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ASSESSMENT OF THE STATUS OF TEACHING SUBJECTS INFORMATICS AND PROGRAMMING IN TERMS OF SELECTED FACTORS

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Abstract: The paper presents a part of authors' research results, they obtained within a wider research focused on possibilities to influence students' attitudes and approaches to individual subjects, mainly the less favourite ones. Following the empirically derived hierarchy of subjects identifying the degree of individual subjects popularity among students, and influence of various factors on students' attitudes to these subjects the authors discuss students' interest in studying informatics and programming and try to identify the reasons of students' interest or disinterest in them. They try to answer the question what are currently the most powerful motivation factors for students to acquire new knowledge from these areas.

Key words: informatics, programming, interest in studying informatics and programming, motivation factors

1. Introduction

In Slovakia and as well in other countries both secondary schools and universities face a decrease of students' interest in technical and natural science subject study. This trend is usually interpreted as a consequence of a progressive lack of popularity of natural science subjects as physics, chemistry and mathematics are. The question is how it is with students' attitude to informatics and programming as school subjects. Do these subjects belong to the students' favourite or unfavourite ones? Is their study for students interesting and attractive? What can influence motivation of students in this area? Hereinafter we present a part of the results we obtained within a wider research, which can help us to answer these questions. The whole research was aimed at identifying existing students' attitudes to school subjects and possibilities to influence these attitudes.

2. Methodology of the Research

The research was carried out during a period of the years 2007 - 2008 at a higher secondary (comprehensive) school in Nitra (Gymnazium Golianova ul.). The research sample consisted of students attending the final grades of their study at the school (4^{th} grade of a four-year type of the school and 8^{th} grade of an eight-year type of the school), i.e. the research sample consisted of representatives of 17 – 19 year aged youth category. The group included 82 students out of which 57 students attended a class with extended informatics and programming teaching curriculum (4.C and octave B) and 29 students attended a class with extended foreign language teaching curriculum (octave A). The ratio between boys and girls in the research sample was 58,5 % : 41,5 %.

To obtain necessary research data we administered a questionnaire *Assessment of school subjects by students from the point of view of selected factors* created specially for the purpose of the research. The students expressed their attitudes (favour/popularity, attractiveness – unfavour/unpopularity, non-attractiveness; positive assessment – negative assessment of selected factors) on a seven-point scale. The level of disagreement with a statement (negative assessment of the item) was expressed by the

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values -3, -2, -1 (-3 was the strongest disagreement). The agreement with a given statement (positive assessment of the item) was expressed similarly by the values 3, 2, 1 (3 was the strongest agreement). A neutral attitude to any statement in the questionnaire was expressed by 0 value in the scale. The following scheme presents a summary of the scale:

+ 3	very favourite very interesting very strong positive assessment	- 3	very unfavourite very uninteresting very strong negative assessment
+ 2	favourite interesting positive assessment	- 2	unfavourite uninteresting negative assessment
+ 1	rather favourite rather interesting weak but a positive assessment	- 1	rather unfavourite rather uninteresting weak but a negative assessment
0	neither favourite, neither unfavourite neither interesting, neither uninteresting		

The analysis of the motivation factors (separately in relation to each school subject) addressed the following seven items:

P1 - attractiveness of the subject matter content,
P2 - popularity of a school subject,
P3 - attractiveness of the teaching tasks solutions,
P4 - presentation of the subject matter by a teacher,
P5 - attractiveness of teaching aids used,
P6 - applicability of the obtained knowledge for learner´s future use,
P7 - applicability of the obtained knowledge in practical tasks solution .

The validity of different factors for students (importance of the factor for them personally) was assessed from students´ own viewpoint according to presented scale. On the basis of this assessment we estimated coefficients of the total (global) assessment, coefficients of (partial) positive assessment and coefficients of (partial) negative assessment for each of the motivation factors.

