

PH.D. THESIS SUMMARY

**A Comparison of Hungarian and International
Information Technology Education**

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Introduction

The aim of this research is to compare the Hungarian and international Information Technology education examining the students' knowledge with a method developed by me.

At the beginning of the research my original aim was get acquainted with different education tools, but later this was expanded into examining how these tools could be integrated in the Hungarian education.

My knowledge of international Information Technology education broadened constantly in the course of the research. I got an insider's view of Information Technology education in China, Japan, and Taiwan as well as in Germany, Slovakia, Rumania and Austria.

The tool of comparison in the field of international Information Technology education was a web-based test I developed through the research. Since it is quite difficult to send out questionnaires physically to the various schools and the order of the questions cannot be changed in that case, and also because students sitting close to each other in the classroom can see the other's answers, so the most effective solution seemed to be a web-based Informatics test. The questions of the test were matched after the analysing of the learning material of different countries. With this tool I could analyse the Hungarian Information Technology education on a sample of students attending primary and secondary schools to those entering higher education.

The developed tool gave me the chance to compare the IT skills of Hungarian students and their Rumanian and Slovakian peers.

Future work is to make same comparison with German students. Unfortunately the number of students filling in the test did not reach yet the required amount.

The developed tool was presented in Austria too and some researcher interested for it to standardize the Information Technology Education.

All mine results are due to this tool and it could be instrumental in the hands of decision-makers of the education system. Part of mine results were published on the website of the Education-Office in Hungary.

Research methods

Questions of various difficulty were formed in the main topics of Information Technology in this research. The topics chosen were part of Informatics education in almost every country: theoretical knowledge, word processing, spreadsheet calculation, database management and programming. There can be significant deviations in the curricula of some countries; therefore the test was expanded with questions on cryptographical knowledge as well as formal languages and automats

since in certain German provinces these are also part of the Information Technology curriculum

The database structure for the test had to be planned in a suitable way so that the data could be obtained and used later on. The personal data of the students filling in the test were put in a separate table as well as their answers to the questions.

When filling in the test the students first had to give their actual grade and some other data (figure 1.). If students gave the username of their teacher then the teacher also could see how they succeeded and would get a feedback on their progress. *Grade* was important because he/she would get a question sheet depending on the grade given. Students could mark topics not taught to them (except basic information technology and office packages). If they marked one, the system would not ask questions dealing with the topic but saved it with the answer „I have never learned that“. With this option students got fewer questions and answers would flow in at a quicker pace. Next, students could begin to fill in the test.

Computer Science Test for Students

Name:

Sex*: -

Username of teacher:

Province*: -

Schooltype*: -

Grade*: -

Special training?*: -

Check the Theme that **have never learned**:

- Programming
- Object Oriented Programming
- Database management
- SQL
- Cryptology
- Formal language and Automats

Figure 1. Student's registration entries

Every test question has 6 possible answers, only one of which is correct, 3 of them bad, and the 5th choice is: „I have never learned that“, the 6th: „I have forgotten it“. The answers „I have never learned that“ and „I have forgotten it“ show which part of the curriculum the students have not 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 saves 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 a correct answer is accepted only if it arrives in the available time interval.

Finishing with the last question of the test a student can see his/her own results, i.e. how many correct and incorrect answers he/she gave and how many were marked as „I have never learned that”, or „I have forgotten it”.

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 their 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 the results. Some reports can be generated helping the work of teachers. It is recorded whether the students have given them the right to inspect. It is also indicated if they have marked a question as not learned or if the topic of the question is familiar to them but they have forgotten the right answer.

The evaluation of the answers is only possible after processing the saved data. The first step is to check whether the students of the given country have learned the given topic. If they have not, the comparison with the data of the students of other countries is impossible to make.

If the students knew the topic because they had learned it, the program checked if the time spent answering the questions was within the limits given. If so, the answer could be accepted as right.

The mean and the standard deviation of the right answers had to be calculated by the different school types and various grades in Hungary and other participating countries while making comparisons with the help of statistical means. In order to be able to do this, enough students filling in the test were needed in each grade. When comparing the IT skills of students in two countries, the Independent Samples T-test of SPSS was taken with $p=5\%$ significance level.

