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A Comparison of Informatics Skills by schooltypes in the 9-10th grades in Hungary

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Abstract: The students can enter higher education after high school or vocational school. The learning material is the same in Computer Science education, but what the students in high school learn in the 9th grade, those in the vocational school learn it in the 9-10th grades. The students have to be same knowledge level at the end of secondary grammar school, if they did not choose the special training of this subject. I wanted to analyse the computer science knowledge in the 9th -10th grades, because I wanted to see the difference in informatics skills of students from different schooltypes. Why is this important? I think the same learning material in these grades will give the same results in knowledge level, so this was my starting hypothesis. An analysis of informatics skills by schooltypes in secondary grammar schools was made with the help of a web based Informatics Test. After composing an on-line test on the base of the National Curriculum I analysed how effectively can students of different grades answer questions dealing with different subjects**.** From different towns of Hungary over 60 teachers used the test to see the knowledge level of more than 1000 students having answered these questions, but I needed only the answers coming from the 9th -10th grades now. After the evaluation of the test results the correctness of the original presumption emerged. First the Kolmogorov-Smirnov-test **was used** to see if the groups showed standard normal distribution in answering the questions. The means of the correct answers by schooltypes were examined using a Z-test with two parameters and the Eta-squared calculated revealed how much schooltypes influenced the difference of means. Significance level was 5% through the analysis. Significant divergence by schooltypes was not found in the 9th grade and just in the topics word processing and spreadsheet calculation was found a weak or middle weak connection between schooltypes and knowledge level showing the hypothesis being correct. As a second result of this analysis I found some difference between the taught material and that of the National Curriculum.

Keywords: computer science knowledgement, secondary grammar school, Hungary

I. INTRODUCTION

I made the comparison of informatics skills by schooltypes in the first two years of secondary grammar school, because I wanted to know whether the hypothesis that students from these schooltypes have the same knowledge level in computer science was true or not (see Figure 1, The Education system in Hungary) [1].

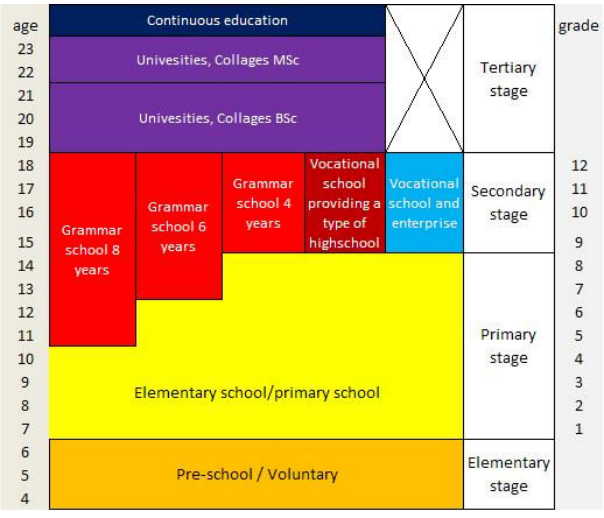

Figure 1. The Education system in Hungary

The audit was extended to all subjects of CS as described in the National Curriculum in Hungary. I composed an on-line test on the base of the National Curriculum and I analysed how effectively can students of different grades answer questions from different subjects [2]. The web-based format meant they could face the questions in a different order so they could not help each other. A further benefit of the web-based questionnaire was that students could complete the test at home too, not only in school where time was generally limited [3].

65 registered teachers participated in the test, all of them from different schools. According to the database of the test, the test was filled in by 1127 students throughout Hungary (see Figure. 2, prepared using google-analytics) during school classes of the 9th-12th grades [4] [5]. I used only answers from the 9th-10th grades in this article, because this was important to me.

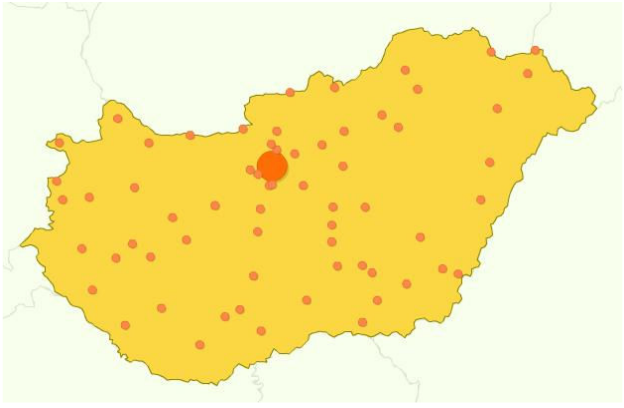

Figure 2. The distribution of schools using the Test

II. COMPUTER SCIENCE EDUCATION IN HUNGARY

Computer science education is based on a National Basic Curriculum (NBC) in Hungary.
According to this curriculum the use of computer science is to be demonstrated in the first four school grades since 2003 (e.g. searching the Internet, painting with computers etc.) and is taught in 1 hour weekly [6].