The coefficient of the total assessment (for each school subject) was counted as a sum of conjunctions of the relevant scale point value and the number of students who marked this scale point, divided by the total number of the respondents.

The coefficient of the positive assessment (for each individual school subject) is derived from the answers of the respondents who marked the individual subject as their favourite one/they are interested in. This means it is not derived from the answers of the whole research sample group as it is in case of the total assessment coefficient. Similarly the coefficient of the negative assessment is derived from the answers of the respondents who marked the individual subject as their unfavourite one/uninteresting for them. It means that the coefficient of the positive assessment was counted as an average value from the values marked on the given three-point scale (+1, +2, +3) by the respondents who expressed their positive attitude to the individual subject. The sum of conjunctions of the relevant scale value and the number of the respondents who marked the corresponding scale point was divided by the total number of the respondents who expressed their positive attitude to the subject. The coefficient of the negative assessment of the relevant subject was counted as a mean of the values marked on the given three-point scale (-1, -2, -3) by the subgroup of the respondents who declared their negative attitude to the appropriate subject.

The research data were processed for the whole research sample without any differentiation of the respondents according to their study profiles (extended study of informatics and programming or foreign languages acquisition).

3. Results of the assessment of the observed factors

The results of the analysis of the observed motivation factors for the school subjects informatics and programming are presented in the table 1.

Table 1. *Evaluation of the observed factors for the subjects informatics and programming*

Subject	INFORMATICS			PROGRAMMING		
Factors	Coefficient of the total assessment	Coefficient of the positive assessment	Coefficient of the negative assessment	Coefficient of the total assessment	Coefficient of the positive assessment	Coefficient of the negative assessment
Attractiveness of the subject matter content	1,46	1,99	-1,50	1,00	2,05	-2,07
Popularity of a school subject	1,48	1,97	-1,46	1,18	1,32	-2,08
Attractiveness of the teaching tasks solutions	0,92	1,95	-1,67	1,17	2,26	-1,00
Presentation of the subject matter by a teacher	0,91	1,92	-1,78	0,83	2,10	-2,06
Attractiveness of teaching aids used	1,53	2,06	-1,67	1,44	2,13	-1,6
Applicability of the obtained knowledge for learner´s future use	1,45	2,31	-1,30	1,06	2,33	-1,82
Applicability of the obtained knowledge in practical tasks solution	2,06	2,31	-1,17	1,50	2,34	-1,50

To display in a graphical form how the students assessed the determined items we used a box & whisker plot. The box & whisker plot for the subject informatics (I) is presented in figure 1 (motivation factors IP1 – IP7) and for the subject programming (P) in figure 2 (motivation factors PP1 – PP7). The plots show median and quartile and variational interval for determined factors in both fields.

As the graph in figure 1 and the presented values of the quartile intervals of the different items show, the most heterogeneous answers of the students involved were recorded with the items IP3, IP4 and IP6. On the contrary, the most homogeneous students` answers occurred with the items IP1, IP2, IP5 and IP7.

It is clear from the graph (figure 1) and the assessments of the different factors for the subject informatics visible on it, that the students assess the factors IP3 (attractiveness of the school tasks solutions) and IP4 (presentation of the subject matter by a teacher) rather positively (scale median 1 and the middle 50 % of the assessment values reached the scale range from 2 to -1 within the scale limit values from 3 to -3). Further positive assessment was recorded also in the item IP6 (utilization of the obtained knowledge for learner´s future use). The scale median is equal to 2 and the middle 50 % of the assessment values reached the scale range from 3 to 0 within the scale limit values from 3 to -2. Taking into account a relatively high value of the total assessment we can say that students consider knowledge obtained within the subject informatics to be necessary and useful for their further life in society, as the introduction of the information and communication technologies into all economy or social areas is being more and more implemented. Analysing results of students` assessments for each factor we recorded the highest assessment values in the factor items IP1, IP2, IP5 and IP7 (scale median 2), in which the respondents evaluated attractiveness of the subject matter, popularity of the school subject (informatics), teaching aids used in teaching informatics and possibilities to apply knowledge obtained in this subject in solving practical tasks.

