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Informatics teaching from the students' point of view

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Branches of science and technical/engineering study have for a long time been the less favoured disciplines and students have not been interested in studying them. Informatics/computer education, based on its character, belongs to these disciplines, but on the contrary it belongs rather to the group of popular school subjects. The paper presents methodological background and major results of an evaluation of selected aspects of informatics teaching from students' point of view at upper secondary school level (ISCED 3A) in the Slovak Republic, Czech Republic and Belgium. Within this research, 14 selected factors were explored and these were popularity of the subject informatics, applicability of gained knowledge in one`s own future, attractiveness of the informatics curriculum content, demands of the informatics curriculum, clarity of presentation of new material by teachers, attractiveness of curriculum presentation by teachers, suitability of particular methods for curriculum presentation, engagement level of tasks to be solved, clarity of textbooks used, usability of knowledge for solving practical problems, attractiveness of teaching aids used, way in which students make written notes of the presented subject matter, appropriateness of specific methods in written notes preparation and source of concern related to the subject.

Key words: Informatics, upper secondary level of education - ISCED 3A, evaluation of the teaching process, factors influencing quality of education, screening of students` opinions.

INTRODUCTION

Computer science, as a separate branch of science, has had unlike other natural sciences, a relatively short history but it has been a branch of a great importance. Also, computer science as a subject in school has an important role in the education system. Nowadays, basics of computer science are taught in secondary schools (ISCED 3) of most countries, mostly under the name informatics. Although due to its character computer science/informatics belongs to the natural science and technical subjects; unlike the other natural science and technical subjects it enjoys relatively considerable students' interest (Záhorec and Hašková, 2009). To a great extent, this can be a result of the fact that informatics teaching falls in the area of science and computer literacy development.

The international survey OECD PISA (*Programme for International Students Assessment*) has measured and evaluated results of education in OECD countries in three year cycles since 2000. Respondents of the surveys are 15 years old students. In 2006 the PISA monitoring was focussed on evaluation of students` science literacy in which their knowledge in four areas was assessed: role of

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science and technology; relation between science and technologies; basic notions; important principles.

From the data presented in the PISA National Report (Koršnáková and Kováčová, 2007), the following results are found:

1. The results gained by the Slovak students in the area of science literacy were significantly lower than the average value gained by the OECD countries.
2. The two highest levels of the science literacy (levels 5 and 6) were gained only by 5.8% Slovak students – the first level (6) was gained only by 0.6% of the students, what is less than a half of the OECD average. For all these two levels are considered to be an important indicator of potention for new technologies and innovations designing in each country.
3. Totally one fifth of the monitored students from Slovakia (20.2%) obtained results on the bottom level of the science literacy (level 1 and below it – insufficient level).

Results of the PISA monitoring showed that Czech Republic had significantly better results than Slovak Republic. Based on the results of the PISA monitoring (Palečková et al., 2007), Czech students belong to the ones with above-average results, both in science test (mean OECD – 498 points; Czech students – 513 points; Slovak students – 488 points) and mathematical part of the test (mean OECD – 500 points; Czech students – 510 points; Slovak students – 492 points). Above average results of the Czech students in sciences and maths were confirmed not only in the three cycles of the PISA research (Palečková and Tomášek, 2005; Frýzková and Palečková, 2007; Palečková et al., 2010) but also in two cycles of the international research IEA TIMSS – *Trends in International Mathematics and Science Study* (Straková and Kašpárková, 1999; Kuraj and Kurajová, 2006; Mandíková and Tomášek, 2010). As for the Slovak students, international monitorings show that they have acquired a lot of science knowledge but they have problems applying it in problem solving.

The question is: In what level, based on the results gained by the Slovak students in the above-mentioned monitorings, can we assess the quality of informatics teaching at schools in Slovakia? Having found exact evidence on the current state of computer science/ informatics teaching in terms of its quality, we decided to carry out a broader scaled research. Although the quality of teaching school subjects is usually assessed mostly on the basis of their curriculum content analysis and students` learning achievements, we decided to set the evaluation of current state of informatics teaching at schools on students` opinions and evaluations of this state. Moreover, with respect to the common historical development of the Slovak and Czech system of education (in frame of the former Czechoslovakia) and provably different results reached in the area of science and technical education, we decided to pay attention not only to the situation at Slovak schools but also to the state of teaching informatics in the Czech Republic. Another comparative country, with which the situation in Slovakia was compared, was Belgium (in regard to accessibility).

RESEARCH FOCUS

The main goal of the research was to evaluate the current state of teaching informatics at the upper secondary school level of the system of education in the Slovak Republic (ISCED 3A; 16 – 19 year old students). In addition to, we decided to evaluate, in the same way and based on the same criteria, the situation in the Czech Republic and Belgium, and consequently to process the results in a comparative study.

Due to the diversity of schools at the upper secondary level and a wide range of specific implementations of computer science education in these schools, we decided to focus our attention on a single type of school in this category: 4-year and 8-year grammar schools; more specifically, students in the 16 to 19 year old range. In Belgium the equivalent to a grammar school in Slovakia and the Czech Republic is the curriculum of general secondary education (ASO - *Algemeen Secundair Onderwijs*).

According to the Slovak State Educational Program (Hauser, 2008), a student at a secondary level grammar school is required to complete three lessons of computer science a week. A student graduating from computer science is required, by the Ministry of Education Regulation § 6318/2008, to amass six hours a week of computer science related subjects. The school can offer the student a subject at a more advanced level, but only if the number of lessons does not exceed the limit for optional classes.

In terms of secondary schools in the Czech Republic, computer science is classified as a mandatory part of the general grammar school curriculum of their lower (ISCED 2A) and higher (ISCED 3) education levels. Computer science lessons at grammar school are required to build on previously attained basic knowledge that students should have acquired at a lower level following the Framework Educational Program of Basic Education. The framework curriculum at a secondary school requires students to complete at least four hours of lessons per week throughout their education. The school masters of secondary schools are also able to offer even more hours devoted to teaching computer science in any year of study (Jeřábek et al., 2007).

Students of the ASO program in Belgium have computer science/informatics included in their curriculum as a compulsory subject, with time allocation of one lesson per week in the third and fourth years of their study (Vanderbiesen et al., 2011). The subject content is largely the same as informatics curriculum in the Slovak and Czech public grammar schools.

A specific feature of the research was the fact, that the evaluation of the current state of informatics teaching at the above-mentioned schools was set on students' opinions and evaluation of various factors influencing and having impact on quality of informatics teaching. We are aware of the fact, that this approach creates some limitations regarding possibilities to generalize the research findings, as there was no evaluation of informatics lessons by teachers nor evaluation of teachers by other reviewers. However, we consider students` evaluations and their identification of the strengths and weaknesses of the teaching of any school subject as important and significant.

RESEARCH METHODOLOGY

Data collection

In the preparation phase of the research, 14 factors influencing the quality of informatics teaching were specified. These factors were found important in our previous experience and research results (Záhorec et al., 2010), in professional literature in this area (Kurland et al., 1989; Holmboe et al., 2001; Lapidot and Hazzan, 2003; Ragonis et al., 2010; Van Diepen et al., 2011; Saeli et al., 2012) and in communication with other experts (both research workers and informatics and programming teachers from various types of schools and having various durations of their teaching experience). Specifically, attention was given to the following factors: P1 – the popularity of a subject; P2 – the applicability of gained knowledge in the students' future; P3 – attractiveness of the curriculum content; P4 – the demands of the curriculum; P5 – the clarity of presentation of new material; P6 – the attractiveness of curriculum presentation by teachers; P7 – the suitability of particular methods for curriculum presentation; P8 – the engagement level of tasks to be solved; P9 – the clarity of textbooks used; P10 – the usability of knowledge for solving practical problems; P11 – the attractiveness of teaching aids used; P12 – the way students make written notes of the subject matter presented; P13 – the appropriateness of specific methods in written notes preparation; P14 – sources of concern related to the subject.

The assessment of the above-mentioned factors, which affect the quality and attractiveness of informatics education at schools, was based on the students' point of view and their assessing opinions of them. It means that we explored the students' subjective attitudes to informatics/computer education as a school subject (the popularity of the subject, interesting content, usability for their future) and their opinion of the realisation of the teaching of this school subject (the comprehensibility of textbooks used, the method of teachers' presentation of the subject, the use of teaching aids in the classroom, the engagement of teaching aids). We developed a questionnaire for surveying relevant attitudes and opinions of students. Individual questions in this questionnaire corresponded with the 14 evaluation factors listed above.