Results of the research

The results of this research are concluded in this part of summary. Monitoring was held on $p=5\%$ significance level in the whole analysing process. I used the Kolmogorov-Smirnov-test with z-test to compare the means of correct answers or I used the Independent sample test of SPSS to make decisions.

Results of Hungarian students

Information Technology education is based on a National Basic Curriculum (NBC) in Hungary.

According to this curriculum the use of information technology 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 0,5-1 classes a week.

According to the NBC the following subjects are taught from the 5th grade to the 12th grade at school:

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

In the 5- 6th grades IT is taught in 18 classes, in the 7-8th grades in 37 classes a year. In high school IT is taught in the 9th grade in 74 classes, but in vocational schools in the 9-10 grades there are only 37 classes a year. In Hungary IT is nothing but selectable in the 11-12th grades.

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

Measuring the Information Technology knowledge of participating students at the end of the primary stage in Hungary.

Student's informatics skills were compared by school types at the end of the primary stage to see the differences in these skills.

Hypothesis1: students of grammar schools have not better IT skills than students of elementary schools.

Because the learning material is the same in school type in the 11 – 14 year age group (5th to 8th grade), so an analysis of the knowledge level of students at the end of the primary stage (the 8th grade) was needed, just before they enter the secondary stage. The web based test was filled in by 52 students from the 8th grade of elementary schools and 69 students from grammar schools. The following analysis is based on these student's results.

The analysis of the test results showed the students' informatics skills not differing, so the original hypothesis proved correct.

The second result of the analysis was that - as calculated means of the different subjects showed - directions of the National Curriculum regarding IT are not entirely followed in the practice, something teachers should reckon with in the secondary stage.

A comparison of informatics skills by school types in the 9-10th grades in Hungary

Students can enter higher education after finishing high school or vocational school. Information Technology learning material is the same in both school types, but the topics students learn in the 9th grade of high school are taught only in the 9-10th grades in the vocational school. Further, at high school it is taught in 74 classes, but in vocational schools only in 37 classes a year.

IT is nothing but selectable in the 11-12 grades In Hungary. On basic level it is taught in 2 classes a week, on a higher level in 3 classes a week and a final exam can be taken.

Hypothesis 2: the participating students should be on the same knowledge level in the 9-10th grades of secondary grammar school if they did not choose a special training of this subject.

I analysed IT knowledge in the 9th -10th grades in order to see the difference in informatics skills depending on school type. I supposed the same learning material in these grades should result in similar knowledge level, therefore this was my starting hypothesis. The number of participants of this research in the 9th grade was as follows: 355 students from high school and 144 students from vocational schools, while in the 10th grade 112 students and 165 students, respectively.

Analysis of the test results showed the students' informatics skills similar, independent of school type. In the 10th grade two subjects (word processing and spreadsheet calculation) were found where high school students showed better results, but generally only weak correlation existed between subjects and school types.

The second result of the analysis was that directions of the National Curriculum are not entirely followed in IT. The knowledge of students was very poor in database management and programming. This means, the above number of classes a year are not enough to teach these subjects in secondary grammar school. Time is obviously enough only to teach word processing and spreadsheet calculation in these grades and nothing else.

Measuring Information Technology knowledge at the end of secondary grammar school in Hungary

A comparison of the informatics skills by school types was made at the end of secondary grammar school, in order to see if the next hypothesis is true:

Hypothesis 3: the participating students from high school should be on the same knowledge level in information technology as students from vocational schools at the end of secondary school.

The learning material is the same in this two school types, so I wanted to analyse the knowledge level of participating students at the end (the 12th grade) of secondary grammar school, before they enter higher education. The web based test was filled in by 104 students from high schools and 100 students from vocational schools.

Analysis of the test results showed the participating students' informatics skills similar, independent of school type, meaning there is no need of putting them in different courses when entering higher education.

Thesis 1: The participating students from high schools have the same IT skills as students from vocational schools at the end of secondary grammar school.