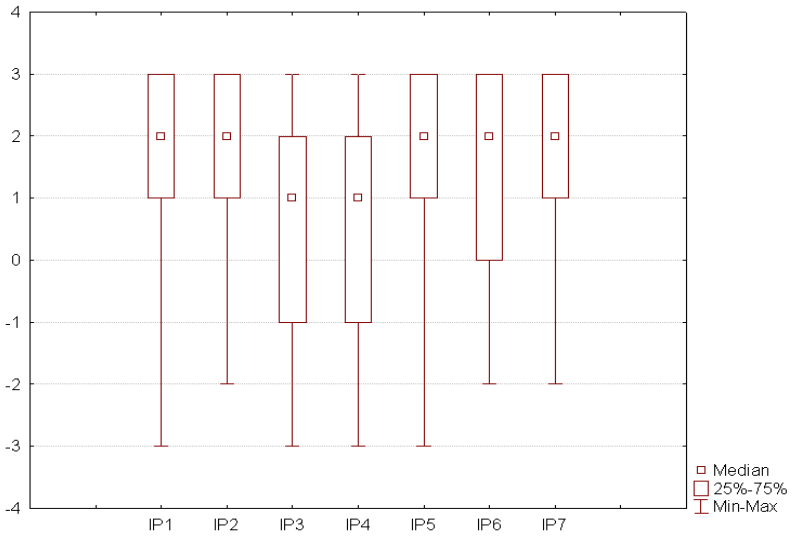

Figure 1. *Box and whisker plot for the subject informatics– graphical presentation of differences in the determined items assessments*
(determined items: IP1 – attractiveness of the subject matter content, IP2 – popularity of the school subject, IP3 – attractiveness of teaching tasks solutions, IP4 – presentation of the subject matter by a teacher, IP5 – attractiveness of the used teaching aids, IP6 – applicability of the obtained knowledge for learner´s future use, IP7 – applicability of the obtained knowledge in practical tasks solution)

The graphical presentation of students` assessments related to each determined item for the subject programming is expressed in figure 2.

The graph 2 and the values of the quartile intervals of the particular factors presented in it show that the most homogeneous students` answers were recorded in the items PP2, PP5 and PP7 (middle 50 % of the assessment values reached the scale range from 3 to 1 within the scale limit values 3 – (-3)). A greater heterogeneity of the students` answers was recorded in the items PP1 (middle 50 % of the assessment values reached the scale range from 3 to 0 within the scale limit values 3 – (-3)) and PP4 (middle 50 % of the assessment values reached the scale range from 2 to -1 within the scale limit values 3 – (-3)). The most diversified respondents` answers occurred in the items PP3 and PP6 (middle 50 % of the assessment values reached the scale range from 3 to -1 within the scale limit values 3 – (-3)). These where the items in which respondents expressed their ideas about attractiveness of the teaching tasks solutions and about possible utilization of the gained knowledge in their own future life or carreer.

The statistical data collected from the respondents show that there is a relative accord of motivational force hierarchy order of the determined motivation. The most influential motivation factor within the observed ones was identified utilization of the obtained knowledge in practical tasks solving. The coefficient of the total assessment for this factor reaches the highest values in both subjects (informatics 2,06 and programming 1,50 - see the values in the table 1). An interesting finding is connected with the assessment of motivation through the utilization of the obtained knowledge at practical tasks solving. The factors P6 - utilization of the obtained knowledge for learner´s future (IP6 - 1,45 and PP6 - 1,06) and P2 - popularity of the subject (IP2 - 1,48 and PP2 - 1,18) were scored less then the motivational factor P5 – attractiveness of teaching aids used in the teaching process (IP5 - 1,53 and PP5 - 1,44).