Research sample

The research focussed on the upper secondary school level (ISCED 3A; 16 – 19 year old students), specifically 4-year and 8-year grammar schools (Slovakia - SK and Czech Republic - CZ) and general secondary ASO schools (Belgium – BE, Algemeen Secundair Onderwijs).

Table 1. Composition of survey sample respondents.

Country	Number	Gender	
		boys (M)	girls (F)
Slovakia (SK)	246	154	92
Czech Republic (CZ)	70	39	31
Belgium (BE)	52	29	23
Total	368	222	146

Given our limited opportunities, the research sample within each country was based on the availability of schools (utilizing our already established cooperation with various universities in relevant regions and their possibilities to tell them of the available secondary schools of the relevant type). Consequently, the research sample in Slovakia consisted of respondents from 8 schools, in the Czech Republic from six schools; and in Belgium the research samle consisted of students of the same school. In Belgium, the research sample was not a representative one, the data and results regarding Belgium can serve only for informative purposes. As for the Slovak and Czech schools from which the students were engaged in the data collection, these came from different regions and residential cities of different sizes. However, the size of the research samples in these two countries we consider also to be too small to claim them as totally representative.

The overall composition of the research sample divided by the country and gender factors is presented in Table 1.

Data processing

In the questionnaire used the respondents expressed their answers (evaluations of the relevant assessed factors) according to their opinions of the ordinary items, P1, P2, P3, P4, P5, P6, P8, P9 and P10, using a 7-point scale (1 – most negative assessment/attitude; 4 – neutral assessment/attitude; 7 – most positive assessment/ attitude). In the nominal questionnaire items P7 and P11 – P14, the respondents were asked to choose among several given answers the most suiteable answer for them.

Data obtained for each questionnaire item were processed depending on the factor COUNTRY, GENDER and combination of the factors COUNTRY*GENDER. Statistical processing of the obtained data was based on the use of *chi*-square test, contingency coefficient, analysis of variance for repeated measurements ANOVA, Greenhous-Geisser and Huynh-Feldt corrections for repeated measures in the analysis of variance and graphical visualization.

The only assumption of validity of *chi*-square test is that the expected frequencies are greater than or equal to 5 (1).

$$e_{ij} = \frac{r_i s_j}{n} \geq 5 \qquad (1)$$

This condition was violated in some cases. For this reason, it was not possible to rely solely on the results of *chi*-square test. That is why the coefficients of contingency were calculated and the dependence was visualized graphically. To assess and compare associations between the nominal variables, the contingency coefficient *C* was used.

Detailed information on the conceptual and methodological basis of the research was published in the proceedings of the international symposium ITME 2011 – *International Symposium on IT in Medicine and Education* (Záhorec and Hašková, 2011). This paper brings an overview of the main research findings regarding the assessment of

Table 2. Repeated measures analysis of variance.

	SS	df	MS	F	p
Intercept	48096.23	1	48096.23	8235.616	0.0000
COUNTRY	86.47	2	43.24	7.403	0.0007
GENDER	7.08	1	7.08	1.213	0.2714
COUNTRY*GENDER	0.03	2	0.01	0.002	0.9977
Error	2114.09	362	5.84		

Table 3. Greenhouse-Geisser and Huynh-Feldt corrections (Lower Bound) for repeated measures ANOVA.

	Lower bound epsilon	Lower bound adjusted df1	Lower bound adjusted sv2	Lower bound adjusted p
Item	0.1250	1.0000	362.0000	0.0000
Item*COUNTRY	0.1250	2.0000	362.0000	0.0000
Item*GENDER	0.1250	1.0000	362.0000	0.1194
Item*GENDER*COUNTRY	0.1250	2.0000	362.0000	0.2630

the ordinary questionnaire items, P1 – P6 and P8 – P10 depending on the factor COUNTRY and combination of the factors COUNTRY and GENDER. The research findings result from the statistical analysis of the nominal questionnaire items. Regarding the nominal questionnaire items P7 and P11 – P14, we focus our attention more on the results in which the dependence of the students` answers on the factor COUNTRY or GENDER was significant (COUNTRY – P11a, P12, P14; GENDER – P7, P14).

RESEARCH RESULTS

Ordinary item research results

Table 2 shows the results of the analysis of repeated measures of data collected through sample surveys which tested the effect of COUNTRY and GENDER, both as independent factors, as well as their interaction on the aggregate questionnaire score (score of ordinary items P1, P2, P3, P4, P5, P6, P8, P9 and P10). Table 3 shows the results of tests of differences in respondents' answers to the relevant individual ordinary items.

Tests of differences in respondents' answers to individual items, based on the Greenhouse-Geisser and Huynh-Feldt corrections (Lower Bound) for repeated measures ANOVA, confirmed the statistical significance ($p < 0.05$) of the results of differences in relation to the factor COUNTRY (Table 3). The effect of the factor COUNTRY on the ratings of the ordinary items P1, P2, P3, P4, P5, P6, P8, P9 and P10 is illustrated in Figure 1. The graph shows the point and interval estimates of the average assessment of the questionnaire items separately for groups of Slovak, Czech and Belgian respondents.

Formulation of the individual questionnaire items is seen in the research methodology, data collection section.

The statistical analysis of the responses given by respondents to the questionnaire items based on the COUNTRY factor showed statistically significant differrences. This does not apply to the interaction of COUNTRY and GENDER factors. A p-value of 0.9977 was produced by the analysis of repeated measures. We can thus say that there is no statistically significant difference in the responses to the nominal items as a whole, in relation to the combination of the COUNTRY and GENDER factors. The overall results of individual groups of respondents, according to a combination of COUNTRY and GENDER factors, are shown on the graph in Figure 2, which shows the mean and confidence interval of the factor groups.

The graphs in Figure 2 confirm the results of a multivariate repeated measures ANOVA analysis. Response lines of individual groups are similar and thus confirm the independence of the respondents' answers to questionnaire items, as a whole, from the interaction of the COUNTRY and GENDER factors.

Although the dependence of the responses given by respondents to the ordinary items based on the GENDER factor did not show statistically significant differences in general, the data were processed also for each ordinary item in distribution by the COUNTRY and GENDER factors. The effect of the GENDER factor in each country on the rating of the ordinary items, P1 – P6 and P8 – P10, is presented graphically in Figure 3.

Nominal item research results

The null hypotheses to each nominal item were statements in which the answer on the relevant item does not depend on the factor COUNTRY / GENDER. Most of the null hypotheses were confirmed (Table 4). The

Table 4. Results of *chi*-square tests of the nominal items P7 and P11 – P14 dependence on COUNTRY and GENDER factors.

Item / factor	Pearson's *chi*-square test			Contingency coefficient	Cramer coefficient
	χ2	sv	p	χ2	χ2
P7 (5) / COUNTRY (3)	13.18522	8	0.1057	0.12901	0.09199
P7 (5) / GENDER (2)	12.41715	4	0.0145	0.18067	0.18369
P11a (2) / COUNTRY(3)	7.01785	2	0.02993	0.09449	0.09491
P11a (2) / GENDER (2)	3.42570	1	0.0642	0.09648	
P12 (7) / COUNTRY (3)	146.54410	12	0.0000	0.39834	0.30709
P12 (7) / GENDER (2)	9.01194	6	0.1729	0.15481	0.15670
P13a (2) / COUNTRY(3)	4.08060	2	0.13000	0.07219	0.07238
P13a (2) / GENDER (2)	0.08089	1	0.7761	0.01483	
P14 (7) / COUNTRY (3)	45.77430	12	0.0000	0.23558	0.17141
P14 (7) / GENDER (5)	13.93940	6	0.0303	0.19104	0.19462