According to the NBC the following subjects are taught from the 5th grade to the 12th grade at the schools of Hungary:

- Word processing
- Spreadsheet calculation
- Presentation
- Algorithm and programming
- Database management

Generally the Microsoft Office packet is taught and it can be seen that teaching Word processing takes 4 years (Table I.).

Basic algorithms or rather programming appears in Computer Science sooner, but recursion, list and tree data structures are only selectable part of the curriculum. Database management begins in the 9th grade.

In the5- 6th grades CS is taught in 18 hours, in the 7-8th grades in 37 hours per year.

My earlier analysis of the test results showed students from grammar school have not better CS skills than students from elementary school [7].

In high schools it is taught in the 9th grade in 74 hours, but in vocational schools in the 9-10 grades there are only 37 hours a year. The learning material is the same in all secondary grammar schools, but in high school CS is taught only one year though the number of classes are doubled.

In Hungary CS is just selectable in the 11-12 grades.

On basic level it is taught in 2 hour per week, on a higher level in 3 hour per week and a final exam can be taken.

Table I. The subjects of CS by grades in Hungary

Subject	Grade							
	5	6	7	8	9	10	11	12
Word processing								
Spreadsheet calculation								
Presentation								
Algorithm and programming								
Database management								

III. THE TEST

The idea was to prepare a web-based on-line question form with many test questions and to have students from all regions of Hungary to answer it in all grammar school grades. Why web-based? Because when on paper, all students get the questions in a fixed order and they have to fill in during lesson time. When web-based they get it in a different order, so they can't help each other. Another positive aspect of web-based tests is that it can be filled in at home too so it doesn't take the teacher's time at school.
The students filling in the test first have to give their actual grade and some other data (Figure 3.).

Name is not required data, so the test can be filled anonymously. *Sex* is important in our case, so it is required data in order to see how many girls or boys filled in the test [8] [9]. If students give the username of their teacher than the teacher can also see how they succeeded and gets feedback on their progress. *Province* is also required to choose in order to make a comparison of the various regions. *Schooltype* can be secondary school, high school or university. *Grade* is important because he/she will get a question sheet depending on the level of the grade given. Because the same questions are put in a different order in all test forms even if students are writing the test at the same time and in the same room they will not be able to help each other.

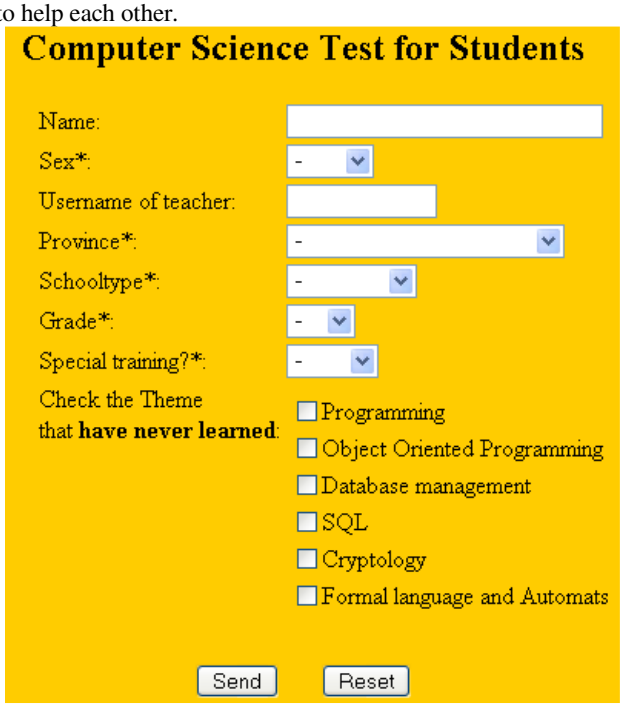

Figure 3. Data of students

The numbers of questions in different Grades were:

- 5th Grade: 11 questions
- 6th Grade: 26 questions
- 7th Grade: 70 questions
- 8th Grade: 113 questions
- 9th Grade: 136 questions
- 10th Grade: 137 questions
- 11th Grade: 151 questions

Special training means having learned computer science in more lessons than at basic level. (Anyhow, nobody marked this.)

