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INFORMATICS EDUCATION PREPARATION AND RESULTS OF STUDENTS

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Abstract

The article reviews the results of the knowledge evaluation of the future economists and managers in the subject Informatics for Economists and their analysis. Determining the level of existing knowledge of the student is an important prerequisite for continuing education at all levels, including tertiary level. Acquiring new knowledge is difficult, unless the student has a solid foundation on which it can build their knowledge further. The resulting assessment provides a subjective view of the given sample questions and monitor whether and in what specifically the student has shortcomings. The results of students' knowledge in both study forms (distance and full-time) of bachelor's degree in the past five years are analyzed. The authors look for possible causes, interactions and trends that are being discussed.

Keywords

Informatics, education, analysis, study preparation and results.

Introduction

The information and knowledge society requires computer and information literate citizens. This is twice true for students of universities. Learning, not only at universities in an individual mental work: the more deeply and especially mentally process a substantive content, the better we understood. Foundations must be laid on quality education from an early age. The present human civilization is characterized by a growing flood of information, and must face a very challenging search, deciding and selecting the right resources, which requires large amounts of energy and time for sorting out such an amount of data and select only those that are actually needed. The main factor of success in modern society is reliable and fast access to information. It is important not only for individuals, but much more for organizations that need to manage this information (Spitzer, 2014, s. 87).

"The growing importance of information in contemporary society, and development tools that allow them to share, leads to increasing demands on citizens. Emphasis is placed on the orientation of the available information resources, and knowledge and skills associated with both finding and evaluating information and using them in different situations. It is an indispensable part of authorship and respect for the ethical treatment of information. This raises numerous discussions about the necessary changes in our educational system, also related university programs. The spool diverse forms of informatics education into higher education are fully in line with the trends in this sector of the education system are picked up and becomes one of the important criteria for evaluating the quality of individual universities. Closely related to the issue of accreditation of new fields and restoring the accreditation of courses already in place. The study plan for each field should include the widest range of elements that will lead to an increase in information literacy of students.

Education in information area is a long process, which leads to an increase the level of information literacy and which should penetrate the entire educational system - from primary schools to universities. Its individual levels should undertake follow smoothly. Colleges are the last link in the educational chain, which may contribute to the preparation for lifelong learning, orientation in an increasing amount of knowledge and information, their evaluation and effective use. The existing system of teaching at universities no longer satisfies the requirements for the study and subsequent professional or scientific activities, but also the demands of everyday life in society. Institutions providing higher education of students should create conditions for a qualified solution of problems in studying and in their personal lives and to help them in the labor market. They should allow them to prepare for the world of information sharing, rapid change and complex relationships. This requires a change in teaching style and use of methods based on the use of information resources“(Asociace knihoven, 2009; authors' of the paper translation).

Theoretical bases, material and methods

The key capabilities in the form of knowledge, skills and attitudes appropriate to the context of the knowledge society are essential for every human being. They represent an added value for the labor market, social cohesion and active citizenship because they offer flexibility and adaptability, satisfaction and motivation. Given that these capabilities should get everyone, this recommendation proposes a reference tool that countries of the European Union to help ensure that these features are fully integrated into their strategies and infrastructures, particularly in the context of lifelong learning (The European Union explained, 2014).

Basic competences in computer science and technology are ranked in the list „Eight key competences for lifelong learning“(Key competences, 2007). Key competences were defined and accepted in the document „Recommendation of Council and Parliament of European union 18th December 2006 – key competences issues in the process of long life learning“. The document says that „Competences are defined as a mixture of knowledge, skills and attitudes appropriate to the situation. Key competences are those, which people need for personal development, social integration, activity and employment” (Recommendation, 2006). The informatics teaching at Faculty of Management and Economics (FaME), Tomas Bata University (TBU) in Zlín within globalization trends responds to the requirements Ministry of Education (MŠMT, 2014). The eLearning course has a module structure (Buřita a kol. 2010) and consist of 10 blocks with LMS Moodle (Výuka, 2012):

- Introduction: pretest (diagnostic test), educational objectives, abstract, content, sources, references, definition of terms, forum, registration questionnaire, requirements, news, FAQ, user manual for students. Pretests contains 40 opened questions related to ICT.
- Thematic modules: with self-retests, syllabi of lectures, exercises and assignments for self-study study materials, block of tasks, and verification of information, important dates, and interactive communication teacher with students. Each module contains some self-retests and solved tasks related to ICT.
- Summary: exam required students' project, final test and questionnaire. Final test contains practical tasks and 40 closed questions from a particular level of educational aims.

Experience of the evaluation of the course Informatics for Economists, particular aspects of ICT education show the publications in scientific journals (Buřita a kol. 2010), (Buřita and Rosman, 2014), and at conferences (Rosman, 2013) in the years 2011-2014. This topic was often discussed at the ICTE conferences in 2001-2014. Authors of the paper and creators of number of contributions were to the discussion also involved.

The aim of the research is the process experiences of the education results obtained in the evaluation of students' of the first year bachelor degree during the past five years, for the academic years 2010-2011 to 2014-2015. Overview of student achievement is maintained in the Excel tables.

The aim of the analysis is not only to determine the precise results, but especially to reveal the reasons mutual respect and dependence potential trends so that in the future, managed to reduce the percentage of negative results.

The input assumptions of informatics study were evaluated based on the results of the introductory test. The introductory test detects the status of students' knowledge in the field of ICT (Information and Communication Technologies) at the start of the study. Students who achieve the outcome grade A-C gain acknowledgment of the course. The summary of research results confirms the authors' estimation that about 40% of students in the subject failed.