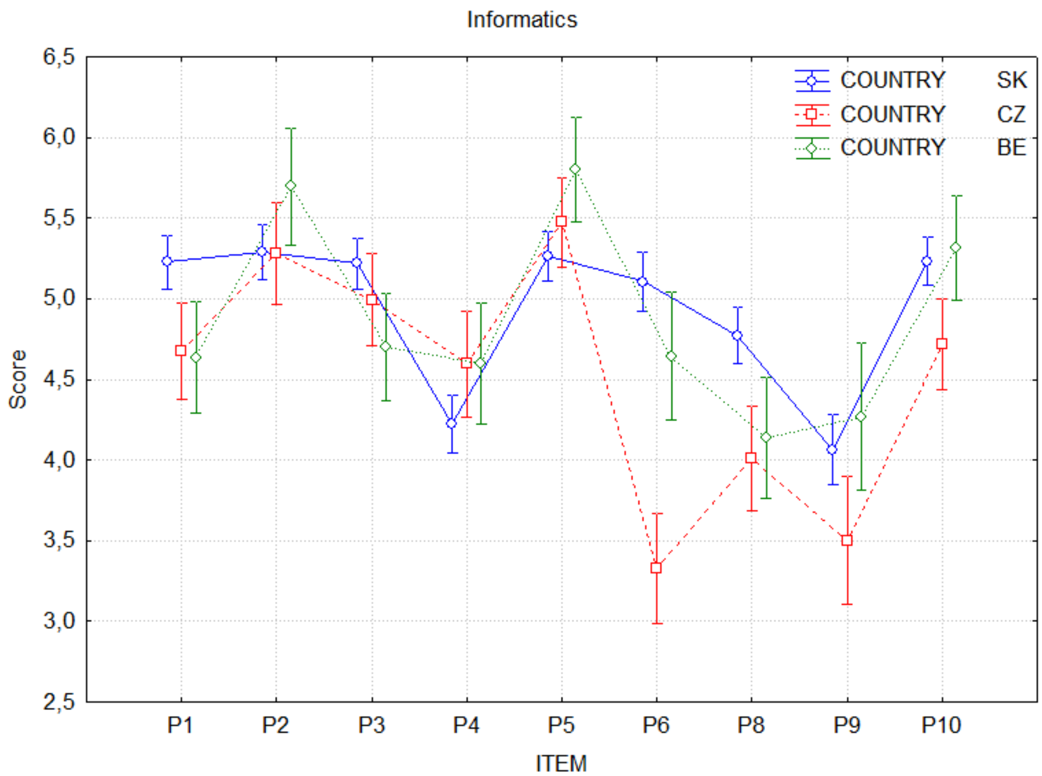

Figure 1. Average point and interval score of individual items based on COUNTRY.

differrences between the respondents' responses dependent on the observed factors were statistically significant only in the following cases:

1. item P7 in relation to the factor GENDER,
2. item P11 a in relation to the factor COUNTRY,
3. item P12 in relation to the factor COUNTRY,
4. item P14 in relation to the factor COUNTRY,
5. item P14 in relation to the factor GENDER.

Results of the *chi*-square tests of the questionnaire item, P7 depending on the factor GENDER and questionnaire item P11a depending on the factor COUNTRY are visualized in Figures 4 and 5 (the alternative answers to each nominal questionnaire item are presented in the relevant paragraphs of the research result and discussion).

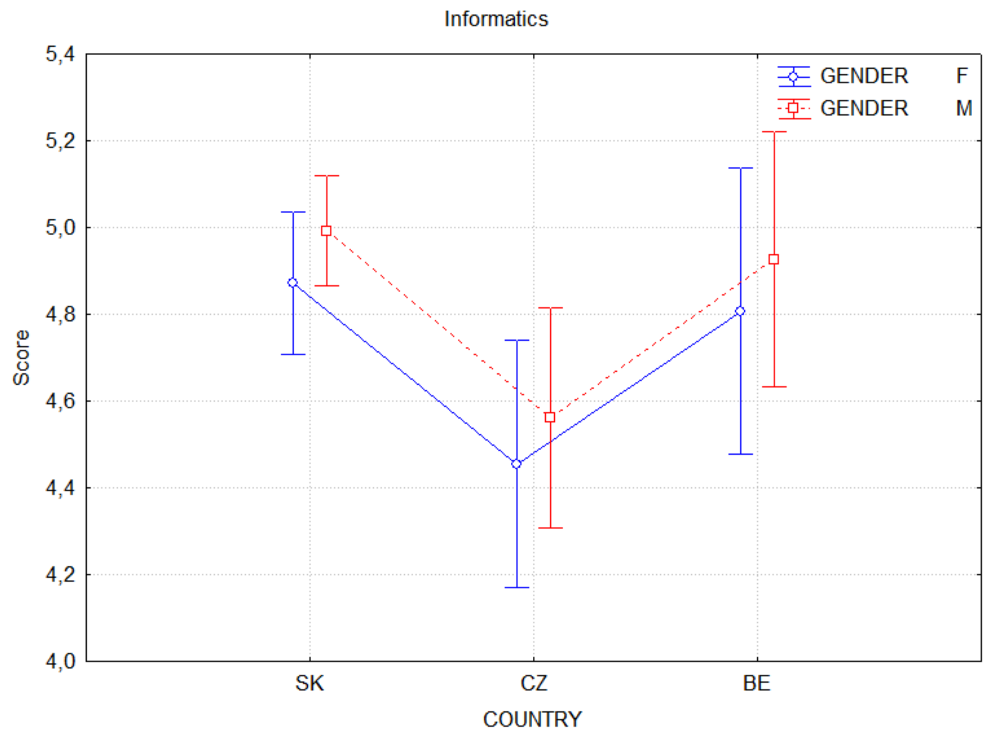

Figure 2. A visual representation of mean and confidence intervals according to a combination of the COUNTRY and GENDER factors.

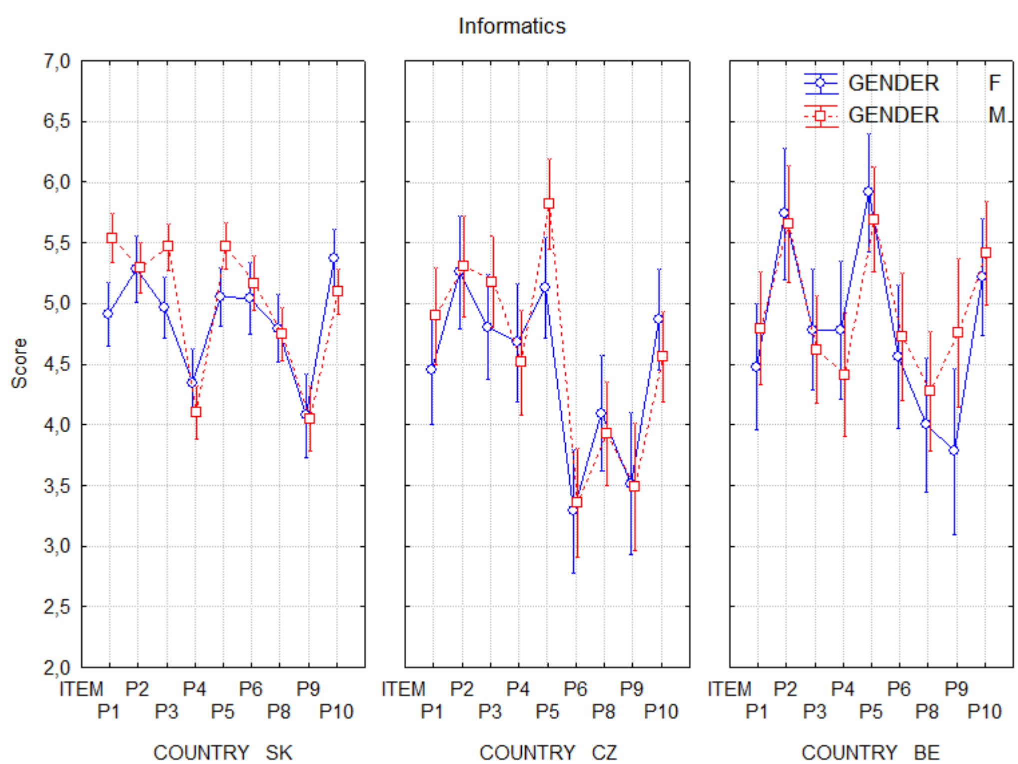

Figure 3. Average scores rating of individual items divided by the COUNTRY and GENDER factors.