The categories asked about in the test were as follows:

- Basic computer science
- Office packages
- Programming
- Object oriented programming
- Database management
- SQL
- Cryptography
- Formal languages and automats

The students can check topics (except basic computer science and office packages) not taught to them. If they check one, the system would not ask questions dealing with the topic but save it with the answer „I've never learned that". With this option students get fewer questions and answers would flow in at a quicker pace. Next, students can begin to fill in the test.

Every test question has 6 possible answers, only one of which is correct, 3 of them bad, and the 5th choice is: „I've

never learned that", the 6th is: „I've forgotten it". The answers „I've never learned that" and „I've forgotten it" show which part of the curriculum have the students learned in that grade and if they could remember it or not.

Every question has two time limits given in seconds. The first is the minimum time to read, understand and answer the question, the second is the maximum answering time. The software will save the total time used by the student. These time limits are not seen or known by the students. These are used during the evaluation so the correct answer is accepted only if it arrives in the available time interval. Teachers can register on this site too if they are willing to give some of their data. The system is protected by registration code, and registered teachers can log in with username and password. If a student filling in the test gives the username of the teacher too, than the teacher can later see his/her answers and results. Some reports are helping the work of the teacher.

IV. TEST RESULTS

A. *Number of Participiants*

The web based test was filled out by students of various grades summarized in the following table (Table II.).

Table II. The distribution of the students by schooltypes and grade

Grade	High school	Vocational school
9	355	144
10	112	165
11	32	115
12	104	100

According to the table big difference can be seen in the number of participants by schooltypes in the 9th and 11th grade. I analysed just the first two years, because I wanted to know what knowledge differences will show between students from different schooltypes in the next academic year.

B. *Results by subjects*

The following tables show the results by schooltypes in 9th grade depending on grade and subject (Table III, Table IV). The mean shows how many quastions could the students answer, the next column shows the ratio in percentage and the next one shows the standard deviations.

Table III. . Results by schooltypes in 9th grade (Highschool)

		Highschool		
Subject	Number of questions	Mean	%	Std. dev
Theoretical knowledge	46	11,0	23,9%	6,63
Word processing	14	5,7	40,8%	2,77
Spreadsheet calculation	9	2,1	23,2%	1,77
Database management	18	1,0	5,8%	2,08
SQL	14	0,1	0,5%	0,52
Programming	26	0,3	1,1%	1,23

Table IV. . Results by schooltypes in 9th grade (Vocational school)

		Vocational school		
Subject	Number of questions	Mean	%	Std. dev.
Theoretical knowledge	46	11,6	25,2%	6,39
Word processing	14	5,2	36,9%	2,51
Spreadsheet calculation	9	1,9	21,1%	1,70
Database management	18	0,4	2,4%	1,18
SQL	14	0,0	0,1%	0,17
Programming	26	0,8	3,1%	2,13

According to the table, at first look we can not see big differences between the schooltypes, but we have to make deeper analysis to verify this impression. As regarding various subjects, we can see a big break in successful answers from database management. Compared to subjects learnt earlier where students gave correct answers in more than 20%, there is strong decrease in the numbers of successful answers. This means that against all of the directions of the National Curriculum teachers did not taught all parts of Computer Science.

The following tables show the results by schooltypes in 10th grade depending on grade and subject (Table V, Table VI).

Table V. Results by schooltypes in 10th grade (Highschool)

		Highschool		
Subject	Number of questions	Mean	%	Std. dev
Theoretical knowledge	46	12,4	27,1%	7,90
Word processing	14	5,9	42,4%	3,22
Spreadsheet calculation	9	3,0	33,8%	2,09
Database management	18	2,5	13,9%	2,91
SQL	14	0,3	2,4%	1,26
Programming	26	1,3	5,2%	3,58

Table VI. Results by schooltypes in 10th grade (Vocational School)

		Vocational school		
Subject	Number of questions	Mean	%	Std. dev.
Theoretical knowledge	46	10,1	21,9%	4,95
Word processing	14	4,3	31,0%	2,30
Spreadsheet calculation	9	2,2	23,9%	1,41
Database management	18	1,1	6,4%	2,25
SQL	14	0,1	0,4%	0,39
Programming	26	0,3	1,1%	1,20

According to the table the situation, at first, looks the same in this grade. Regarding the various subjects, we see an advance of successful answers in database management, but the proportion of successful answers by schooltypes is similar to that in the 9th grade. This means teachers have enough time to begin teaching database management in this grade now, one year later then National Curriculum orders it.

