurikule (čak i ako je zastupljenost polja s najnižim ocjenama bolja u gimnazijama, velik dio važnih polja ocijenjen je kao nedovoljno zastupljen). Većina ispitanika smatra da bi najprikladniji oblik obrazovanja nastavnika informatike bio integrirani master studij, koji bi istodobno pokrivao sve informatičke i pedagoške aspekte.

Iako je istraživanje prikazano u ovome radu preliminarnog tipa (istraživanje je provedeno na uzorku koji je obuhvatio samo zaposlene nastavnike informatike u Vojvodini, odabrane na temelju strukture srednjih škola), njegovi rezultati mogli bi biti važni za dvije ciljne skupine: nadležna ministarstva i sveučilišta koja provode obrazovanje nastavnika informatike. Na temelju rezultata ovog istraživanja, mogu se dati sljedeće preporuke za navedene ciljne skupine:

Ministarstva bi trebala dati prednost integriranim studijima u obrazovanju nastavnika informatike; osigurati prilagodbu srednjoškolskog kurikula, kao i njegovo redovito ažuriranje, tako da sva aktualna tematska polja informatike budu zastupljena: osigurati kvalitetno kontinuirano stručno usavršavanje nastavnika promjenom sustava akreditacije za takvu vrstu obrazovanja, a koja se primjenjuje na redovne sveučilišne kolegije.

Sveučilišni programi za obrazovanje nastavnika trebali bi pružiti oblik nastavne prakse u sklopu specijaliziranih integriranih osnovnih i master studija za nastavnike informatike; izraditi kurikul studijskog programa na način koji će predvidjeti potrebe budućih srednjoškolaca, također uzimajući u obzir i mišljenje nastavnika; ponuditi kvalitetno stručno usavršavanje nastavnika, posebno u onim poljima u kojima su nastavnici svoje znanje ocijenili nižim ocjenama, kao i u poljima za koja su istaknuli potrebu dodatnog usavršavanja.

Daljnje istraživanje trebalo bi ići u dva smjera. Prvi bi trebao imati za cilj osiguravanje bolje pokrivenosti u smislu uključivanja postojećih i budućih nastavnika. Stoga se planira istraživanje koje će povećati broj srednjoškolskih nastavnika, uključiti nastavnike informatike zaposlene u osnovnim školama, kao i studente na sveučilišnim studijskim programima koji će biti budući nastavnici informatike. Drugi smjer istraživanja ima za cilj osigurati softverske alate koji bi se mogli koristiti pri procjenjivanju kompatibilnosti, prilagođavanju kurikula za obrazovanje nastavnika informatike i programa njihova trajnog obrazovanja trenutnoj situaciji u području informatike, općem i posebnom pedagoško-metodičkom korpusu nastave informatike, kao i osnovnoškolskim i srednjoškolskim kurikulima.