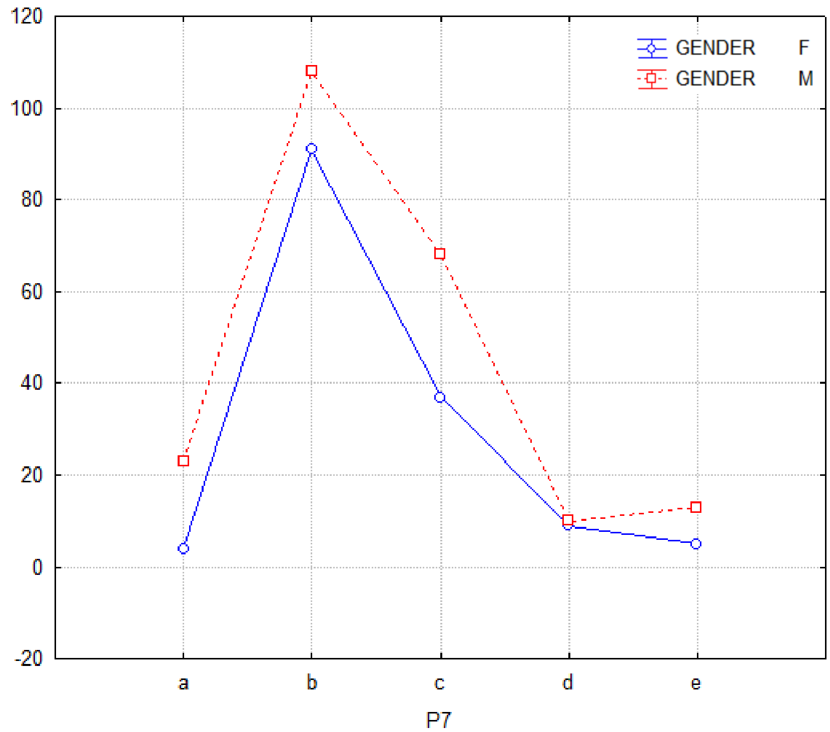

Figure 4. Interaction graph for the item P7 according to the factor GENDER. The alternative answers *a* – *e* are seen in the result and discussion of the study, paragraph of item P7.

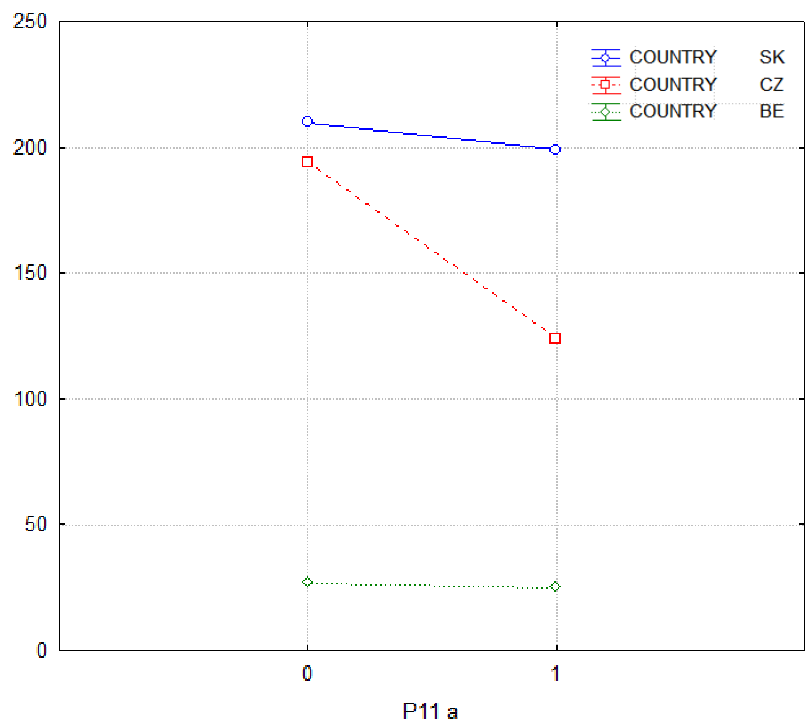

Figure 5. Interaction graph for the item P11a according to the factor COUNTRY.

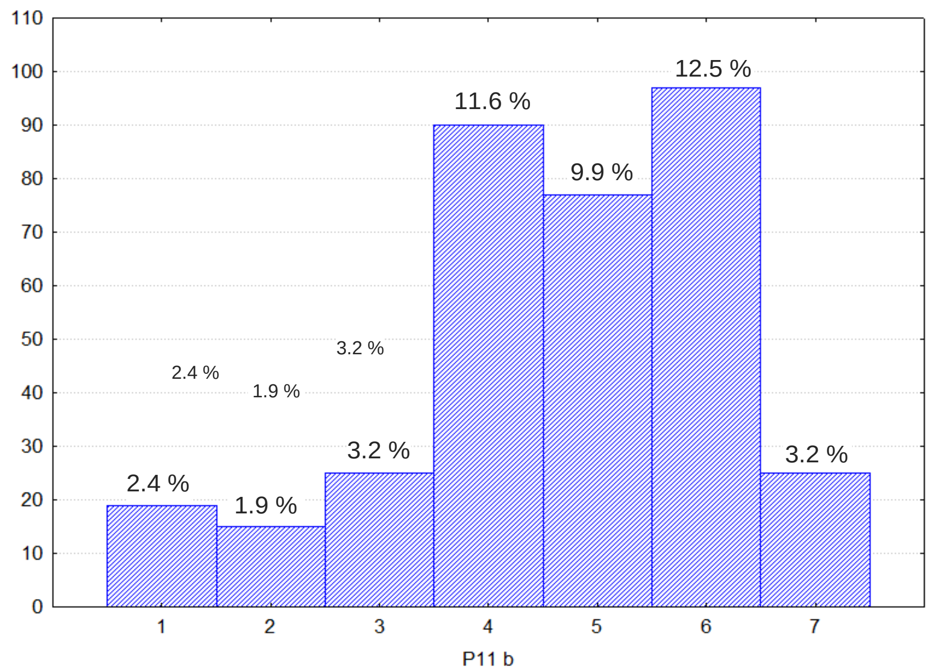

Figure 6. Histogram of responses to the item P11b (for the whole research sample without differentiation of COUNTRY and GENDER). Meaning of the particular scale points is seen in the result and discussion of the study, paragraph of item P7.

From the graphs we see that the response curves in each of these graphs do not copy themselves, confirming the results of the *chi*-square tests.

Respondents who in the first part of the questionnaire item P11 (that is P11a) stated that their informatics teachers use in their teaching practice, in addition to computers, other teaching aids (choice of the answer *yes* – 1; Figure 5), were asked in the second part of this questionnaire item to assess how interesting the teaching aids are to them. Their responses are summarized in a histogram in Figure 6. The histogram shows asymmetries in the distribution of negative and positive critical reviews with a predominance of positive responses (marked points 5 – 7 of the scale used) and a very high frequency of neutral statement (4).

Results of the *chi*-square test of the questionnaire item P12 dependent on the factor COUNTRY (Table 4) are visualised in the graph in Figure 7. The graph shows the differences of the responses to the item P12 dependent on the COUNTRY factor, which is a case of the highest significant level. The lines representing answers of the respondents in particular groups (SK, CZ, BE) plotted in the graph do not copy each other, conforming the results of the *chi*-square test.

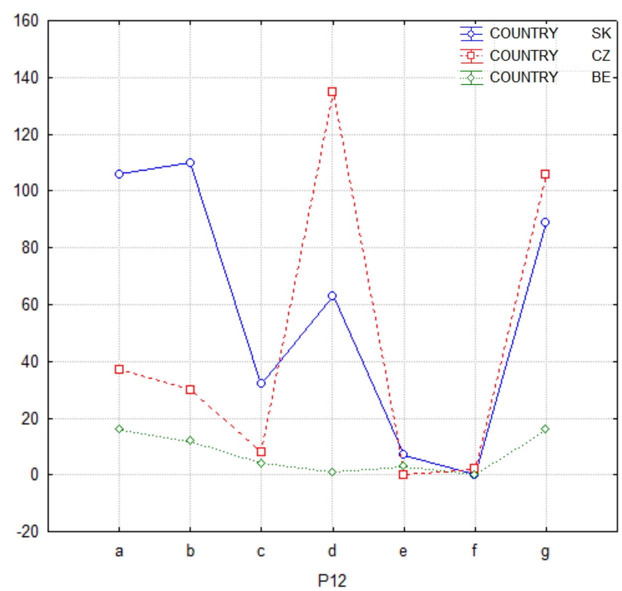

Figure 7. Interaction graph for the item P12 according to the factor COUNTRY. The alternative answers *a* – *g* are seen in the result and discussion of the study, paragraph of item P12.