C. *Monitoring the standard normal distribution*

To compare the means by schooltypes we needed to confirm that the groups show standard normal distribution in answering the questions. We used the Kolmogorov-Smirnov test to decide [10]. As everyone answered the theoretical questions we used those as basic datas, because other subjects were markable as "I have never learned that".

The null hypothesis was that there was not significant difference between the standard normal distribution and the results of the schooltypes. The monitoring was held on the p=5% significancy level in the two schooltypes. The following table shows the maximum values of level p by schooltypes (D_{max}), and the critical values of the Kolmogorov-Test (D_{crit}). If

the turnout is less than the critical value of the Kolmogorov-Test, we may keep the null hypothesis, and the samples follow the standard normal distribution (Table VII.)

Table VII. The results of Kolmogorov-Test

Grade	Schooltypes	D_{max}	D_{crit}	Decision
9	Highschool	0,07	0,8	keep the null hypothesis
9	Vocational school	0,05	0,11	keep the null hypothesis
10	Highschool	0,08	0,13	keep the null hypothesis
10	Vocational school	0,04	0,11	keep the null hypothesis

According to the table results by schooltypes in the 9th and 10th grades show the calculated values less than the critical values of the Kolmogorov-test on the 5% significancy level, so the muster follows normal distribution.

D. Analysis of the means by subject

The next step in the analysis is to inspect whether the means by subject are equal using a Z-test [11].

The null hypothesis is that no significant difference exists between the means by schooltypes. The monitoring was held on the p=5% significancy level. The critical value of Z-test was between -1,96 and 1,96 on the p=5% significancy level. If the calculated value of Z-test falls in this range, we can keep the null hypothesis. The following tables show the calculated values of Z-test in the 9th grade and the decision on keeping or not the null hypothesis (Table VIII.).

Table VIII. Scores of the Z-test between schooltypes in 9th grade

Subject	Value of Z-test	Decision
Theoretical knowledge	-7,19	The means are not equal
Word processing	-14,50	The means are not equal
Spreadsheet calculation	-9,10	The means are not equal
Database management	-1,91	The means are equal
SQL	-0,38	The means are equal
Programming	-3,86	The means are not equal

We can say by p=5% significancy level that the four subjects where students of high schools and students of vocational schools are on different knowledge levels was theoretical knowledge, word processing, spreadsheet calculation and programming. This may be the consequence of the difference in weakly classes on behalf of highschools.

The following tables show the calculated values of Z-test in the 10th grade and the decision on keeping or not the null hypothesis (Table IX.).

Table IX. Scores of the Z-test between schooltypes in 10th grade

Subject	Value of Z-test	Decision
Theoretical knowledge	0,43	The means are equal
Word processing	-6,37	The means are not equal
Spreadsheet calculation	-6,46	The means are not equal
Database management	-1,01	The means are equal
SQL	-0,16	The means are equal
Programming	0,52	The means are equal

We can say by p=5% significancy level that the two subjects where students from high school and students from vocational school were not on the same knowledge level was word processing and spreadsheet calculation. These results show differences in just two subjects at this grade. The reason can be that CS teaching was finished at vocational schools in this year with same material as at high schools one year earlier.

More analysis of these subjects is needed to see if there is a strong connection between schooltypes and CS knowledge level or not.