The second result of the analysis was that directions of the National Curriculum are not entirely followed in IT, something we must reckon with in higher education. The knowledge of students was very poor in database management and programming therefore we have to teach this topics from a basic level.

Decision about using the test in international comparisons

Hypothesis 4: The Informatics test developed is suitable to make international comparisons

This hypothesis is based on the Hungarian test results. If the first three hypothesis' are correct, we can use the web-test in international comparisons too.

The survey measuring the informatics skills of students entering the Bánki Donát Faculty of Mechanical and Safety Engineering at Óbuda University.

At the Bánki Donát Faculty of Mechanical and Safety Engineering students are graduating in Mechanical Engineering, Safety Engineering and Techtronic Engineering. Originally I supposed that the lowest results will be produced by students of Mechanical Engineering, while students of Techtronic Engineering would do the best at this Faculty.

Hypothesis 5: IT skills of mechanical engineers are the worst and the skills of techtronic engineers are the best at Óbuda University.

111 Mechanical Engineers, 41 Safety Engineers and 56 Techtronic Engineers filled in the test. This means that half of the first year's students took part in this research.

Results show that National Basic Curriculum specifications are not followed point by point in Information Technology. Word processing was learned by most of the students, but spreadsheet calculation looked quite neglected: ~10% of the students marked it as "never learned". The others could give correct answers in ~30% of the questions.

More than 29% of the students have never met database management not even in secondary grammar school. Those who learned it could answer 10% of the questions correctly.

More than 60% of the students have never learned programming, which shows, teachers in the secondary grammar school do not take care or do not have the opportunity to care with this topics. To teach the basics of database management, programming and object oriented programming is a further educational load on teachers since these topics are missing from the secondary education.

All in all it can be said there is no connection between the subjects and the chosen major: students enter the Bánki Donát Faculty of Mechanical and Safety Engineering at Óbuda University with the same IT knowledge. This is monitorable with the calculation of the deviation quotient. Our hypothesis was correct.

A comparison of informatics skills of Students entering BA and BSc studies

Earlier we have seen no recognizable difference in IT knowledge of BSc students of the same faculty. The next hypothesis inspects the situation in the case of BSc and BA students.

Hypothesis 6: It is not significant divergence in the IT knowledge of BA and BSc students at the time they enter higher education.

307 BA and 772 BSc students took part in this research and filled in the test. After having analysed the results no significant divergence was found in their IT knowledge. Teachers can anticipate the same IT knowledge level of any students entering the universities. It means the hypothesis was correct and together with the earlier hypothesis result shows that students finishing the secondary grammar school and entering higher education have the same IT skills. The results of a different grouping of the survey students participating make the first thesis still stronger.

All of these results of mine could be instrumental in the hands of decision-makers of the education system.

A survey measuring the informatics skills of Hungarian grammar school students by genders

The comparison was based on data obtained from secondary grammar schools, because experiences in higher education show that boys are learning programming easier than girls.

Hypothesis 7: the boys participating are better than girls in programming.

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

Table I. The distribution of the students by gender and grade

	Gender	
Grade	Boys	Girls
9	206	239
10	138	88
11	71	45
12	56	29

Significant divergence by gender was found in theoretical and programming knowledge of participating students. The hypothesis proved to be true and showed that the difference in skills between girls and boys is growing in the 11th grade. This suggests that girls need different methods when teaching programming. There are already some working examples abroad: an international Computer Science BSc for girls exists at the Hochschule Bremen in Germany which is very successful. All of the

students who qualify get a Computer Science job after having finished the school. It would be worth trying a similar teaching method in Hungary too.

Thesis 2: The boys participating in the survey get significantly better marks in programming than girls.

A comparison of informatics skills of participating students from Hungary and Slovakia.

The National Basic Curriculum of Hungary describes the learning material to teachers grade by grade, subject by subject.

The National Educational Program of Slovakia does not assign precisely what teachers have to teach in the various grades but announces the standards to be reached at the end of the senior section; the aim is to reach pre-set standards when leaving the school.