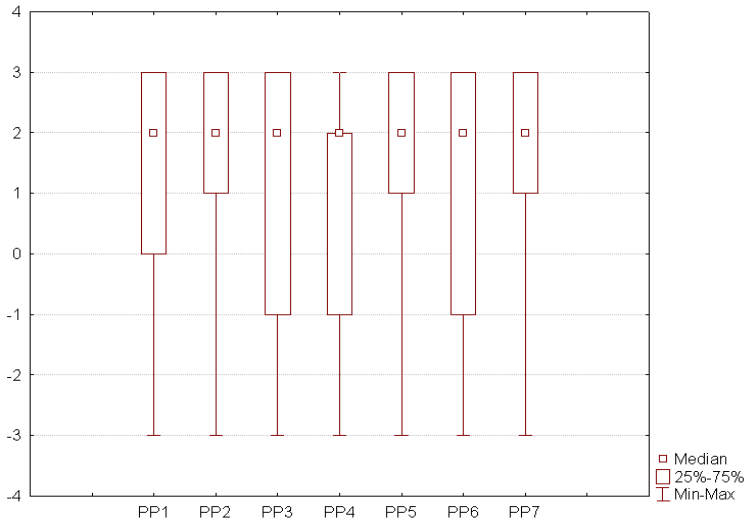

Figure 2. *Box and whisker plot for the subject programming – graphical presentation of differences in the determined items assessments*
(determined items: PP1 – attractiveness of the subject matter content, PP2 – popularity of the school subject, PP3 – attractiveness of teaching tasks solutions, PP4 – presentation of the subject matter by a teacher, PP5 – attractiveness of the used teaching aids, PP6 – applicability of the obtained knowledge for learner´s future use, PP7 – applicability of the obtained knowledge in practical tasks solution)

Considering students` evaluation of the fifth item for both subjects - informatics and programming, we came to a conclusion that one of the most significant factors highly influencing the quality and the level of teaching these subjects is the extent of the use of attractive teaching aids in teaching process. The graph in figure 3 shows that students find the teaching aids used during teaching informatics *attractive/interesting* (30,2 %) or even *very attractive/interesting* (29,1 %). An interesting percentage picture represents the other group of students. This is the group of the respondents who evaluated attractiveness of the used teaching aids as *rather unattractive/uninteresting* (5,8 %), *unattractive/uninteresting* (7,0 %) and *very unattractive/uninteresting* (1,2 %).

Different motivational factors – the questionnaire items don't have a normal (symmetrical) distribution that we can see in the histograms placed through the expected normal distribution.

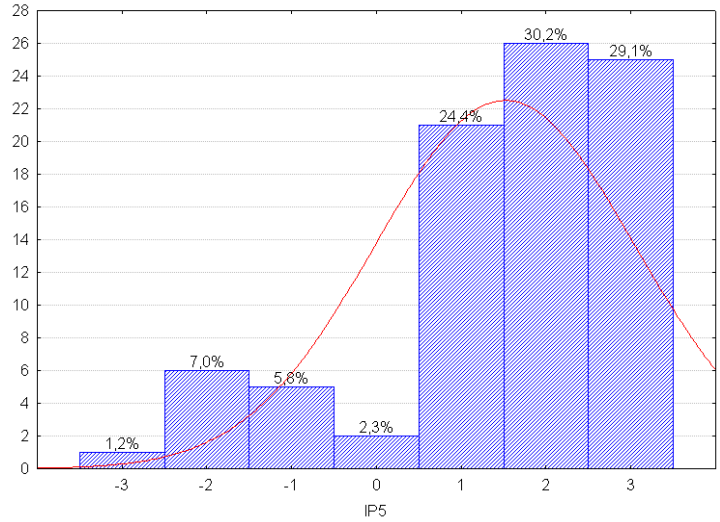

Figure 3. *Histogram of the item IP5 - attractiveness of the teaching aids used in teaching informatics*

