TEACHING INFORMATICS AT UPPER SECONDARY LEVEL OF EDUCATION (ISCED 3A) IN THE SLOVAK REPUBLIC: EVALUATION OF THE CURRENT STATE

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Abstract

A key aspect for evaluation of a school subject teaching, which is applied in the majority of EU countries, is filling the school curricula with the content subject mater, the extent of their connection with practice and its needs and impulses, compatibility and comparability in the European education area. The paper is based on a widely conceived international research oriented on the comparative evaluation of the current state of teaching the school subject informatics from the point of view of specific factors at the upper secondary level of education (ISCED 3A) in three EU countries - Slovak Republic, Czech Republic and Belgium. The authors describe statistical processing of the collected data and present quantitative and qualitative analyses of the obtained research results.
Key words: *quality in education, school subject informatics, the upper secondary level of education (ISCED 3A).*

Introduction

Evaluation of education is currently very frequently used term in the field of educational policy, not only in terms of evaluation of educational content but also in terms of ensuring and maintaining, or improving adequate level of quality of the teaching process (Graffiti, 2003; Kapusta, Munk, & Turčáni, 2010). In assessing the quality of teaching, the information about students' attitudes to teaching the subject has very important screening value, but also the whole range of other factors is important (Brosnan, 1998). Frequently discussed issue in various expert forums is a tendency of decreasing attractiveness and quality of teaching science and technology subjects. This tendency is reflected not only in Slovakia but also abroad (Čížková & Čtrnáctová, 2003, 2007; Held, 2007; Höffer & Svoboda, 2005; Škoda, 2001; Veselský & Tóthová, 2004). The question is to what extent this problem affects informatics and programming which also belong to science or technically oriented subjects. Is informatics or programming interesting

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and attractive for students? What is the strength of individual factors affecting the attractiveness and quality of informatics education at schools from the perspective of students? Whereas exact answers to these questions do not exist, we decided to carry out a larger scale research to assess the current state of quality and popularity of teaching informatics at a higher level of secondary education in terms of specific factors.

The research is based on an assessment of 14 factors which are supposed to have a significant influence on quality education, e.g. comprehensibility of teacher's presentation of new study materials, attractiveness of the solved tasks, attractiveness of the teaching aids used (for more detail on the conceptual and methodological basis of the research see the article published in the journal *Problems of Education in the 21st Century 2/28*: Záhorec, Hašková, & Munk, 2011). According to limited possibilities, the research was focused on three countries - Slovak Republic, Czech Republic and Belgium. At present, the research data obtained from the three countries are processed and evaluated. This contribution brings a part of the preliminary results, specifically, some findings regarding the factor of appropriateness of different ways of explaining the new subject matter (related to the school subject informatics) and the factor of attractiveness of teaching aids and their significance in influencing or conditioning the quality of teaching informatics science at the upper secondary level of education from the perspective of students.

Methodology of Research

Because of the specialization diversity of schools at the upper secondary level of education and with that associated wide range of specific forms of implementation of informatics and programming education at these schools, it was decided to pay attention to just one type of schools in this category, to four- and eight-year grammar schools (age group of students 16 to 19 years). Creation of the research sample was based on the nonrandom accessible sampling. With respect to the fact that it was decided to assess the current state of informatics education not only in Slovak schools but also in Czech and Belgian ones, there were created three research groups: one representing the Slovak grammar schools (409 respondents), one representing the grammar schools in the Czech Republic (318 respondents) and one representing the Belgian grammar schools (52 respondents). The concerned schools in all of the three groups represented different regions of the relevant country and residential sites of different sizes.

Data collection was based on administrating of a specially created questionnaire *Evaluation of quality and attractiveness of teaching informatics/programming by students in terms of specific factors*. The questionnaire items were related to the 14 examined factors which are supposed to have a significant influence on quality education. In the individual items of the questionnaire students evaluated informatics according to their own attitudes to this subject (e.g. popularity of the subject, interesting content, usability for their future) and in terms of teaching the subject (e.g. comprehensibility of the used informatics textbooks, the ways in which informatics teachers explain the new subject matter, the use of teaching aids at lessons, attractiveness of the used teaching aids).

Reliability of the used research tool was validated by assessing its reliability and identification of suspicious items by reliability/item analysis (Záhorec, 2010).

Evaluation of the research data obtained from the questionnaire administering was based on their statistical processing using *chi*-square test, contingency coefficient 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).

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

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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 as well and the dependences were visualized graphically.

To assess and compare associations between the nominal variables, the contingency coefficient *C* was used. Values close to zero mean very small, insubstantial dependence and values close to 1 indicate practically perfect dependence. Cohen (Cohen, J. 1988, In Rimančík, 2007, p. 73) has created a scale for the interpretation of correlation coefficients: correlation in absolute value below 0.1 is trivial, 0.1 to 0.29 low, 0.3 to 0.49 medium, 0.5 to 0.69 high, 0.7 to 0.89 very large and value of 0.9 is almost perfect. The contingency coefficients can be interpreted in a similar way.