The analysis was carried out separately for distance and full-time students. The requirements at the outcome studies are indeed the same (credit work, input and output test), but the study conditions are different (time allocation for study, study motivations, differential status and level of previous training in ICT). For analysis processing, we have determined the two hypotheses:

H1: Is the true that the number of entering students in bachelor level at FaME is declining.

H2: Is valid the opinion that the readiness of high school graduates in informatics is growing.

Both hypotheses respect the FaME representatives view, presented at the semester teaching staff meetings. Numbers of students also affects the demographic development of the country.

Results of analysis

This chapter contains the results of the analysis of the input assumptions and results achieved in the subject Informatics for Economists, for the period 2010-2014 in distance study (DS) and full-time (FS) study. Requirements for input and output for each form of study in the subject are the same.

The differences between the two study forms consist in different time allocations of lectures and consultations during the semester, lack of exercise in the distance studies. Any form of study has a separate eLearning course in LMS Moodle with self-tests, syllabi of lectures, exercises and assignments for self-study.

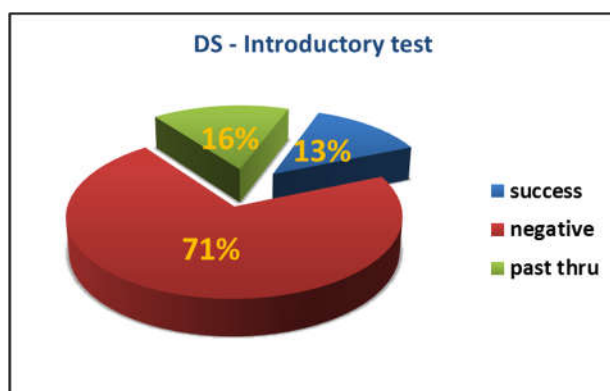
The full-time students hand in the exercise tasks. For the distance studies, the tasks for exercises are available at the Student Portal FaME (Studijní portál Výuka, 2012).

Distance study, input assumptions

The summary of results in the introductory test, detecting the ICT skills and qualifications to study informatics of DS students, is shown in Tab. 1 and in Graph 1.

Results	2010-11		2011-12		2012-13		2013-14		2014-15		Summary	
	num	%	num	%	num	%	num	%	num	%	num	%
Grade A	16	7,6	2	1,3	4	2,7	4	2,5	4	2,1	30	3,5
Grade B	12	5,7	3	1,9	11	7,4	7	4,4	7	3,7	40	4,6
Grade C	12	5,7	2	1,3	15	10,1	5	3,2	9	4,8	43	5,0
Grade D	18	8,6	9	5,8	9	6,0	9	5,7	13	6,9	58	6,7
Grade E	21	10,0	12	7,7	14	9,4	13	8,2	17	9,0	77	8,9
F-Failed	82	39,0	102	65,4	40	26,8	58	36,7	66	35,1	348	40,4
Unpresent	49	23,3	26	16,7	56	37,6	62	39,2	72	38,3	265	30,8
Summary	210	100	156	100	149	100	158	100,0	188	100,0	861	100,0
Success	40	19,0	7	4,5	30	20,1	16	10,1	20	10,6	113	13,1
Negative	131	62,4	128	82,1	96	64,4	120	75,9	138	73,4	613	71,2
Past thru	39	18,6	21	13,5	23	15,4	22	13,9	30	16,0	135	15,7

Tab. 1: The results of the introductory test – distance study [own]

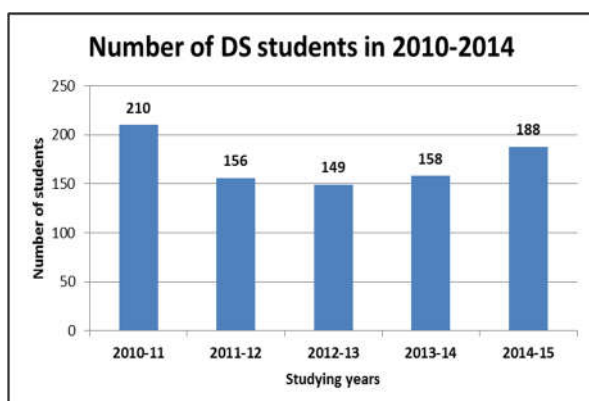


Note on Graph 1:
Success = grade A, B, C,
Negative = F and absent,
Past thru = grade D, E

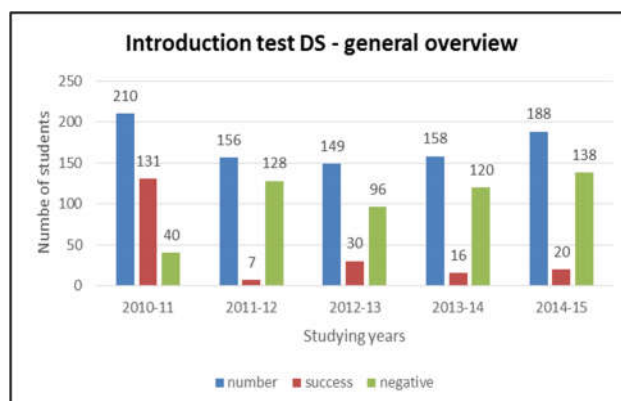
Graph 1: Summary DS in the introductory test [own]

Survey of number DS students admitted to study at FaME in the years 2010 – 2014 shows Graph 2. The detailed results of DS students in the introductory test are shown in Graph 3.

The result of analysis confirms the conclusion that the vast majority of DS students (71%) have the requisite knowledge and therefore does not meet the requirements for successful completion of the course Informatics for Economists, without attending at the course at the university.