Nowadays the use of interactive electronic teaching aids in teaching should be an integral part of teaching any lesson regardless of school subject or its content. At present there is an adequate amount of attractive teaching aids relevant to each level of the school system on offer. Their proper and reasonable application into teaching process helps learners to acquire and remember knowledge, facts and causalities in an easier way and for a longer time. In this context the use of interactive boards seems to be one of the most significant up-to-date trends in utilization of modern teaching aids (Brečka, Koprda, Maroš, 2009). In our opinion the level and the quality of interactive teaching are often higher than it is in case of the traditional teaching. Furthermore, besides the increased learners` knowledge level, intensive experience gained at such lessons also helps to develop emotional and creative traits of students` personalities. Interactive object-lesson teaching delivered to learners with the use of attractive teaching aids and multimedia educational programmes leads to higher motivation and activation of learners in lessons, and it also develops their independent way of their thinking.

A characteristic feature of the assessment of all the observed motivation factors in the subject informatics is a fact that the coefficients of the positive assessment have reached significantly higher values than the coefficients of the negative assessment (1,99 : -1,50; 1,97 : -1,46; 1,95 : -1,67; 1,92 : -1,78; 2,06 : -1,67; 2,31 : -1,30; 2,31 : - 1,17). This is what we consider to be an interesting and very positive finding. As to the subject programming the same can be stated for the motivation factor attractiveness of teaching tasks solutions (2,26 : -1,00), way of presentation of the subject matter by a teacher (2,10 : -2,06), attractiveness of the used teaching aids (2,13 : -1,6), utilization of the obtained knowledge for learner´s future (2,33 : -1,82) and utilization of the obtained knowledge in practical tasks solving (2,34 : -1,50).

The graphic presentation (figure 4) of the results collected from the respondents` assessments of the first item in the questionnaire related to the subject informatics (item P1 – *How do you evaluate different school subjects from the view point of their subject matter?*) shows that crucial number of the respondents expressed their rather positive attitude to this subject. In the evaluation they declared sufficient interest in the educational content of this subject. More than three quarters of the respondents (83,7 %) expressed positive attitude to the issue of the attractiveness of the subject matter which is taught within the subject informatics. Only a small part of the respondents (4,6 %) expressed rather negative or even absolutely negative attitude to this item.

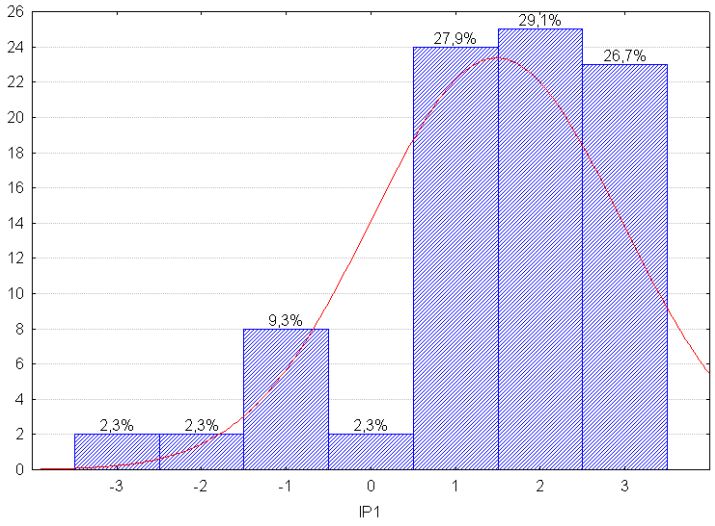

Figure 4. *Histogram of the item IP1 – attractiveness of informatics subject matter*

An analogical situation was obtained after analysing students` answers related to their evaluation of the subject matter taught within the school subject programming. The result of the processed data is presented graphically in the histogram in figure 5.