As it was already above-mentioned, in this article only the results for two factors of the explored 14 factors are presented. One of them is the factor of appropriateness of different ways in which a teacher explains the new subject matter (questionnaire item P7) and the second one is the factor of attractiveness of teaching aids and the rate of their significance to influence the quality of teaching informatics (questionnaire item P11).

In the seventh item (P7) respondents were asked to choose one of five alternative answers. The formulation of the item was:

Different students prefer different ways of new subject matter explanation. What kind of explanation do you prefer?

a) – *teacher explains the subject matter without using visual teaching aids,*
b) – *teacher explains the subject matter using various teaching aids,*
c) – *teacher involves also the students in the explanation of the new subject matter,*
d) – *teacher gives individual tasks to students and supervises their progress,*
e) – *other ..... (state what you like)*

In the eleventh item (P11) the respondents answered the following question:

Do you use also other teaching aids during the lessons of informatics in addition to computers (for example various instructional programs, interactive learning objects, simulation models...)? If so, what kinds and how do you evaluate them?

In case of the positive answer (choice of the answer *yes*), respondents assessed in the second part of this questionnaire item the teaching aids using the following seven point scale:

1 – very uninteresting,
2 – uninteresting,
3 – rather uninteresting,
4 – neither uninteresting nor interesting,
5 – rather interesting,
6 – interesting,
7 – very interesting.

In the following part there is an analysis of the results of students' responses to items P7 and P11, depending on factors STATE and SEX.

Results of Research

Dependence of item P7 from the factor STATE

The null hypothesis for exploring the item P7 (*Different students prefer different ways of new subject matter explanation. What kind of explanation do you prefer?)* dependence from the factor STATE (Slovak Republic, Czech Republic, Belgium) was:

H0: The answer on the item P7 does not depend on the factor STATE.

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From the table 1 we see that the relation between values of the seventh item and the nationality of the respondents (factor STATE) is not statistically significant ($p > 0.05$), i.e. the evaluation of the questionnaire item seven does not depend on the factor STATE, so the null hypothesis is considered confirmed. The value of contingency coefficient 0.12901 is statistically insignificant based on the results of *chi*-square test.

Table 1. Chi-square test of independence for the item P7 from the factor STATE.

STATE(3) x P7(5)	χ^2	sv	p
Pearson's *chi*-square test	13.18522	8	0.1057
Contingency coefficient	0.12901		
Cramer coefficient	0.09199		

A positive finding is the fact that in all of the three groups most frequent response was option *b* (*I prefer the kind of explanation, when the teacher explains the subject matter using various teaching aids*). This method is preferred mostly by Czech students (out of 318 respondents in the group 57.2 % chose this option). This option was chosen in a group of 409 Slovak respondents by 53.5 %, in a group of 52 Belgian respondents by 51.9 %. The relative frequencies of the given answers indicate that students in all three countries prefer also the way in which the teacher activates students by involving them in the explanation of the new subject matter. This way of explanation prefers 32.0 % of Slovak, 28.3 % of Czech and 21.2 % of Belgian students.

Based on the achieved results for the factor of the presentation of subject matter by teachers, we can conclude that a significant number of respondents from the total number of the respondents declared a positive looking at the explored factor (54.9 %). We can deduce that by the teachers used teaching methods supported by various visual teaching tools (interactive whiteboards, digital learning tools, etc.) enable students to gain knowledge of appropriate quality and to acquire needed skills. A lot of studies have confirmed the importance of the use of attractive teaching aids as an effective support for the mediation of the explained subject matter to students. However, their successful implementation in education depends not only on students' attitudes to the relevant school subject but also on the teacher himself.

The results of *chi*-square test questionnaire item P7 depending on factor STATE presented in the table 1 are visualized in the figure 1. Response curves in different groups show equal course, so the figure 1 confirms the results of *chi*-square test.

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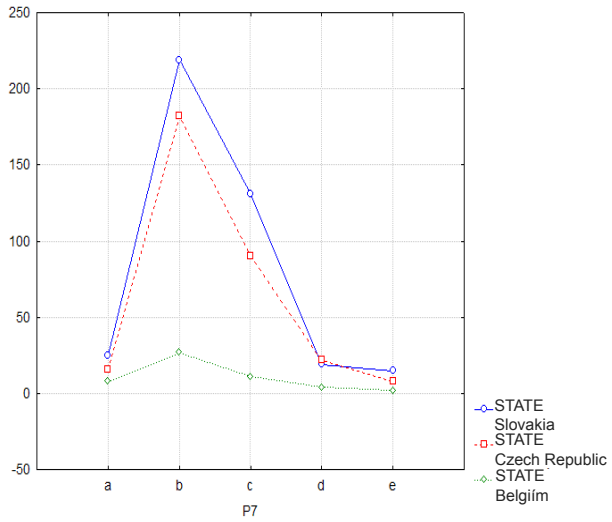

Figure 1: Interaction graph for the item P7 according to the factor STATE.