Graph 2: General overview of students in DS [own]



Graph 3: General results introductory test DS [own]

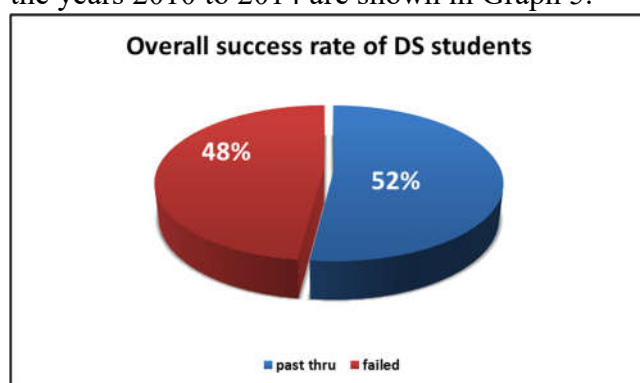
Distance study, study results

The summary results of DS in the subject Informatics for Economists are shown in Tab. 2.

Results	2010-11		2011-12		2012-13		2013-14		2014-15		Summary	
	num	%	num	%	num	%	num	%	num	%	num	%
Grade A	22	10,5	12	7,7	9	6,0	7	4,4	14	7,4	64	7,4
Grade B	30	14,3	10	6,4	10	6,7	13	8,2	33	17,6	96	11,1
Grade C	36	17,1	18	11,5	25	16,8	21	13,3	37	19,7	137	15,9
Grade D	28	13,3	17	10,9	16	10,7	14	8,9	14	7,4	89	10,3
Grade E	17	8,1	33	21,2	3	2,0	5	3,2	5	2,7	63	7,3
Grade F	17	8,1	29	18,6	2	1,3	10	6,3	2	1,1	60	7,0
Non-admission	60	28,6	37	23,7	84	56,4	88	55,7	83	44,1	352	40,9
Summary	210	100,0	156	100,0	149	100,0	158	100,0	188	100,0	861	100,0
Past thru	133	63,3	90	57,7	63	42,3	60	38,0	103	54,8	449	52,1
Failed	77	36,7	66	42,3	86	57,7	98	65,8	85	45,2	412	47,9

Tab. 2: The overview of the final assessment of students – distance study [own]

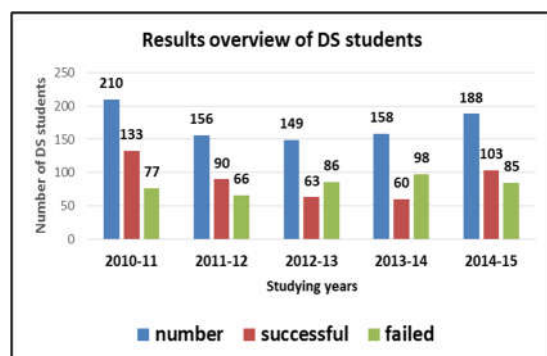
Total overview of the success DS students is shown in Graph 4; the detailed results of DS in the years 2010 to 2014 are shown in Graph 5.



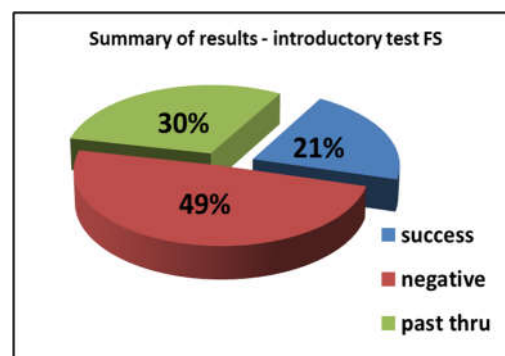
Note on Graph 4 and 5:
Past thru = grade A to E
Failed = grade F and non-admission to exam (non-compliance)
Number = number of the DS students
Failed = grade F and non-admission to exam (non-compliance)
Successful = grade A to E

Graph 4: The overall success rate of DS students [own]

Results of the analysis confirmed that the ratio of success/failure (52/48%) of the students in education of informatics and knowledge level of DS students are surprising, even alarming.



Graph 5: Results overview of DS students [own]



Graph 6: General overview introductory test FS [own]

Note on Graph 6: Success = grade A, B, C; Negative = F and absent; Past thru = grade D, E

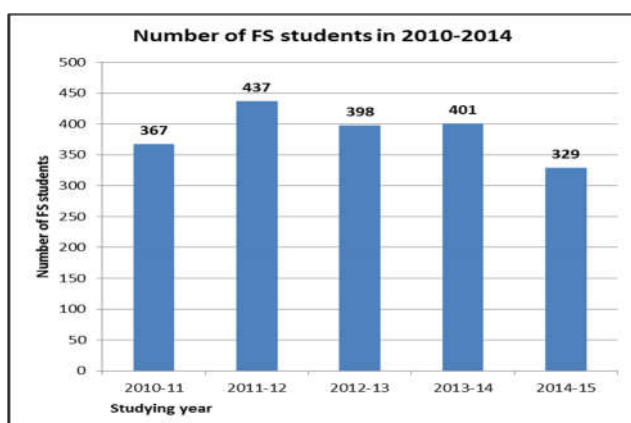
Full-time study, input assumption

The summary of results in the introductory test, detecting the ICT skills and qualifications to study informatics of FS students, is shown in Tab. 3 and in Graph 6.