Information Technology education in Slovakia bears a close resemblance to the one in Hungary from the point of view of the materials discussed. Theoretical knowledge, word processing, spreadsheet calculation, database management and programming are parts of the curriculum in both countries.

Students filled in the web-test from the 5th grade in Hungary and in Slovakia, but comparison could be made only in the 5th and the 8th grades as well as in the first three years of the secondary school because of the low number of participants (Table II.). The participating Hungarian students were divided in two groups: one of them learned just the basic Information technology at school, while the other group choose Information Technology as an optional subject in the 11th and 12th grade.

Table II. The number of participants from Hungary and Slovakia

Grade	Hungarian		Slovakian
	Basic education	Informatics course	Basic education
5.	79	0	126
6.	14	0	114
7.	18	0	108
8.	169	0	50
9.	552	0	111
10.	302	0	97
11.	104	69	102
12.	212	91	21

Hypothesis 8: The participating Hungarian students have better IT skills than their Slovakian peers because there are more Informatics classes beginning the 5th grade in Hungary.

Hypothesis 9: The participating Hungarian students choosing Information Technology as an optional subject have better programming skills than their Slovakian peers, because of the emphasis put on programming at this level in Hungary.

The first hypothesis in this part of the research (*hypothesis 8*) according to which Hungarian students have better IT skills than their Slovakian peers was only partly justified. Results used in this research from Hungarian students who learned only the basics of Information Technology.

Topics were found not taught in either of the countries. Examining the efficiency of teaching Informatics in Slovakia and in Hungary it can be said that in the beginning Hungarian students did better concerning theoretical knowledge and they received a better basic education but later this advantage disappeared.

Hungarian students performed better in word processing during the whole test; teachers seem to put the emphasis on this topic in our country.

The starting advantage in spreadsheet calculation disappears by the end of secondary school; Slovak students provided the same results.

Hungarian students are more likely to have learned database management than Slovaks, but a much later than assigned in the curriculum and efficiency is not satisfactory either. As for programming skills it is just the other way around.

Slovakian students learn algorithms already in the 8th grade; their Hungarian peers do not meet this topic until they finish secondary school. If they specialized in Informatics there is enough time to learn it in the second half of secondary school. This research was resulting that students participating from Hungary were significantly better in word processing than Slovakian students, independently from the grade they attend.

Thesis 3: The Hungarian students participating are significantly better in word processing than Slovakian students.

The second starting hypothesis (*hypothesis 9*) was that Hungarian students specialized in Information Technology would reach higher scores in programming than Slovakian students. This assumption turned out to be correct in the 11th grade. Students choosing this are getting to know the beauties of programming and produce higher scores than the Slovaks.

Thesis 4: The participating Hungarian students specialized in Information Technology are significantly better than Slovaks.

A Comparison of IT Skills of Hungarian and Rumanian Students

The goal of this research was an analysis of the Information Technology skills of Hungarian and Rumanian students at the end of grammar school. Information Technology education in Rumania bears a close resemblance to the one in Hungary from the point of view of the material discussed. Theoretical knowledge, word

processing, spreadsheet calculation, database management and programming are parts of the curriculum in both countries. Though topics are the same, the number of IT classes are different (Table III.).

Table III. Number of Information Technology classes in Rumania

Grade					
1.-4.	5.-8.	9.	10.	11.	12.
0	0/1	1-2; 3-4; 5-6*	1-2; 3-4; 6-7*	3-4; 6-7*	3-4; 6-7*

* depends on specialization

In Rumanian schools the bulk of students get their first experience in Information Technology in the 9th grade. It also happens, that students study Informatics in one class a week through one or two years in the 5th-8th grades of certain schools, but this is rare and the curriculum also depends on the teacher to a great extent. Rumanian students of Humanities have 1 or 2 classes weekly in the secondary grammar school. Those who are admitted to a natural sciences course are taught Information Technology in 3-4 classes a week in secondary school; this number can be raised to 6-7 classes a week if one studies in a Mathematics-Informatics course and has chosen to learn Informatics intensively.