E. Measures of association

Earlier we saw there exists a difference of means in some subjects at the 9th-10th grades of secondary grammar schooltypes. In this case we can establish the influence of the chosen group on the calculated means with the calculation of the Eta-squared (H^2) [12]. For the calculation of the Eta-squared first we calculate the main mean ($\bar{\bar{x}}$), where n is the pieces of musters, $\bar{x}$ is the mean of the musters, m is the number of musters (1).

$$\bar{\bar{x}} = \frac{\sum_{j=1}^{m} n_j \bar{x}_j}{\sum_{j=1}^{m} n_j} \tag{1}$$

We have to calculate the values of the variance Between-Groups Sum of Squares (SSB) (2) and the variance Within-Groups Sum of Squares (SSW) (3), where the standard deviation (s_j) of musters appears in the formula:

$$SSB = \frac{\sum_{J=1}^{m} n_j (\bar{x}_j - \bar{\bar{x}})^2}{\sum_{j=1}^{m} n_j} \tag{2}$$

$$SSW = \frac{\sum_{j=1}^{m} n_j s_j^2}{\sum_{j=1}^{m} n_j} \tag{3}$$

The Total Sum of Squares (SST) is the summation of the variance between groups and the variance within groups (4).

$$SST = SSB + SSW \tag{4}$$

The following tables show the calculated values in the 9th and 10th grade (Table X, Table XI).

Table X. Calculated values of main means and variances in 9th grade

Subject	$\bar{\bar{x}}$	SSB	SSW	SST
Theoretical knowledge	11,17	0,08	6,57	6,64
Word processing	5,56	0,06	2,70	2,76
Spreadsheet calculation	2,03	0,01	1,76	1,77
Programming	0,43	0,05	1,50	1,55

Table XI. Calculated values of main means and variances in 10th grade

Subject	$\bar{\bar{x}}$	SSB	SSW	SST
Word processing	4,99	0,61	2,69	3,30
Spreadsheet calculation	2,51	0,19	1,70	1,89

The value of the Eta-squared (H^2) is the quotient of the variance between groups and the total deviation quadrate (5).

$$H^2 = \frac{S_k}{S} \quad (5)$$

The calculated value in percentage shows how much the grouping influences the difference between means. Square root from the Eta-squared (6) gives a value between 0 and 1 (H),

$$H = \sqrt{H^2} \quad (6)$$

This shows the measures of association, how strong the connection is between grouping and the achieved result. The more it achieves the stronger the connection. The next tables (Table XII, Table XIII.) show the calculated values and the strength of the connection.

Table XII. How strong the connection is between the grouping by schooltypes in the 9th grade

Subject	H^2	H	Strength of the association
Theoretical knowledge	1,14%	0,11	no connection
Word processing	2,24%	0,15	no connection
Spreadsheet calculation	0,40%	0,06	no connection
Programming	3,28%	0,18	no connection

Calculating the Eta-squared we can see that the four subjects discussed earlier show no difference by schooltypes in 9th grade. This means there is no difference between students' CS knowledge at different schooltypes in the 9th grade.

Table XIII. How strong the connection is between the grouping by schooltypes in the 10th grade

Subject	H^2	H	Strength of the association
Word processing	18,51%	0,43	middling weak connection
Spreadsheet calculation	10,17%	0,32	weak connection

The values of the Eta-squared of these two subjects (word processing and spreadsheet calculation) shows a difference by schooltypes in the 10th grade. This value in the case of word processing is more than 18% meaning a middle weak correlation exists between the subject and schooltype. The strength of the association in the case of spreadsheet calculation is lower. The value of Eta-squared is ~10% which means a weak correlation exists between the subject and schooltype.

After the analysis we can say the CS knowledge level is same in the 9th grade at high school and vocational school. In the 10th grade we can recognise a weak connection between schooltype and knowledge level. The students at high school have better results in word processing and spreadsheet calculation. The number of successful answers are the highest in these two subjects which means this is the area where teachers at secondary grammar schools are successful despite of deviating the orders of the National Curriculum.

F. Correlation between the wordprocessing knowledge and the spreadsheet calculation knowledge

A partial correlation calculation was done regarding the subjects in order to do a deeper analysis of the results by schooltypes (Table XIV, Table XV, Table XVI, Table XVII) [Falus-Ollé, 2008].