In teaching programming students learn knowledge necessary to create programme algorithms; they learn how to write them down formally, how to adapt them and how to document programmes. They learn basic methods of problem analysis and learn how to design simple programmes. They use basic control statements, control blocks, block repeating, algorithm branching and simple and some composite data types. They model simple systems through problem decomposition.

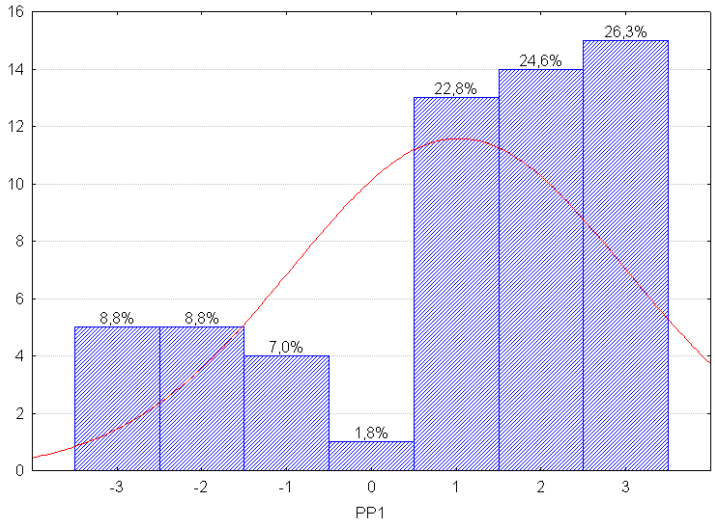

Figure 5. *Histogram of the item PP1 - attractiveness of the programming subject matter*

The topic about the content of teaching informatics at upper secondary comprehensive and technical schools is often beeing discussed and solved not only in subject committees of schools but also in professional journals and at workshops and conferences. A close look at the informatics curricula, in connection with the obtained results, naturally leads to an important question and objection whether the number of lessons allocated for teaching the topic algorithm design and programming is sufficient. Currently less and less attention is paid to algorithm design teaching in the subject informatics at schools. This fact is remarkable mainly in one-year informatics courses at some secondary vocational and technical schools. The informatics curricula of these schools do not comprise any or only a little reference to algorithm design. Definitely a great number of objectors of such approach could be found but we are convinced that teaching algorithm design at least at a minimal level is an unseparable part of teaching the subject informatics. More or less algorithmical thinking and problem solving is the most typical feature of informatics as a science branch which differentiates it from other sciences. To understand, for example, a relation “language – grammar – automatic machine” or “determinism – nondeterminism” is a difficult problem even for higher education students. But despite of this fact students considering continuation of informatics study at universities should be given a chance to gain some idea about these topics already in upper secondary comprehensive and technical schools. Students are usually not aware of the fact that informatics as a science branch is interconnected with mathematics (algebra). Their idea about studying informatics at a university is, in a better case, linked to programming. Unfortunately, most of them imagine informatics study to be something like assembling hardware components, building computer networks and partially they connect it with some work in application software environment.

In this context it is very interesting to compare results of the assessment of the motivation strength of the factor of attractiveness of informatics (figure 4) or programming (figure 5) subject matter and of the popularity of the school subject mathematics (figure 6) for the same group of the respondents.