Hypothesis 10: The participating Hungarian students learning basic Information Technology have better Information Technology skills than Rumanian students of Humanities who have 1 or 2 classes weekly in the secondary grammar school.

Hypothesis 11: The participating Hungarian students specialized in Informatics have better Information Technology skills than Rumanian students of humanities because they spend more time with these subjects in the course.

Hypothesis 12: The participating Hungarian students specialized in Informatics have better IT skills and programming knowledge than Rumanian counterparts attending a science course.

Hypothesis 13: The participating Hungarian students specialized in Informatics have the same IT skills and programming knowledge as Rumanian students specialized in Mathematics-Informatics.

Rumanian students of Humanities can be compared to Hungarian students participating in basic Informatics education in the 10th and in the 12th grades of secondary school because of their number (Table IV.). The knowledge of Hungarian students specialized in Information Technology and that of the Rumanian students of Humanities are worth to compare only in the last year of secondary school because the

number of students filling in the test reaches the required amount only in this age group.

The knowledge of Hungarian students specialized in Information Technology and that of the Rumanian students attending a science course and a Mathematics-Informatics course is worth comparing only in the last two years of secondary school because the number of students filling in the test reaches the required amount there.

Table IV. Number of participants from Hungary and Rumania

Grades	Hungarian		Rumanian		
	basic education	Informatics course	students of Humanities	sciences course	Mathematics-Informatics course
5	79	0	0	0	0
6	14	0	0	0	0
7	18	0	0	0	0
8	169	0	0	0	0
9	552	0	0	0	0
10	302	0	205	0	0
11	104	69	31	94	212
12	212	91	213	87	158

The 10th hypothesis according to which participating Hungarian students learning basic Information Technology have better Information Technology skills than their Rumanian peers was only partly justified. It was true in the 10th grade except for spreadsheet calculation in which Rumanian students turned out to be more successful. In the 12th grade Rumanian students achieved better results in database management; the Hungarian ones reached higher scores in spreadsheet calculation.

Hungarian students performed better in theoretical knowledge and word processing in both grades. This means that Rumanian teachers focused on all topics more evenly, while in Hungary high emphasis was put on word processing.

Thesis 5: The participating Hungarian students learning basic Information Technology are significantly better in word processing and theoretical knowledge than Rumanian students of Humanities.

The 11th hypothesis was that as for Information Technology skills Hungarian students specialized in Information Technology would reach higher scores than Rumanian students of Humanities. This assumption turned out to be correct in the 12th grade where the research was made. Just the topic of database management shows the same level of knowledge in both countries.

Thesis 6: The participating Hungarian students specialized in Information Technology are significantly better in word processing, theoretical knowledge, spreadsheet calculation and programming than the Rumanian students of Humanities.

The 12th hypothesis was that participating Hungarian students specialized in Informatics would do better than their Rumanian peers attending a science course.

This proved to be true in the 11th grade except for object oriented programming, a subject not compulsory in either country.

In the 12th grade Rumanian students achieved better results in object oriented programming and SQL, and achieved the same results in programming and database management.

Thesis 7: The participating Rumanian students attending a science course are significantly better in object oriented programming and SQL at the end of secondary grammar school than Hungarian students specialized in Informatics.

Generally, participating Hungarian students performed better in theoretical knowledge, word processing and spreadsheet calculation in both grades compared.

Thesis 8: The participating Hungarian students specialized in Informatics are significantly better in theoretical knowledge, word processing and spreadsheet calculation than Rumanian students attending a science course.

Here you can see the advantage of more weekly classes (3-4) taught in science courses of Information Technology education in Rumania. Students can make up for their handicap, and have the same knowledge in programming and database management, and even more so in object oriented programming.

The 13th hypothesis was that as for IT skills and programming the participating Rumanian students attending a science course and a Mathematics-Informatics course would reach the same scores than the Hungarian students specialized in Information Technology.

This assumption turned out to be partly correct in the 11th and 12th grade. Hungarian students received higher scores in word processing, while Rumanians in programming. They achieved the same scores in the other topics of Information Technology in the 11th grade.