Table XIV. Partial correlation between the subjects in the 9th grade of Highschool

Subjects	Control Variables	Th. k.	Word proc.	Spr. cal	Data. man.
Theoretical knowledge	Correlation	1	**0,500**	**0,494**	0,080
	Sig. (2-tailed)		0,000	0,000	0,123
Word processing	Correlation	**0,500**	1	**0,337**	-0,022
	Sig. (2-tailed)	0,000		0,000	0,666
Spreadsheet calculation	Correlation	**0,494**	**0,337**	1	0,045
	Sig. (2-tailed)	0,000	0,000		0,382
Database management	Correlation	0,080	-0,022	0,045	1
	Sig. (2-tailed)	0,123	0,666	0,382	

Table XV. Partial correlation between the subjects in the 9th grade of Vocational school

Subjects	Control Variables	Th. k.	Word proc.	Spr. cal	Data. man.
Theoretical knowledge	Correlation	1	**0,507**	**0,453**	0,053
	Sig. (2-tailed)		0,000	0,000	0,464
Word processing	Correlation	**0,507**	1	**0,278**	0,008
	Sig. (2-tailed)	0,000		0,000	0,916
Spreadsheet calculation	Correlation	**0,453**	**0,278**	1	-0,073
	Sig. (2-tailed)	0,000	0,000		0,314
Database management	Correlation	0,053	0,008	-0,073	1
	Sig. (2-tailed)	0,464	0,916	0,314	

According to the table the results by schooltypes in the 9th grade show positiv calculated values of correlation between theoretical knowledge and word processing, the calculated values show middle strong connection.

The strong of correlation is weak between word processing and spreadsheet calculation. We can recognise same results with earlier analysing, the students learn more theoretical knowledge and word processing, but is not in this grade enough time to learn everything from spreadsheet calculation what NBC declare.

We can not see connection between database management and the other subject it shows the earlier analysing results too, the students have not learned this subject. I have not analysed the programming and SQL subject, because the number of successful answers was very low. We can in this point declare again is not difference in 9th grade between Highschool and Vocational school.

Table XVI. Table 13. Partial correlation between the subjects in the 10th grade of Highschool

Subjects	Control Variables	Th. k.	Word proc.	Spr. cal	Data. man.
Theoretical knowledge	Correlation	1	**0,548**	**0,535**	0,191
	Sig. (2-tailed)		0,000	0,000	0,029
Word processing	Correlation	**0,548**	1	**0,492**	**0,303**
	Sig. (2-tailed)	0,000		0,000	0,000
Spreadsheet calculation	Correlation	**0,535**	**0,492**	1	0,198
	Sig. (2-tailed)	0,000	0,000		0,023
Database management	Correlation	0,191	**0,303**	0,198	1
	Sig. (2-tailed)	0,029	0,000	0,023	

Table XVII. Table 14. Partial correlation between the subjects in the 10th grade of Vocational school

Subjects	Control Variables	Th. k.	Word proc.	Spr. cal	Data. man.
Theoretical knowledge	Correlation	1	**0,285**	**0,294**	0,001
	Sig. (2-tailed)		0,000	0,000	0,993
Word processing	Correlation	**0,285**	1	**0,308**	**-0,259**
	Sig. (2-tailed)	0,000		0,000	0,000
Spreadsheet calculation	Correlation	**0,294**	**0,308**	1	-0,106
	Sig. (2-tailed)	0,000	0,000		0,159
Database management	Correlation	0,001	**-0,259**	-0,106	1
	Sig. (2-tailed)	0,993	0,000	0,159	

According to the tables the results by schooltypes in the 10th grade show some difference to 9th grade. The correlation is weak between theoretical knowledge and word processing and between theoretical knowledge and spreadsheet calculation. It is wronger then in Highschool.

We can recognise a new correlation between word processing and database management, but this value is positiv in Highschool and negative in Vocational school.

This can possibly mean that students in Highschool start to learn database management in this grade, the students in Vocational school learn more word processing and less database calculation.

V. SUMMARY

According to the hypothesis exposed in the introduction students from high schools have the same CS skills as students from vocational schools. Now we know our hypothesis was true. Analysis of the test results showed the students' informatics skills the same, independent of which type of secondary grammar school were they from. We found only in the 10th grade two subjects where high school students show better results, but generally only weak correlation exists between subjects and schooltypes.

The second result of the analysis was that we have seen by calculated means of the different subjects that directions of the National Curriculum are not entirely followed in CS. The knowledge of students was very poor in the subjects database management and programming. This means the number of classes per year is not enough to teach these subjects in secondary grammar school. Teachers can teach obviously only word processing and spreadsheet calculation in this grades and nothing more.

The partial correlation values show positive correlation between theoretical knowledge and word processing and spreadsheet calculation in Highschool and in Vocational school. This may mean students in secondary grammar school learn just this subject. The students from Highschool have more chance to learn database management and programming in the 10th grade , as against students from Vacational school, who learn more word processing but not to much database management and programming.

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