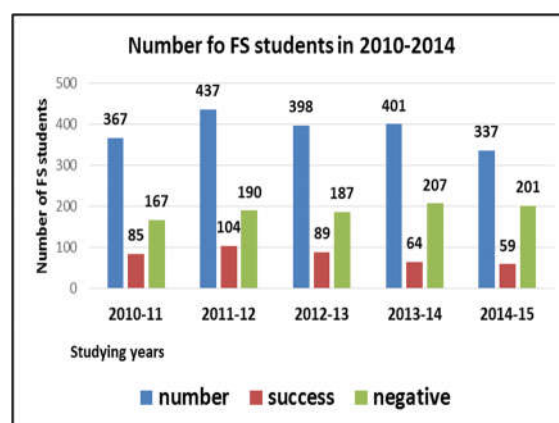
Results	2010-11		2011-12		2012-13		2013-14		2014-15		Summary	
	num	%	num	%	num	%	num	%	num	%	num	%
Grade A	14	3,8	17	3,9	18	4,5	17	4,2	12	3,6	78	4,0
Grade B	33	9,0	38	8,7	35	8,8	23	5,7	21	6,2	150	7,7
Grade C	38	10,4	49	11,2	36	9,0	24	6,0	26	7,7	173	8,9
Grade D	53	14,4	61	14,0	48	12,1	54	13,5	43	12,8	259	13,4
Grade E	62	16,9	82	18,8	74	18,6	76	19,0	34	10,1	328	16,9
F-Failed	136	37,1	154	35,2	161	40,5	178	44,4	161	47,8	790	40,7
Unpresent	31	8,4	36	8,2	26	6,5	29	7,2	40	11,9	162	8,4
Summary	367	100	437	100,0	398	100,0	401	100,0	337	100,0	1940	100,0
Success	85	23,2	104	23,8	89	22,4	64	16,0	59	17,5	401	20,7
Negative	167	45,5	190	43,5	187	47,0	207	51,6	201	59,6	952	49,1
Past thru	115	31,3	143	32,7	122	30,7	130	32,4	77	22,8	587	30,3

Tab. 3: Results of the introductory test – full-time study [own]

Survey of number FS students admitted to study at FaME in the years 2010 - 2014 shows Graph 7. The overview results of FS students in the introductory test is shown in Graph 8.



Graph 7: Number of students in FS [own]



Graph 8: Results of the introductory test in FS [own]

The result of analysis confirms also the conclusion that the preparation of FS students (49%) is not satisfactory for successful completion of the course Informatics for Economists at the university.

In particular, it lacks of solid theoretical foundations of informatics, there is lack of knowledge of ICT in preparation at the secondary level. In demonstrating practical skills while students usually do not have problems, problems mainly occur in the absence of theoretical knowledge.

Full-time study, study results

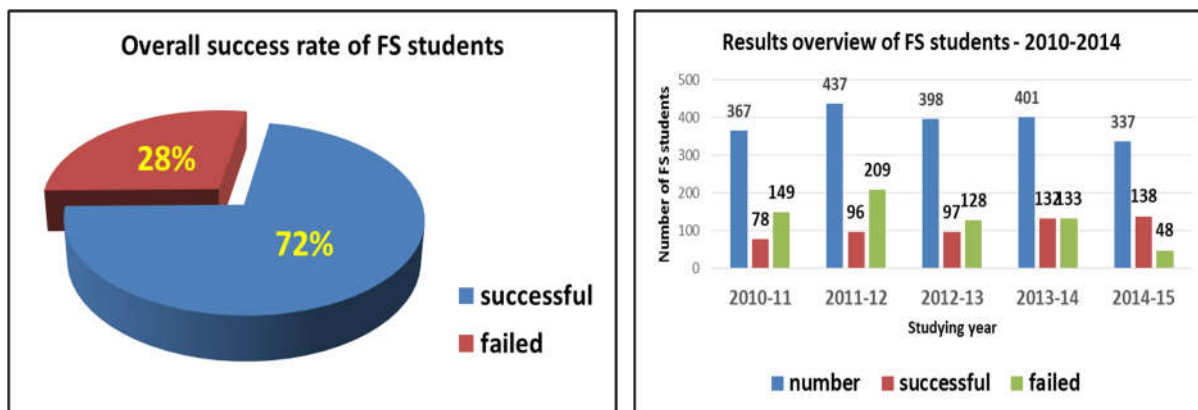
The summary results of FS in the subject Informatics for Economists are shown in Tab. 4.

The total overview of the success FS students is shown in Graph 9; the detailed results of DS in the years 2010 to 2014 shown in Graph 10.

Results	2010-11		2011-12		2012-13		2013-14		2014-15		Summary	
	num	%	num	%	num	%	num	%	num	%	num	%
Grade A	28	7,6	15	3,4	42	10,6	20	5,0	28	8,3	133	6,9
Grade B	48	13,1	31	7,1	53	13,3	39	9,7	68	20,2	239	12,3
Grade C	64	17,4	86	19,7	78	19,6	77	19,2	55	16,3	360	18,6
Grade D	61	16,6	91	20,8	87	21,9	87	21,7	35	10,4	361	18,6
Grade E	88	24,0	118	27,0	41	10,3	46	11,5	13	3,9	306	15,8
Grade F	51	13,9	63	14,4	37	9,3	38	9,5	41	12,2	230	11,9
Non-admission	27	7,4	33	7,6	60	15,1	94	23,4	97	28,8	311	16,0
Summary	367	100,0	437	100,0	398	100,0	401	100,0	337	100,0	1940	100,0
Past thru	289	78,7	341	78	301	75,6	269	67,1	199	59,1	1399	72,1
Failed	78	21,3	96	22	97	24,4	132	33,2	138	40,9	541	27,9

Tab. 4: The overview of the final assessment of students – full-time study [own]

Results of analysis FS students confirm that the level of knowledge of informatics, as well as the resulting success (72%) is significantly better than by DS students (52%). Explanation can be found in better input assumptions for the study and also grant more hours on the subject.