Rumanian students attending a Mathematics-Informatics course have the same IT skills and better programming knowledge in the 12th grade than Hungarian students specialized in Informatics.

Thesis9: The participating Rumanian students specialized in Mathematics-Informatics have significantly better skills in programming than Hungarian students specialized in Informatics at the end of secondary grammar school.

Here must be mentioned that while in Rumania object-oriented programming has been discussed in these two courses, students do not learn it in Hungary, not even in a specialized Informatics course, though those who have to deal with programming cannot avoid getting to know this field thoroughly later on.

Now a final conclusion can be made: Information Technology skills of students depend heavily on the time and efforts invested by teachers.

Teachers in Rumania deal with all the topics described in the National Educational Program (where programming is not prescribed for students of Humanities).

Teachers in Hungary have to follow strictly the National Basic Curriculum grade by grade, subject by subject. However, one can see now, what really counts is the time invested and the efforts made by teachers.

Rumanian students of the Real Profile (i.e. the Sciences program) have the same or even more practice in programming than Hungarian students specialized in Informatics, though the latter have the same or better IT skills. Unfortunately, Hungarian teachers concentrate on word processing and spreadsheet calculation and teach programming just for students specialized in Informatics, although algorithmic thinking would be important for every student before finishing secondary school. Therefore Hungarian teachers should spend more time with other topics of Information Technology not just with word processing and spreadsheet calculation.

Thesises

At last, you find here the summary of my thesis's as follows:

- Thesis 1: The participating students from high school have the same IT skills as students from the vocational schools at the end of secondary grammar school.*
- Thesis 2: The participating boys get significantly better marks in programming than girls.*
- Thesis 3: The participating Hungarian students are significantly better in word processing than Slovakian students.*
- Thesis 4: The participating Hungarian students specialized in Information Technology are significantly better than Slovaks.*
- Thesis 5: The participating Hungarian students learning basic Information Technology are significantly better in word processing and in theoretical knowledge than Rumanian students of Humanities.*
- Thesis 6: The participating Hungarian students specialized in Information Technology are significantly better in word processing, theoretical knowledge, spreadsheet calculation and programming than Rumanian students of Humanities.*
- Thesis 7: The participating Rumanian students attending a science course are significantly better in object oriented programming and SQL at the end of secondary grammar school than Hungarian students specialized in Informatics.*
- Thesis 8: The participating Hungarian students specialized in Informatics are significantly better in theoretical knowledge, word processing and spreadsheet calculation than Rumanian students attending a science course.*
- Thesis9: The participating Rumanian students specialized in Mathematics-Informatics are significantly better in programming than Hungarian students specialized in Informatics at the end of secondary grammar school.*

Conclusion

With the help of the method developed (in which a growing international interest shows) some final conclusions can be made. We could not find any difference in the IT skills of the participating high school and grammar school students from Hungary at the end of the secondary school. They enter higher education with the same IT knowledge, but the directions of the National Curriculum are not entirely followed in the case of IT, something we must reckon with in higher education. The knowledge of students was very poor in database management and programming therefore these topics should be taught from a basic level.

Significant divergence by gender was found in the theoretical and programming knowledge of participating students. Boys are better in programming than girls. This suggests girls need different teaching methods to get to the level of boys.

The participating Rumanian students attending a science course and a Mathematics-Informatics course have better programming and database management (SQL) knowledge than Hungarian students specialized in Informatics.

Unfortunately, Hungarian teachers concentrate more on theoretical knowledge, word processing and spreadsheet calculation and teach programming only to students specialized in Informatics: it is high time to teach more subjects in more classes, as we see in Rumania.

Results born by using my method may be useful for the decision-makers of the Education System of Hungary. Comparison results suggest that Information Technology should be taught in more classes in Hungary before taking a special course. In this case teachers could spend more time with database management systems and programming in basic courses and they could have more chance to teach theoretical knowledge, word processing and spreadsheet calculation and other topics too. Furthermore it would be advantageous to teach object oriented programming in a special course, because it is not to come around when teaching programming today.

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