The results of the item P12 proved that there are differences in the way the students in the concerned countries take their notes of the subject matter presented within informatics teaching. In relation to the students` satisfaction with the ways used, only one fifth (19.8 %) of the total number of the respondents proclaimed their unsatisfaction (P13a). The p-value (p = 0.13000)

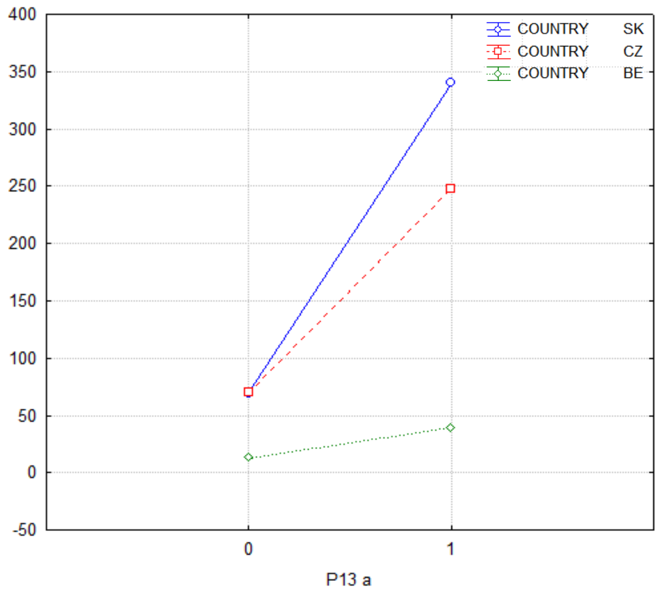

Figure 8. Interaction graph for the item P13a according to the factor COUNTRY.

obtained from the item P13a (Table 4) proves that there is no statistically significant relation between the students` responses to this item and the students` nationality (p > 0.05), that is the item P13a does not depend on the factor COUNTRY. The graph in Figure 8 visualises the results of the *chi*-square test of the questionnaire item P13a depending on the factor COUNTRY (0 – *no, I am not satisfied*; 1 – *yes, I am satisfied*). An overview of the answers of the minority group of the unsatisfied respondents, in which they chose the way they would prefer more to make the written notes (P13b), is summarized in a histogram in Figure 9.

Figures 10 and 11 present a summary of the responses to item 14 according to the factors COUNTRY and GENDER, a case with proven dependence on both factors.

Results of the *chi*-square test of the questionnaire item P14 depending on the factor COUNTRY (SK, CZ, BE) are visualised in Figure 10. The lines representing answers of the respondents in particular groups to the item P14 plotted in the graph do not copy each other, conforming the results of the *chi*-square test.

Statistical analysis of the respondents` responses to the questionnaire item P14 aproved also dependence of this item on the factor GENDER. The p-value (p = 0.0303) (Table 4) proves that the differences between the answers of boys and girls are statistically significant in relation to p < 0.05. Contingency coefficient is 0.191404, meaning a trivial degree of dependence according to Cohen. Based on this result, we can state that respondents' responses to the questionnaire item P14 depend on the factor GENDER.

DISCUSSION

Comparison of the ordinary item results based on the COUNTRY factor

In general, following the results of repeated measures analysis of variance presented in Table 2, we can state that responses to the ordinary items (P1 – P6 and P8 – P10) are significantly affected by the factor COUNTRY (p-value of less than 0.01) and they are not affected by the factor GENDER nor by the interaction of the factors COUNTRY*GENDER (p > 0.05).

The results in Figure 1 show that the level of informatics teaching from the student’s perspective of almost all observed factors is rated most positively in Slovakia. The only two exceptions are items P4 and P5 which, in case of Slovak respondents, had significantly the lowest scores (4.2 for P4 and 5.3 for P5). Slovak students rated informatics as a slightly more difficult school subject (P4) than the Czech and Belgian students. The average Slovak student rated this subject *as neither demanding nor easy*, while Czech and Belgian students rated it as *rather easy*.

This may be closely related to the results in the item P5, in which students reflected on the clarity of the teacher’s presentation of new material. While the Czech and Belgian students *usually understand* their teacher’s presentation, Slovak teachers often present material inappropriately; so students are not entirely clear on what is being presented to them (the mean score of the Slovak respondents’ P5 rating was 5.3, that is the rating *I rather understand’* than do not understand). This factor – the clarity of presentation of new material by teachers - might be seen, on the background of the obtained research results, as a weakness in teaching informatics in the Slovak Republic. Paradoxically, however, teachers in Slovakia, in comparison with Czech and Belgian ones are able to engage their students the most (see the outcome of the item P6). Respondents rated the attractiveness of the teacher’s presentation of the Slovak class curriculum with an average score of 5.1. This means that Slovak teachers present the material in such a way that students, according to our rating scale, rate it as a *rather interesting* way of presenting curriculum. Belgian students rate the presentation of new material by their teachers between *neither interesting nor uninteresting* and *rather interesting* (final average score, 4.7). From this aspect, informaticsteachers in the Czech Republic were rated as the worst of the three countries. According to the Czech respondents, the way teachers present the subject matter is *rather uninteresting* (the value of the final average score, 3.3). An analogous situation exists with regard to the evaluation of the engagement level of tasks that teachers solve with their students during informatics classes in the studied countries (see the results of the item P8). Slovak teachers– paradoxically and judging by the results of the questionnaire item P5, which states that students only *rather understand* than do not understand

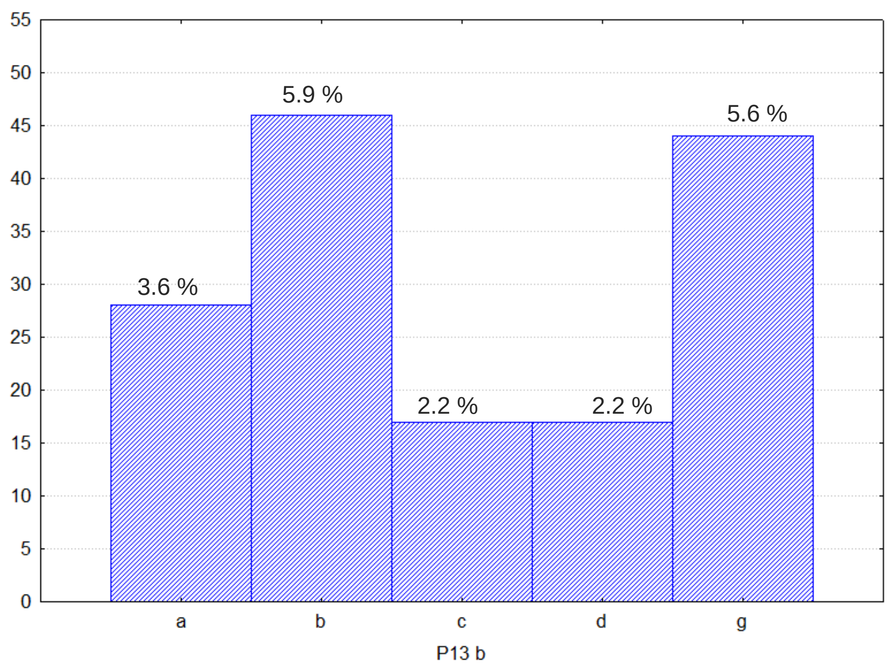

Figure 9. Histogram of responses to the item P13b (for the whole research sample without differentiation of COUNTRY and GENDER). The alternative answers *a* – *g* are seen in the result and discussion of the study, paragraph of item P13.

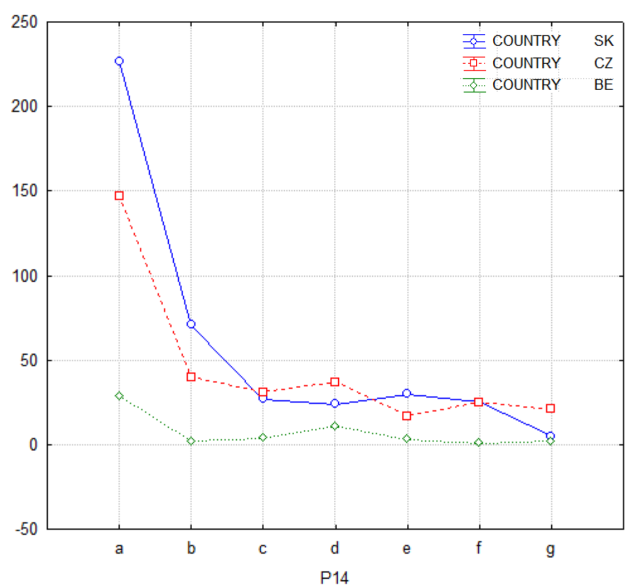

Figure 10. Interaction graph for the item P14 according to the factor COUNTRY. The alternative answers *a* – *g* are seen in the result and discussion of the study, paragraph of item P14.