Graph 9: The overall success rate of FS students [own] **Graph 10:** FS students results - general overview [own]

Note on Graph 9: Number = number of the DS students; Successful = grade A to E; Failed = grade F and non-admission exam (non-compliance)

Discussion

The number of accepted DS students to enroll in the analyzed period fluctuated between 150 and 200; after declining in the second and third year of analysis, growth occurs again. The number of accepted FS students in the analyzed period is between 320-440 students. Decrease in this number shows up last year analysis. The total number of students in both forms of the reporting period 2010 to 2014 was between 520 and 590 students; this means that generally maintains roughly constant condition in the total number of students received the both forms.

The input assumptions for the study of the subject do not meet the **71% of the distance study students and 49% of full-time students**. It can be concluded that the FS students are better prepared to study at a university in terms of ICT skills. The results of DS students expresses the ratio of 48/52% (success/failure); FS students expresses the ratio of 72/28%. It can draw a clear conclusion that the FS students have better results that respects a totally different (better) condition for studying.

Conclusion

The analysis confirmed the need to correct the established ideas and clichés that appear by ratings and studies of the course. An honest analysis of the data obtained is the best answer to the myths about the status and quality of studies students of our universities. Although the results are only one faculty, but it can be inferred that the other Czech universities are not doing otherwise.

Regarding the evaluation of hypotheses, both must be rejected. The numbers of student intake at FaME although fluctuating, but the declining trend is not confirmed. Is it possible that missing of domestic students replacing students from Slovakia that are studying at our faculty. But it is not statistically detected. The level of preparedness of high school students in ICT is sustained and largely insufficient for successful students graduating from high school. In no case is such that it could be taught computer science at FaME canceled.

Observation and findings during the pedagogical experiment brought ideas for further development and practical improvement of the course. In the DS it is necessary to revert to the original subsidy hours on the subject, i.e. expansion of existing 10 hours per semester to the original range of 20 respectively 25 hours.

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ASSESSING THE DIFFICULTY OF EXERCISES BY MONITORING PUPIL DILATATION WITH EYE-TRACKING

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Abstract

With the rising amount of information pupils are required to take in and digest, the competence of teachers to navigate through the difficulty of assigned exercises in terms of mental operations difficulty also rises in importance. In this context the taxonomy of exercises that train cognitive functions is often being brought up. The more demanding an exercise is the more complex mental processes are happening during its solving, which means higher cognitive labor by students. Students' pupils dilate more with increasing mental labor and contract the moment the student solves the exercise or gives up. The first phase of our experiment monitors students' pupils' reactions when they solve exercises of varying difficulty.

Keywords

dynamics of pupil diameter changes, eye tracking, exercise difficulty, cognitive difficulty of exercises, cognitive effort, mental effort

1. Introduction

Nowadays individual approach of the teacher to their students is being increasingly emphasized. This approach should be maintained in all education activities including those in which students solve exercises. Exercises during lessons are assigned by the teacher, who uses their own battery of questions and tasks relevant to the goals of education units or uses exercises from current text-books in natural didactic situations. In any case the way of communication being set by exercises should not be an improvised or intuitive activity.

Exercises are traditionally understood as “pedagogical situations created for students to achieve a certain learning goal” (Průcha, Mareš & Walterová, 2009, p. 258). The important part being student's activation, which makes learning more effective. Exercises thus become catalysts of learning processes (Thonhauser, 2008). In modern didactics exercises are understood as tools creating opportunities for learning (Knecht, 2014), because they bring education contents to students that reflect the goals of education. They serve the fixation or diagnostic functions, but also motivational.

Many studies are dedicated to the issue of exercises. Generally speaking exercises are evaluated and designed by their (a) cognitive difficulty, (b) variety, (c) cognitive value or (d) didactic value (Kalhous & Obst, 2002). Each of these aspects prefers to order and formulate the individual exercises in a way that their final aggregate creates a compact whole that reflects the education goals.

With the individualization of education rises the importance of teacher's ability to discriminate in the abovementioned aspect – the cognitive difficulty of exercises. The most rigorous taxonomy in this regard was compiled by D. Tollinger (1970). Her classification of exercises comprises five basic categories that are classified by the difficulty of cognitive

operations required for their successful solving. It is based on Bloom's taxonomy of cognitive goals. The classification includes:

- a) exercises requiring memory reproduction of knowledge;
- b) exercises requiring simple mental operations with knowledge;
- c) exercises requiring complex mental operations with knowledge;
- d) exercises requiring communication of knowledge;
- e) exercises requiring productive (creative) thinking (Tollinger in Kalhous & Obst, 2002, pp. 331-332).

The created classification is further divided into individual subcategories, also with increasing cognitive difficulty of their solving.

Another classification category of difficulty of exercises is based on the use of didactic operators (i.e. units in the form of instruction or direction to use the relevant cognitive activity). The categories include (1) reproduction, (2) reorganization and (3) reflection or problem solving (Kulič in Knecht, 2014). Individual didactics either rely on the taxonomy by D. Tollinger or stem from their own, principally similar classifications. E.g. based on international research, a PISA (2009) classification of exercise difficulty was founded, used mainly in mathematics. Exercises focus on (1) knowledge reproduction, (2) connecting knowledge or on (3) thinking, during which mathematics exercise solving goes beyond routine, learned calculations.