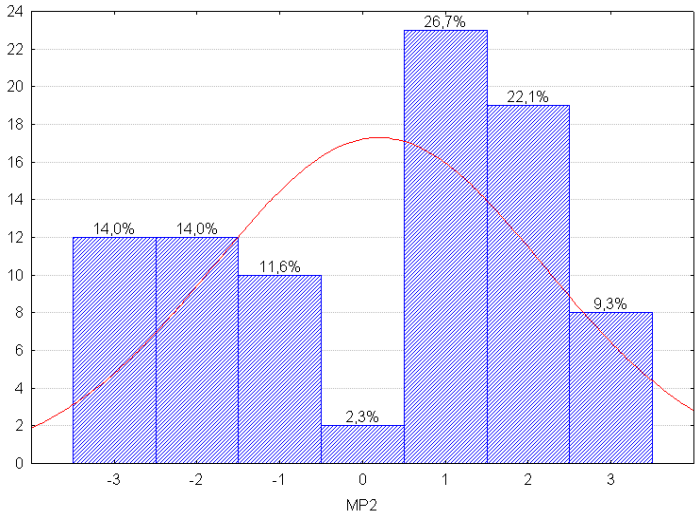

Figure 6. *Histogram of the item MP2 - popularity of the subject mathematics*

The histogram in figure 6 shows how the same respondents assessed their attitude to mathematics. We can see that the respondents evaluated their attitude to school subject mathematics rather negatively. Data show that 58,1 % of the students marked mathematics as the subject they do not like or do not like at all. Proportions of the students who included mathematics to subjects they like and like very much are the same (14,0 %).

Based on the above-mentioned facts we are convinced that as to informatics curricula it is necessary to emphasize mainly principles and not technologies (software products). Unfortunately, these technologies, instead of principles, are more and more becoming part of informatics teaching at our upper secondary (all of them – comprehensive, technical and vocational) schools. The current state of art is that principles of programming algorithm design in informatics curricula are neglected and teachers rather try to make students aware about concrete examples of application programmes. For example, the work with a concrete software product is being taught instead of principles of 2D and 3D computer graphics. Only a few of these software applications contribute to students` algorithmical thinking development (with an exception of programming in database systems or macroinstructions, if the subject is being taught up to such extent). If we teach students to work with a concrete software product, at the first glance it can give them a great advantage, because without any further study they will be able to employ themselves on labour market. But this will happen a very limited period, as these products will very soon be replaced by other technologies. Educational content of the subject informatics and content of so-called information literacy are, in this sense, relatively incompatible and the question is whether they should not be taught separately as two different subjects. On the one hand the target groups in informatics education are different as far as their study orientation and professional profile. On the other hand in relation to development of information literacy (development of general educational background in the area of information literacy), we do not differentiate target groups of students according their study orientation, i.e. the education aims all of them and more or less is the same. This means that in case of informatics we have in mind education in an autonomous science branch whereas in case of information literacy we have in mind socially required knowledge and skills of any school graduate.

A quick look at low values of the coefficients which the total assessment reached for the factor of the way in which a teacher presents the subject matter (IP4 0,91 and PP4 0,83) and attractiveness of the teaching tasks solved (IP3 0,92 and PP3 1,17) at informatics and programming teaching (table 1) may suggest it to be a negative result. Within the total results these values can lead to false conclusions about insufficient pedagogical mastery of teachers, low quality of education or to the idea of incompetent informatics and programming teaching. However, it is not possible to agree with such quick consclusions. The values of the coefficients of positive assessment are the evidence, which

disapproves such statements. The value of the positive assessment of the teacher's way of subject matter presentation in case of informatics is 1,92 and in the subject programming it is 2,10. These values prove a very good mastery of our teachers and an appropriate quality of the teaching they carry on. Presumably, the problem is in certain negative attitude of those students who do not (a priory) find the presented subject matter to be useful and practically applicable for them. This means that those students who evaluate use of the taught knowledge both for practical tasks solving and for their own future use negatively, lack internal motivation to learn the subject and many times they put automatically themselves into a position of a bored recipient or a recipient with excessive requirements on him.