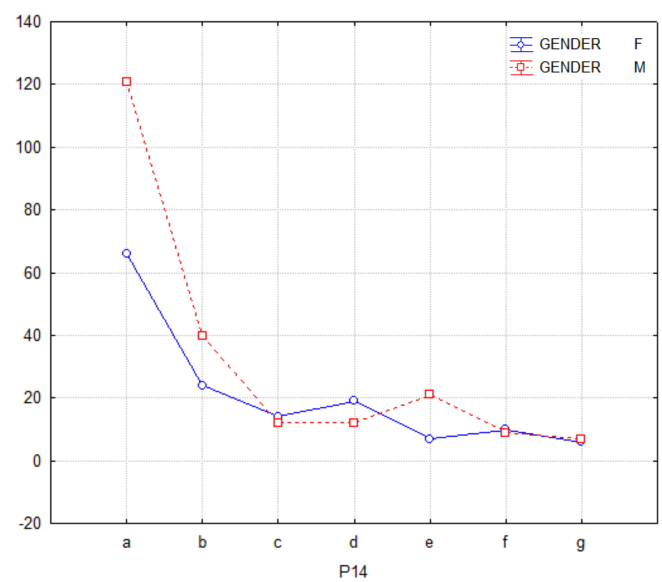

Figure 11. Interaction graph for the item P14 according to the factor GENDER. The alternative answers *a* – *g* are seen in the result and discussion of the study, paragraph of item P14P14.

their presentation – give students tasks that they consider to be *rather interesting*. In comparison with Slovak teachers, Czech and Belgian informatics teachers obtained significantly worse ratings even in this aspect of their assessment (see results for P6 and P8). The tasks assigned by these teachers were not considered to be interesting (mean score CZ – 4.0; BE – 4.2 represents the rating: *neither interesting nor uninteresting*).

The knowledge that students gain in informatics classes is considered to be *rather necessary* by both Belgian and Slovak students. A significantly more negative outcome was recorded in the evaluation of computer science education in the Czech Republic. Czech respondents ranked knowledge of informatics, taught in the school curriculum, as *neither necessary nor unnecessary* more often than *rather necessary* (P10 mean score 4.7). Based on the aspect of attractiveness (item P3), the curriculum covered in informatics classes was rated by all three groups of respondents as *interesting*. Also noteworthy is the fact that the higher the average rating by a group, the smaller the variance of the majority of answers (see Figure 1 for the minimum size of variance in the majority of answers for the group of Slovak respondents, for whom the average score in this item was 5.3, the highest of the three groups; and greater variance of the majority of responses in case of the Belgian respondents, for whom the average score was 4.7, the lowest of the groups).

The weakest aspect of teaching informatics at the upper secondary level (ISCED 3A) in all three countries has proven to be the quality of textbooks, or rather, their scarcity. To ensure a good quality of the computer science/informatics education at schools, a deeper analysis of computer science/informatics textbooks is necessary. The problem of textbooks can have an impact on all other observed factors. On the other hand, we can rate the performance of informatics teachers as very high in all three countries. Despite the highly unfavourable textbook situation, students rate the performance of teachers, in regard to the clarity of curriculum interpretation, as very high. Partially, this regards as well the students' evaluation of the teachers' presentations of the new material in terms of attractiveness and the tasks that teachers give to students during class.

An interesting case is the evaluation of teachers of informatics in the Czech Republic. Their performances in terms of providing an intelligible interpretation of the new curriculum to students can basically be described as a strong feature of informatics teaching. But on the other hand, attractiveness of their presentation of new material is, among the factors studied, clearly identified as the weakest features of informatics education (or compared to the factor of textbooks, this factor received an even worse assessment). The engagement of tasks, which are implemented during informatics lessons by Czech teachers, was identified as a weakness of informatics education in the Czech Republic. This factor is a weakness of informatics education in Belgium, too. This contrasts with the strongly positive result of the clarity of presentations by teachers. When talking about the aforementioned textbook problems, we might speculate that the unsatisfactory situation with the textbooks affects the attractiveness of teachers' presentations, and the attractiveness of tasks given by teachers in the lessons.

Despite the fact that respondents in all three countries recognize the importance of informatics in the acquisition of knowledge for everyday life as an important integral part of education (see the results for the questionnaire item P2), deficiencies in the attractiveness of curriculum presentation, uninteresting classroom tasks, and especially the challenges faced by the lack of proper quality books all contribute to the fact that informatics as a school subject is, in all three countries, considered to be a subject, which is *neither popular nor unpopular*, or rather, only *more or less popular*. But this shows also that unlike other science related subjects, and following also results of other studies (Micheuz, 2008; Grgurina and Tolboom, 2008; Lamanauskas et al., 2004), informatics cannot be classified as a subject the students clearly dislike. Moreover also the results of the ROSE project (Schreiner and Sjøberg, 2007) showed that boys' most prioritized subjects were science related, at least in developed countries such as Japan, Great Britain, Norway and Denmark.

Comparison of the ordinary item results based on the GENDER factor

The results of the statistical testing of the responses to the items P1,P2, P3, P4, P5, P6, P8, P9 and P10 of the questionnaire depending on the GENDER factor are shown in Figure 3. The results of difference testing in the responses of boys and girls in each individual item using the Greenhouse-Geisser and Huynh-Feldt corrections (Lower Bound) for repeated measures of the analysis of variance did not confirm the statistical significance ($p < 0.05$) of responses, when taking GENDER into account as a factor. Despite the fact that differences in the responses of boys and girls are not statistically significant, Figure 3 shows a tendency for boys to evaluate individual factors higher than girls. In this context, paradoxically, boys rate informatics worse in terms of subject being difficult. But girls rate the subject as slightly easier than boys do. Another interesting trend is apparent from the results recorded for the group of Czech and Slovak respondents. In these two countries, girls show a tendency to evaluate the usefulness of knowledge acquired during informatics lessons more positively than boys (girls are more inclined to evaluate this knowledge as *rather necessary* than *neither necessary nor unnecessary*).

The nominal item research results

As mentioned above, the differences between the respondents' responses depending on the observed factors were statistically significant only in five cases: item P7 depending on the factor GENDER item P11a depending on the factor COUNTRY, item P12 depending on the factor COUNTRY and item P14 depending on both factors COUNTRY and GENDER.

The nominal item P7

The first nominal item was the seventh questionnaire item P7. This item focused on the factor of the suitability of particular methods for informatics curriculum presentation:

Different students prefer different ways of explaining new subject matter. What kind of explanation do you prefer? a – teacher explaining the subject matter without using visual teaching aids; b – teacher explaining the subject matter using various teaching aids; c – teacher involving also students in the explanation of the new subject matter; d – teacher giving individual tasks to students and supervising their progress; e – if others, state what you like).

Based on the achieved value ($p = 0.0145$) (Table 4) for item P7, we can conclude that the differences between the responses of boys and girls are in compliance with the value of ($p < 0.05$) which is statistically significant. It means that in terms of intersexual differences boys and girls differ in responses to the seventh questionnaire item, though the significance of the difference between the responses of the two groups is statistically minimal as it shows the value of contingency coefficient (0.18).

In the group of both boys and girls, the highest percentage response rate (Figure 4) was observed for the alternative *b* (*teacher explains the subject matter using various teaching aids*). This option shares 48.6% of the total number of 222 boys and 62.3% of the total number of 146 girls. The second most frequent response was option *c* (*teacher involves also students in the explanation of the new subject matter*), which was marked by nearly one third of the boys (30.6%) and by one quarter of the girls (25.3%). A relatively higher percentage decline can be observed in the group of girls, where the difference between the first and second most frequent answer was 37% with the number of 146 respondents. In the group of the respondents - boys the alternative *d* (*teacher gives students individual tasks and supervises their progress*) had a very little occurrence frequency in the responses. From this result we deduce that to apply heuristic approach and methods of teaching does not fit for boys. The same, however, cannot be stated in the group of girls, in which the mentioned way of the new subject matter teaching is preferred by 6.2% of the respondents (the third most frequent response in the group of girls).