Each taxonomy of exercises represents a hierarchically ordered file that reflects the increasing difficulty of mental operations required of students to solve the exercises. The more difficult the exercises the more complex mental processes are taking place during their solving. Logically enough, solving cognitively more demanding exercises should compel students to employ higher mental activity (see below).

This process can be easily identified by using an eye-tracking device that catches the dilatation of pupils when students display increased mental effort (Rosiek, Sajka, 2015). On the other hand, the pupils contract the moment students solve the exercise or give up on its solving. The issue was tackled already in 1964 by Hess & Polt (1964) who found out that the diameter of human pupils not only changes based on the illumination, but also with the difficulty of solved tasks. In his research, Hess (1975) proved that the dilatation of pupils cannot be affected by will and is connected with feelings or mental efforts (compare cognitive effort Hartl & Hartlová, 2000, p. 261) of the person, with direct relation between the size of pupils and mental effort – higher effort leads to larger pupils. Hess also proved that pupils react differently to mental effort and emotional excitement.

Kahneman (2012), who started his research on the abovementioned assumptions, experimentally verified that the pupil size of tested people changes every second based on the subjectively perceived difficulty of the task they are solving. He found out that with increasing mental effort the size of the pupils grows (up to 50% of their original size) until the moment when a person perceives the task as either intolerably difficult or successfully solves it. In such cases, the pupils contract back again. He also found out that people solving difficult mental task have dilated pupils and do not perceive anything else beside the task. This is because they need to hold many thoughts at the same time in their memory that either need separate action or combining under certain rule. This requires so much mental effort that it cannot be wasted elsewhere. The phenomenon is close to "temporary blindness" and Kahneman characterizes it as a mechanism that prevents attention from overloading.

The level of mental effort that a person needs to exert in solving a task is also affected by time pressure, caused by the degrading of content in short-term memory. A person is forced to

repeat and refresh the required information lest they are lost. People with high capacity working memory are at an advantage, while others protect themselves from mental overload by dividing a difficult task to smaller and simpler steps (Kahneman, 2012).

Kahneman also found out that individuals improving in the right direction and gaining necessary knowledge in a particular field need to exert less mental effort to solve a problem.

Talent produces a similar effect. Highly intelligent individuals require less mental effort to solve a problem, which he experimentally verified by measuring pupil size in connection with brain activity. He called the phenomenon "law of least effort" and noted that if there are several ways to reach an identical goal, people will choose the least difficult approach.

2. Material and Methods

2.1 Method Characterization

Participants' eye movements were recorded on a Tobii TX 300 Eye Tracker, and the data was collected and analyzed using Tobii Studio software. The Tobii 300 tracks eye movements at a resolution of 1920x1080 pixels at a controller refresh rate of 300 Hz.

The texts are taken from the textbook *Dějiny 20. století* [History of 20th Century] (Mandelová, Kunstová & Pařízková, 2005) intended for primary schools and lower level of 8-year grammar schools. The textbook provides a wide range of structural components, verbal and visual. From the content point of view we chose a chapter from fine arts (the topic "Art on a Journey to Surrealism and Abstraction"), which deals with new art movements of the 1920s. As verbal components are concerned, the textbook favors explanatory verbal text, a glossary; the visual part is mainly comprised of artistic illustrations (picture no. 1). Visual components have a stand-alone information value, they represented and interpreted the curriculum learnt.

Test subjects comprised of pupils of lower grades of 8-year grammar schools. The test subject always had the text and questions at their disposal so that we were able to monitor where in the text they search for information and validate possible answers to the questions. One of the key components of visual literacy testing is based on whether (and how long) the test subject is going to look in the text or pictures or both while looking for the answer to the question.

The choice and wording of the questions was chosen with the participants' current knowledge and age in mind.

2.2 Participant sample

For the initial phase of our research we chose pupils from the first and second grades (three boys and two girls aged between 11 and 12) of four different 8-year grammar schools. The respondents work individually under the supervision of the experimenter. The novelty principle is abided as the pupils have not come across this curriculum before.

Pupils are left to use their own individual strategies, which allow them to retrieve or deduce information from the exposed educational text. Partial goal of the research is also the monitoring of the preferences between the textual and visual fields and the extent to which individual structural components are used.

2.3 Procedure

Each participant was tested individually. The sequence of the test was:

- Introduction to the nature of the test;
- Calibration of the Tobii 300 to the participant's gaze (no participants wore glasses);
- Testing through four tasks of different difficulty, which included demographic data questions built into the gaze test using Tobii Studio software;
- Gaze testing was accompanied by short unstructured interview with pupils.

The study was conducted at the Pedagogical faculty of University of Ostrava (Cervenkova et al, 2014).

3. Results and Discussion

Due to students' individual interpretation of knowledge and different learning strategies, it is very likely that the same task can be felt more or less difficult by individual students.

Therefore we set to find out whether tasks with various cognitive difficulties will elicit different physiological reactions of the pupils of students and how profound will these differences be when comparing the performance of several students in solving the same task. Mental effort of students needed to solve individual tasks can be deduced from the dilatation or contraction of their pupils.

3.1 Tasks

During testing, respondents were given four tasks in total, which represented different cognitive levels of work. Selected tasks were testing these central domains: reproduction field, and simple and complex mental operations field. Tasks created by us reflected the original questions by the authors, but they were modified to be answerable using information from any of the two structural parts (verbal and visual). Varying cognitive difficulty of the tasks was created intentionally.