Dependence of the item P7 from the factor SEX

The null hypothesis for exploring the item P7 (*Different students prefer different ways of new subject matter explanation. What kind of explanation do you prefer?*) dependence from the factor SEX was:

H0: The answer on the item P7 does not depend on the factor SEX.

Based on the achieved value $p = 0.0145$ (table 2) for the seventh questionnaire item, we can conclude that the differences between the responses of boys and girls are in compliance with the value of $p < 0.05$ statistically significant, although the degree of dependence is small, as it shows the value of contingency coefficient (0.18). This result rejects the null hypothesis, i.e. the answers of students about the observed item depend on the factor SEX.

Table 2. Chi-square test of independence for the item P7 according to the factor SEX.

SEX (2) x P7(5)	χ^2	sv	p
Pearson's *chi*-square test	12.41715	4	0.0145
Contingency coefficient	0.18067		
Cramer coefficient	0.18369		

From the results obtained, it is evident that in terms of intersexual differences, boys and girls differ in response to the seventh questionnaire item, though the significance of the difference between the responses of the two groups is statistically minimal.

In the group of both boys and girls, the highest percentage response rate was observed for the alternative *b*. 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*, which was marked by nearly one third of boys (30.6 %) and by one quarter of 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, can not 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 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 that contribute to the development of higher cognitive processes. 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, can be used. Additionally, these tasks also have a motivating impact as they are very interesting and they arouse curiosity and desire to find a solution.

Results of *chi*-square test of the questionnaire item P7 dependence on the factor SEX presented in the table 2 are visualized in the figure 2. From the graph we see that the response curve in each group (boys versus girls) to the questionnaire item P7 do not copy themselves, what confirms the results of *chi*-square test.

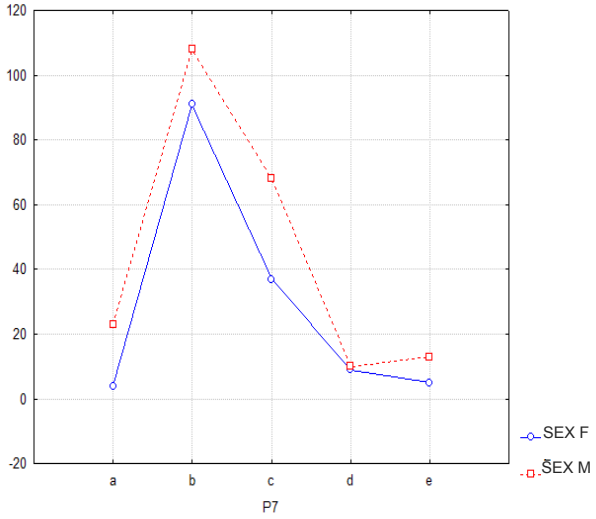

Figure 2: Interaction graph for the item P7 according to the factor SEX.

Dependence of the item P11a from the factor STATE

In the eleventh item, we focused our attention on the teaching aids. Our interest was to find out whether teachers in different countries use in the informatics education also other teaching aids than computers (P11a) and how are these tools assessed by the students (P11b).

The null hypothesis for exploring the item P11a depending on the factor STATE was:

H0: The answer on the item P11 does not depend on the factor STATE.

Based on the achieved value $p = 0.0299$ (table 3) 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). Overall, we reject the null hypothesis and conclude that the rate of the use of teaching aids in teaching informatics in the surveyed countries varies.

Table 3. Chi-square test of independence for the item P11a according to the factor STATE.

STATE(3) x P11a(2)	χ^2	sv	p
Pearson's *chi*-square test	7.01785	2	0.02993
Contingency coefficient	0.09449		
Cramer coefficient	0.09491		

A very negative finding is that except computers, any other teaching aids in teaching informatics are used very rarely, and that can be said about all of the three concerned countries. More than half of the respondents in each group state that the teachers do not use any teaching aids at the informatics lesson (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 is in case of the respondents from the 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 greater level, comparable with the situation in Belgium. For all that, the 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 in comparison with Slovakia or the Czech Republic.

Among the means that respondents reported as used by informatics teachers in their lessons there have been mainly interactive whiteboards, supporting teaching CD and DVD materials of domestic and foreign production and pre-programmed solutions to algorithmic problems.