A part of the strategy in informatics education at schools should be the development of creative thinking. Creative skills are essential for success in social practice and in everyday life. Empirical research shows that individuals with good creative skills can better adapt to changes in both social life and working positions. They can also better assert themselves in their jobs because a high degree of creative skills has a positive impact on tackling new and serious problems. Therefore, also in teaching informatics - and given the nature of this subject, it can be said that especially in teaching informatics - it is necessary to apply more teaching methods contributing to higher cognitive process development. For this purpose, learning tasks focused on creating algorithms or interpretative challenges, in dealing with which a heuristic methodology is applied for creative solutions to problems, should be used. Moreover, these tasks have also a motivating impact as they are very interesting and arouse curiosity and desire to find a solution.

The nominal item P11

The second nominal item was the eleventh questionnaire item P11. In this item, we focused our attention on the teaching aids. Our interest was to find out whether teachers in different countries use in informatics lessons other teaching aids than computers (P11a) and how these tools are assessed by the students (P11b). Based on the achieved p-value ($p = 0.0299$) (Table 4) for the questionnaire item P11a, we can conclude that the differences between responses depending on the nationality of the respondents are statistically significant ($p < 0.05$); although the degree of dependence is trivial, as it shows the value contingency coefficient (0.09).

A very negative finding is that except computers any other teaching aids are used very rarely in teaching informatics, and this involves all three concerned countries. More than half of the respondents in each group stated that teachers do not use any teaching aids at the informatics lessons (scale value 0). In the Slovak and Belgian group, this response was given more or less by the same percentage of respondents (51.3 and 51.9%). A significantly higher percentage of negative responses are found in the respondents from Czech Republic (61.0%).

Given the criticism faced by Slovak teachers following the results of the PISA international monitoring, the given results are positive findings in principle for the Slovak teachers. Compared with teachers in the Czech Republic, they use teaching aids in a significantly higher level, comparable with the situation in Belgium. For all that, Belgian education system is rated higher than the education system in Slovakia or in the Czech Republic, and the funds earmarked for the education sector in Belgium are higher compared to Slovakia or Czech Republic.

Among the means used by informatics teachers in their lessons, according to the respondents, are: mainly interactive whiteboards, supporting teaching CD and DVD materials and pre-programmed solutions to algorithmic problems.

Respondents who in the first part of the questionnaire item P11 (P11a) stated that their informatics teachers use in their teaching practice in addition to computers also other teaching aids, assessed how interesting the used teaching aids are to them (P11b). The second part of the eleventh questionnaire item (P11b) was answered by a minor part (44.7 %) of the total number of the respondents. To assess the teaching aids used by the informatics teachers, the respondents had at disposal a seven-point scale: 1 – *very uninteresting*; 2 – *uninteresting*; 3 – *rather uninteresting*; 4 – *neither uninteresting nor interesting*; 5 – *rather interesting*; 6 – *interesting*; 7 – *very interesting*. As the results (Figure 6) show, in general, the respondents inclined more to the positive responses than to the negative ones; but a lot of them gave a neutral statement.

The nominal item P12

In the questionnaire item P12, attention was paid to the way students make written notes of the subject matter presented within informatics teaching. Respondents in each country chose one of seven alternative answers describing the way they write notes during the informatics lessons:

How do you take notes during informatics classes? a – the teacher dictates to us the notes;
b – we do our notes according to the teacher who writes the notes on the blackboard or screens in an electronic way using a data projector; c – a part of the notes we do according to the notes made by the teacher and a part of the notes we do from the textbooks ourselves; d – we make our notes completely by ourselves on the basis of the teacher's explanation; e – we make all our notes from the textbook ourselves at school; f – we make all our written notes from the textbook ourselves at home; g – we do not make written notes of the subject matter presented at all.

The p-value of 0.0000 (Table 4) proves that the differences among the respondents' answers per country are statistically significant ($p < 0.05$), with a middle measure of interdependence as the contingency coefficient is 0.39834, that is the respondents' responses to the questionnaire item P12 (*How do you take notes during informatics classes?*) depend on the factor COUNTRY. In comparison with the other contingency coefficients (P7 x COUNTRY, P7 x GENDER, P11a x COUNTRY, P11a x GENDER, P12 x GENDER, P13a x COUNTRY, P13a x GENDER, P14 x COUNTRY, P14 x GENDER), this is the highest measure of inter-dependence.

The recorded frequencies (Figure 7) show that students in Slovakia and Belgium make their notes mainly in a traditional way. The most frequent answers (SK – 60.9% responses; BE – 61.6% responses) were: *a (the teacher dictates to us the notes)* and *b (we do our written notes according to the teacher who writes the notes on the blackboard or screens in an electronic way using a data projector).* A little less frequency was recorded for answer *c* (*a part of the written notes we do according to the notes made by the teacher and a part of the notes we do from the textbooks ourselves*). These results show that, in general, students at school are not led to a self-active writing of the studied subject matter. A little bit more positive situation is in the Czech Republic where the possibility *d* (*we make our written notes completely ourselves on the basis of the teacher's explanation*) was chosen by the highest number of the respondents (42.5 %). This can be as a result of the use of the project teaching concept (Breiter et al., 2005). According to Moursund (2003), using the project teaching concept is important for teaching students how to decide what is important and not to make them to memorise everything without any understanding of the learnt subject matters. The answer *g* (*we do not make written notes of the subject matter presented at all*) was recorded by 21.9% of the Slovak, 33.3% of the Czech and 30.8% of the Belgian respondents. This situation is influenced also by the fact that the teachers do not always have suitable quality textbooks and they use alternative teaching materials prepared by them or internet sources. Consequently the answers *e* (*we make all our written notes from the textbook ourselves at school*) and *f* (*we make all our written notes from the textbook ourselves at home*) had a very small or even null rate of occurence. We assume that in these situations students are given teaching materials in the form of electronic sources implemented in virtual teaching environments.

The nominal item P13

In the questionnaire item P12 we tried to find out relevant answers to the question, how, in which way, the students take their written notes during informatics classes. Following this question in the questionnaire item P13 we asked students whether the ways used fitted them and were suitable for them.

The questionnaire item consisted of two parts. The first part (P13a) was: *The way you take notes (the way you marked in the question 12) is it convenient for you or would you rather prefer another way?*

If a respondent chose the answer *I would rather prefer another way*, in the second part of the questionnaire item (P13b) the respondent was asked to choose the way in which s/he would prefer to make the notes. The respondents were offered the same alternatives *a – g,* as stated in P12.

On the basis of the results we got, we can say that the ways they take note at school in informatics subject matter are suitable and appropriate for students; they are satisfied with them and do not want to change them. The p-value (p = 0.13000) obtained for the item P13a (Table 4) proves that there is no statistically significant relation between the students` responses to this item and the students` nationality ($p > 0.05$), that is assessment of the item P13a does not depend on the factor COUNTRY. In accordance with the results of the *chi*-square test, the value of the contingency coefficient (0.07219) is statistically non-significant. The same result was obtained also in tests of the item P13a depending on the factor GENDER. The p-value ($p = 0.7761$; $p > 0.05$) declares that girls' and boys' responses to the questionnaire item P13a are not significantly different.

In the results of the obtained data, only one fifth (19.8%) of the total number of the respondents is unsatisfied and would prefer another way of taking notes. An overview of the ways of taking notes, which the respondents of this minority group would prefer more, is summarized in Figure 9.

The nominal item P14

In the fourteenth questionnaire item P14, we want to find out what makes students nervous before informatics lesson, what they are afraid of and what makes them get scared before the lesson. Respondents chose one of seven alternative answers offering them possible sources of their feeling of fear.

Some students are nervous and afraid before classes*. What makes you nervous before informatics lessons? a – I am not used to be afraid of anything; b – unpreparedness/I am not properly prepared; c – oral examination; d – practical tests; e – getting a bad mark; f – fear of repeated lack of understanding of the presented subject matter; g – others, state what*.