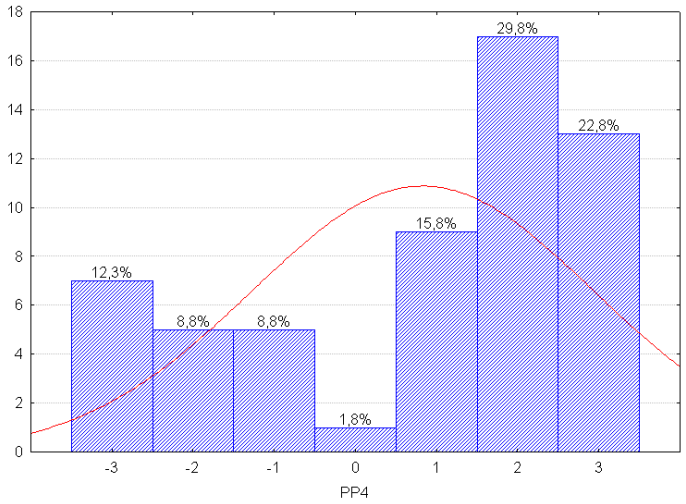

Figure 7. *Histogram of the item PP4 - teacher's presentation of subject matter in the subject programming*

The histogram in figure 7 shows that crucial number of the respondents (68,4 %) assessed the way in which their teachers present the subject matter to them positively. From this fact we deduce that object-lesson form and methodology of the subject matter mediation carried out by teachers who teach the lessons enable students to acquire presented new knowledge and to develop required skills on an appropriate level and quality.

Here another objection against the discussed results could be raised. The objection could address appropriateness to compare the obtained hierarchies of the observed motivation factors for the subjects informatics and programming, if they were collected from unequal research samples of respondents. Whereas the research sample for the subject informatics consisted of both students with study orientation on informatics and programming, and foreign language teaching, the research sample for the subject programming consisted only of students with study orientation on informatics and programming. Intensity of the observed motivation factors for the subject programming was assessed only by students with orientation on informatics and programming because the students with extended foreign language teaching curriculum do not have programming in their curricula. It is highly probable that a part of respondents from the group of students attending the class with extended foreign language teaching curriculum when assessing importance of the individual motivation items for their personalities did not link informatics directly with their future professional carreer. However, with regard to a relatively high score of the final total assessment (1,45) it is clear that also these students consider knowledge gained in the subject informatics to be necessary and useful for their further life in society as the implementation of information and communication technologies into all areas of society and fields of economy is still being intensified. Despite of that there is a big difference in evaluation of this item by the group of students streamed in informatics and programming and the group of students with extended foreign language teaching curriculum. If the study orientation of the part of respondents who evaluated the motivation factors of the subject informatics could influence their assessment of individual items, in the evaluation of the motivation factors in the subject programming this attribute

does not play any role, as in this case only the students attending class with study orientation on informatics and programming assessed the observed factors. Considering the different orientation of the respondents, a suprising result is the fact that in case of the subject informatics for a „more universal“ sample of respondents attractiveness of the used teaching aids and utilization of the obtained knowledge for their own future are equally strong factors (1,53 ~ 1,45), whereas in case of the subject programming for the „computer study oriented“ sample of respondents attractiveness of the used teaching aids remarkably exceeded the importance of the utilization of the gained knowledge for their future professional carreer (1,44 a 1,06).

4. Conclusion

On the basis of the presented results it is evident that informatics and programming as technical subjects in the contrary to natural science subjects (chemistry and physics) do not currently belong to those school subjects to which the youth has any serious negative attitudes. In their case as well as in the case of the natural science subjects one of the most significant motivation factors for the acquisition of the relevant subject knowledge is the students` awareness of its meaningfulness and applicability of the acquired knowledge in possible use either in students` future career or in practice. Our findings are comparable with the findings of the Slovak State School Inspection. In its report about the state of up-bringing and education in upper secondary comprehensive schools in the academic year 2007/2008 based on the complex inspections performed in 31 upper secondary comprehensive schools in Slovakia the Inspection states that the desired quality of practical applications of the theoretical knowledge is not achieved in all lessons and that despite of good working climate and effective use of the teaching aids the quality of education is often lower due to an insufficient motivation of students.

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