Results of *chi*-square test of the questionnaire item P11a dependence on the factor STATE presented in the table 3 are visualized in the figure 3. From the graph we see that the curves of responses to the questionnaire item P11a in each country are not the same, what confirms the results of *chi*-square test.

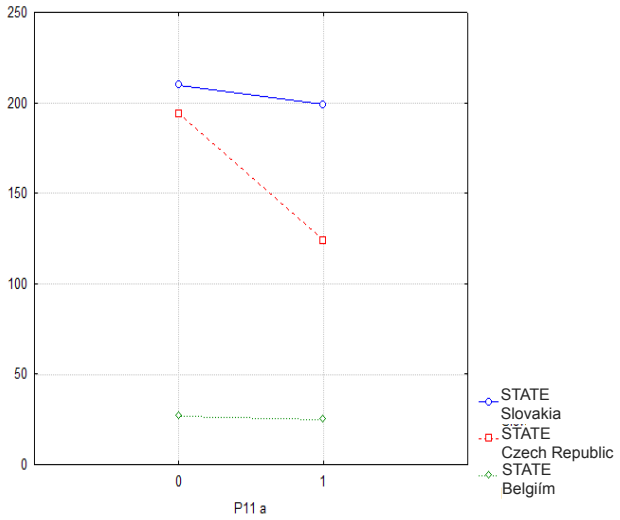

Figure 3: Interaction graph for the item P11a according to the factor STATE.

Assessment of the item P11b

Respondents who in the first part of the questionnaire item P11 indicated that their informatics teachers use in their teaching practice in addition to computers also other teaching aids, were asked to assess in the second part of this questionnaire item, how interesting are the used teaching aids for them. The second part of the eleventh questionnaire item (P11b) was answered by a minor part (44.7 %) of the total number of the respondents. Their responses are summarized in a histogram form in the figure 4 (meaning of the scale points 1 - 7 see in the section *Results of the research*).

The histogram (figure 4) shows asymmetries in the distribution of negative and positive critical reviews with a predominance of positive responses (marked points 5 - 7 of the used scale) and a very high frequency of the occurrence of the neutral relation statement to the used teaching aids (score 4 of the used scale).

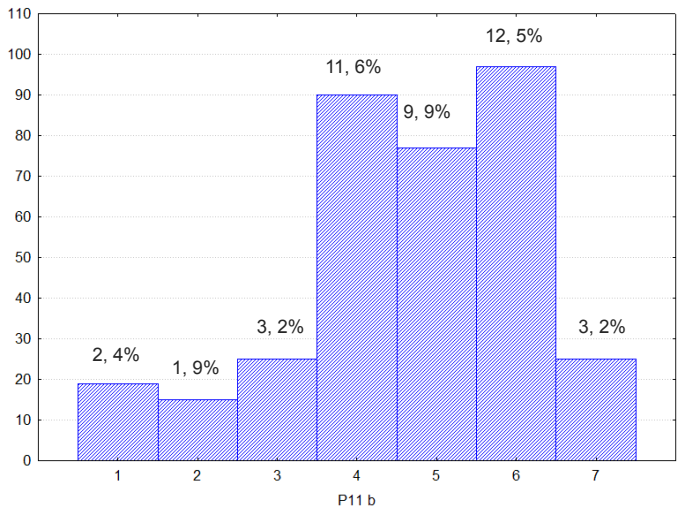

Figure 4: Histogram of responses to the item P11b (for the whole research sample without differentiation of STATE and SEX).

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Conclusions

The main findings of the above reported results can be summarized in the following points:

- Within teaching of informatics in the monitored countries, the students did not show any differences in preferring a particular method of the new subject matter presentations made by teachers. In all three countries, students consistently prefer most, when the teacher explains the subject matter himself, using various teaching aids.
- Slightly significant statistical difference was proved in boys and girls' attitude to the various ways of the subject matter explanation. Results for girls indicate that in comparison with boys the girls more prefer heuristic teaching methods.
- Informatics teachers generally use other teaching aids beside computers in their teaching practice very rarely. However, difference in the level of the use of these means was detected depending on the country. Slovak and Belgian teachers use teaching aids in their practice on significantly higher levels than their Czech counterparts.
- Teaching aids that teachers use in teaching informatics are evaluated by students rather positive than negative (the majority of students finds them as interesting). But relatively large is a group of students, for whom the used teaching aids are not interesting, neither in a positive or in a negative way (they have a neutral relationship to them, the used teaching aids are neither interesting nor uninteresting for them).

The research team involved in the presented research processes and evaluates in successive steps the data obtained from all three countries. Partial results are continuously presented at conferences and published in professional journals and proceedings. The aim of the research team is to complete the partial results into a final empirical study, which will assess the current state and level of quality of teaching informatics at the upper secondary level of education in Slovakia, the Czech Republic and Belgium, and will compare the strengths and weaknesses of informatics education on each side.

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