The first question asked mapped the basic orientation in the text and was oriented towards the central topic of the exposed page. Respondents were able to retrieve the correct information from both the verbal and the visual field. This task validated the correctness of the reproduction of read text or information located in captions of the visual parts. The second task posed a complex mental operation. Based on clues in verbal or visual fields, pupils needed to deduce additional information. By having to complete, compare and combine facts, respondents were forced to use demanding logical mental operations. Task number 3 was based on generalization. It also required to combine available information with complex mental operations. The last question required simple mental operations of listing items and describing facts with the addition of categorization elements (respondents were provided a list of artists and asked to only select those who represented Czech art community).

3.2 Task Solution Evaluation

Table 1 contains the time it took each student to solve analyzed tasks. We see the solution times differ greatly. It is worth noting that the solution time does not correlate with the grade average of the students. It also shows that the more difficult task does not always require more time for solving.

	Task 1	Task 2	Task 3	Task 4	Sum
Ondra	288	191	112	69	660
Vojta	68	224	173	87	552
Zuzka	41	215	58	32	346
Ema	139	76	82	173	470
Viktor	75	69	26	149	319

Tab. 1: Time in seconds required for students to solve the task.

Table 2 shows the dilatation of the right eye pupil of individual students. The table only shows changes of pupils' size that persisted for longer than 500 ms. Changes lasting shorter time were not taken into account.

Based on the change of pupil size of examined students, the most difficult task appears to be task no. 1. This could be caused by the fact, that task no. 1 is the first one and requires students to get acquainted with the new text and exert considerable mental effort while digesting all the new information. The difficulty of tasks no. 2 and 3 deduced by the pupil size change corresponds with our expectations and the given taxonomy of these tasks. However this was not the case for task no. 4, which was supposed to be the first level of difficulty according to Tollinger taxonomy (see above). Paradoxically, students with worse weighted grade average solved this task quicker and with less mental effort than their peers with better grades.

	Pupil dilatation - task no. 1	Pupil dilatation - task no. 2	Pupil dilatation - task no. 3	Pupil dilatation - task no. 4
	[%]	[%]	[%]	[%]
Ondra	106.8	107.0	116.4	106.4
Vojta	110.0	107.5	106.0	104.0
Zuzka	113.2	104.2	108.4	114.9
Ema	121.7	109.5	111.1	110.8
Viktor	107.3	109.5	105.4	110.9
Average	111.8	107.5	109.5	109.4

Tab. 2: Right eye pupil dilatation of individual students in tasks no. 1 to 4

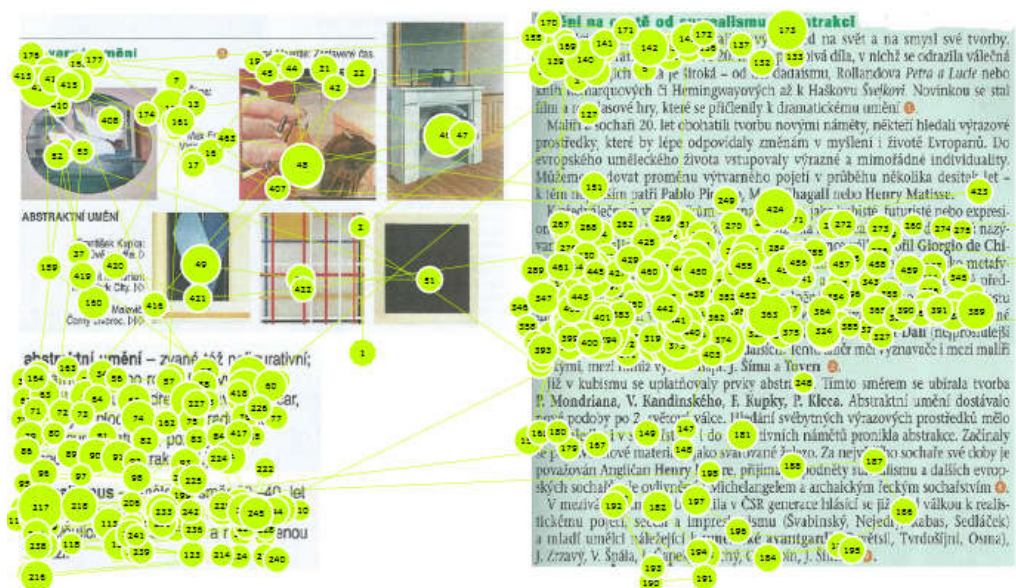
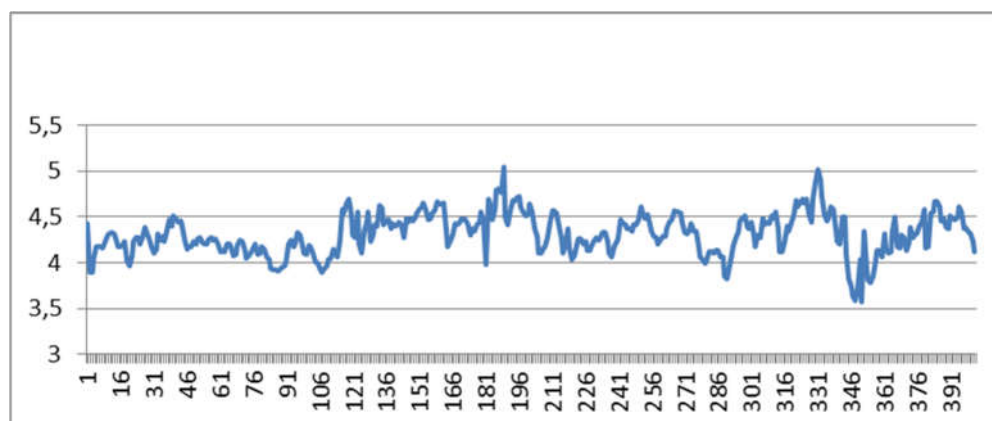