The statistical analysis of the results obtained from the students' responses to the questionnaire item P14 processing proved that there is a statistical dependence between the students' nationality and the responses to this item; although the degree of the dependence is trivial based on the value of the contingency coefficient (0.23558) (Table 4).

The results of the item P1 have shown that informatics cannot be classified as a school subject the students clearly dislike. Students have a neutral attitude towards the subject (it is neither popular nor unpopular for them) or they consider it to be more or less a popular subject. Asking the students about source of concern related to informatics, we expected occurrence of students' rather positive responses to this item which was more or less proved, as 51.7% of the total number of 368 respondents chose the offered alternative *a* (*I am not used to be afraid of anything*). This alternative was the most frequent answer in all three groups of the respondents. In Slovakia and Czech Republic, this answer was followed by the answer *b* (*unpreparedness, that is, I am not properly prepared*) given by 17.4% of the Slovak respondents and 12.6% of the Czech respondents. In the sample of Belgian students the second most frequent answer was the alternative *d* (*practical tests*), selected by 21.2% of the respondents.

The results show that the Slovak students, unlike the Belgian ones, are not afraid of any theoretical or practical testing of the acquired knowledge. They are rather afraid of being not prepared properly for the lesson, which evokes in them fear of getting bad mark in the examination. This can be a reflection of a general approach of the Slovak youths (secondary school students) to education, their subjective estimation of education as a factor influencing human`s success, their possibility to be successful in further professional life. Recent findings of the Institute of School Information and Prognosis in Slovakia have shown that more than a half of the secondary school students do not like attending school. And findings of the Slovak School Inspection have proved increase of mainly upper secondary school students` absence from school. The level of the absence from school rises with the classes and the highest is found in those who have just finished (Bieliková, 2008). A considerable part of the students stay aloof from school in an endeavour “to keep clear of failure” in school.

The other alternative possibilities of the students` fear before informatics lessons in case of the group of Slovak respondents did not exceed 7.3% limit. The relative frequency of the other sources of fear is as follows: *e – getting a bad mark* (7.3%); *c – oral examination* (6.6%); *f – fear of repeated lack of understanding of the presented subject matter* (6.1%); *d – practical tests* (5.9%) and *g – others* (1.2%).

In case of the group of the Czech respondents there is a certain divergence of the percentage values of the specific responses at the item P14 unlike the group of the Slovak respondents. Also the sequence of the alternative responses based on their frequencies varies slightly compared with the results of the sample of the Slovak students.

From the interaction graph of the item P14 for Belgian respondents (Figure 10) we see that except the two already mentioned most frequently reasons given for fear (that is, the alternative *a – I am not used to be afraid of anything* and the alternative *d – practical tests*), the rest of the possible reasons for fear was indicated very infrequently. In absolute frequencies these values were not higher than 4 from the total number of 52 respondents.

The respondents could specify also other matters which usually make them nervous before the informatics lessons: The alternative *g – others, state what*). Slovak respondents declared the following: *I am neither nervous nor afraid because I do know exactly what will happen if the teacher gives me a task to assess me; examination or a written test from the subject matter which I do not understand; if the teacher examines our knowledge of the presented matter in applications which I do not understand; I do not like school, it stresses me for nothing.*

Analysis of the results obtained from item P14 question depending on the factor GENDER proves the correspondence of the most frequently given answers to this question in both groups. 54.5% boys from the total number of 222 male respondents and 45.2% girls from the total number of 146 female respondents declared that before the informatics lessons they are not afraid of anything (Figure 11). There is a correspondence between the second most frequently given answers. In both groups, it was the alternative b (*unpreparedness / I am not properly prepared*), whose relative frequency was 16.4% for girls and 18% for boys. Statistically significant differences are between the alternatives c (*oral examination*) and d (*practical tests*). In case of girls the fear of examination is markedly higher. 9.6% of female respondents are afraid of oral examination and 13% of practical examination; whereas in case of male respondents, these percentages are lower, identically equal to 5.4% for both types of examination. On the other hand, boys are more afraid of getting a bad mark (9.5%) than girls (4.8%).

The results indicate that boys incline to the subject more markedly than girls, which was proved in other national and international researches. For example, Fančovičová (2006) dealt with attitudes of students attending different schools in Slovakia towards digital technologies. She found out that in general students of lower level of secondary schools have positive attitudes towards digital technologies, but the attititudes differ depending on the school which the students attend; and the attitude of boys towards the digital technologies can be characterised as a more positive one. Already before, Brosnan (1998) found out, that boys, between 6 – 11, had significantly more positive attitude towards computer technology than girls and both genders considered these technologies as male matter. At that time, girls in UK did not use computers so often as boys did, and they seldom chose careers connected with computers. Also, Graff (2003) showed that girls were less daring to use information technologies than boys and they used computers much more rarely. Boys were more confident in the use of computers because they had computers in their homes. In our opinion the research results follow the proclamed theory that boys are disposed to a higher level of logical as well as technical thinking than girls, and this predetermines boys to prefer more subjects related to informatics/computer science.

Conclusion

Based on the processed students` assessments of the selected factors of teaching informatics (computer science) at the upper secondary level of education in Slovakia, Czech Republic and Belgium, the following can be concluded:

1. In general, the respondents in all three countries assessed the subject and realisation of its teaching process (the selected factors of its realisation) predominantly positively. A serious problem in all three countries seems to be lack of quality textbooks.
2. Slovak students rated informatics as a slightly more difficult school subject than the Czech and Belgian students. This can be connected to the fact that Slovak teachers often present teaching material inappropriately to the students (the Czech and Belgian students are more satisfied with clarity and comprehension of the subject matter presentation given by their informatics teachers).
3. On the other hand, Slovak students appreciate paradoxically their teachers` presentation of the teaching material as more interesting and attractive; Czech and Belgian students assess their teachers` presentation as less interesting and attractive. The same regards also assessments of the engagement level of tasks that teachers solve with their students during informatics classes in the concerned countries.
4. A very negative finding is that except computers, other teaching aids are used very rarely in teaching informatics in all of the three concerned countries. On the other hand, Slovak and Belgian teachers use teaching aids significantly more frequently in comparison with teachers in the Czech Republic. The students` assessment of the teaching aids used varied from negative to positive critical reviews. Despite the variety of the critical reviews, the positive reviews predominate the negative ones, but a very frequent assessment was the neutral one.
5. In Slovakia and Belgium, the students make their notes mainly in a traditional way, that is, the teacher dictates the notes or writes on the blackboard everything that is substantial to the subject matter (or screens it in an electronic way using a data projector). This means that students in these countries are not led to a self-active writing of the studied subject matter. A little bit more positive situation is in the Czech Republic where students significantly more often do their notes also by themselves. The use of the passive inactive ways of making notes, applied mainly at schools in Slovakia and Belgium, can be partially caused by lack of quality textbooks. Moreover, the general satisfaction of students with this way of making notes of the subject matter can be also considered as a consequence of the problems with textbooks.
6. Slovak and Belgian students consider the knowledge gained in informatics classes to be rather necessary (regarding its usability for practical problems solving) whereas Czech students assess it more in a neutral way (neither necessary nor unnecessary).
7. Despite the fact that respondents in all three countries recognize the importance of informatics in the acquisition of knowledge for everyday life and as an important integral part of education, informatics as a school subject

is, in all three countries, considered to be a subject, which is only more or less popular or even neither popular nor unpopular.

8. A tendency of boys to rate informatics (individual observed factors) slightly higher than girls was proved in all three countries. But paradoxically in terms of the subject being difficult, boys rate informatics worse than girls, that is, girls rate the subject as slightly easier than boys do.

9. On a minimal (trivial) statistical significance, there was approved a difference between boys and girls in prefering ways of explaining new subject matter. Although boys and girls identically prefer the ways the teacher explains the subject matter by using various teaching aids or the involving them in the explanation of the new subject matter, girls are more inclined than boys to prefer the use of heuristic methods in teaching and learning processes.

10. As to the possible reasons of students` fear before the informatics lessons, the respondents in all three countries identically declare predominantly that they are not used to be afraid of anything. Further analysis showed that Slovak students, unlike the Belgian ones, are not afraid of any theoretical or practical testing of the acquired knowledge. They are, similarly to Czech students, rather afraid of being not prepared properly for the lesson which evokes in them fear of getting bad mark when examined by their teacher.

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