Fig. 1: Depiction of the textual and visual information source for tasks 1–4 and visualization of student Ema solving the task no. 1

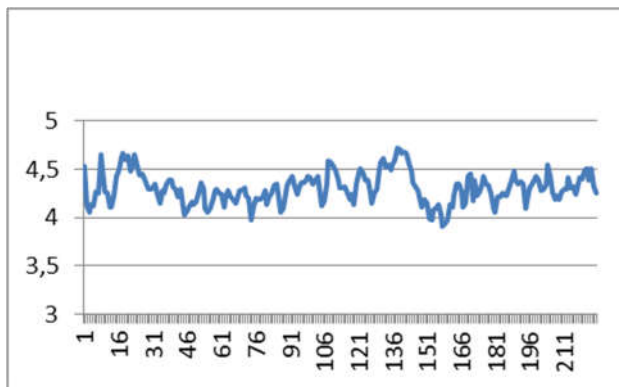
Figure no. 1 shows the textual and visual information source for task 1–4. The sequence of saccades and fixations represents the approach used by Ema to solve task no. 1. At first she got familiar with the visual part of the study material, where she also found the solution of the given task, and then she verified the answer in the textual part. This also corresponds with the two time segments during which her mental effort increased, and therefore also her pupils dilated. This is also confirmed by the Graph no. 1, which shows the same - 2 local maximums.

Graphs 1–4 show the reaction of Ema's right eye pupil when solving tasks 1–4. They show that solving the first and fourth tasks took Ema the longest time. All graphs have time on the X axis, where one unit corresponds to 1/3 of a second, while the Y axis represents pupil diameter in mm.



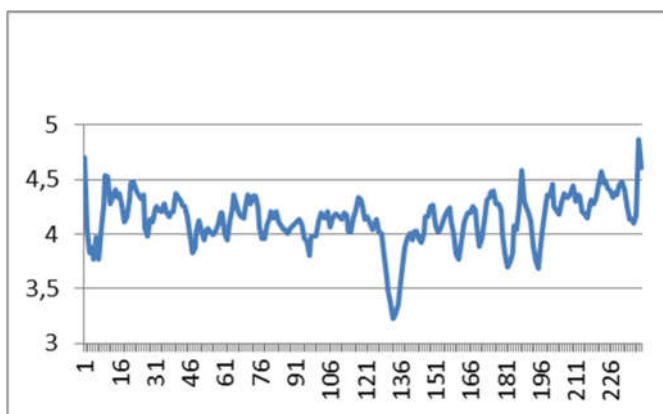
Graph 1: Change of diameter of Ema's right eye pupil while solving task no. 1

Graph no. 2 also has 2 local maximums, where the first maximum at the beginning of the curve corresponds to emotional agitation at the beginning of solving and the second maximum shows the moment when Ema found out the correct solution to the task.



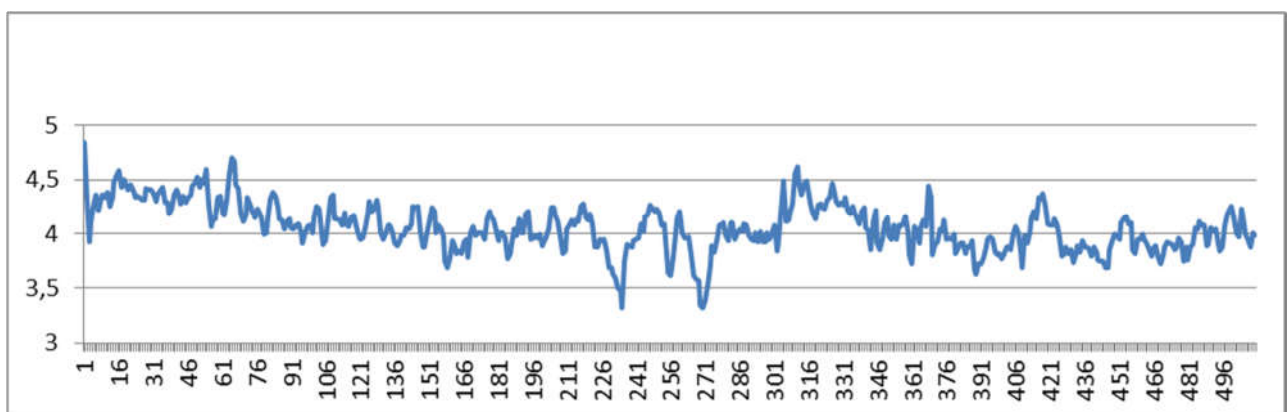
Graph 2: Change of diameter of Ema's right eye pupil while solving task no. 2

Graph no. 3 shows more than 2 local maximums, the first one corresponding to emotional agitation and the other two showing increased mental effort.



Graph 3: Change of diameter of Ema's right eye pupil while solving task no. 3

Graph no. 4 has 2 maximums, the first one is the emotional agitation at the beginning of solving and the second maximum shows the moment Ema discovered the correct solution.



Graph 4: Change of diameter of Ema's right eye pupil while solving task no. 4

4. Conclusion

The aim of the experiment was to find out whether differently difficult tasks (as described by the taxonomy level of tasks) create changes of cognitive effort of students that translate into physiological changes of their pupils. Analysis of the results of the experiment shows that the required cognitive effort to successfully solve a task is more dependent on individual qualities of each student rather than on the taxonomy level of the task (and therefore level of mental operations). We discovered that the same task had different difficulty for each student. This was demonstrated by the varied times it took individual students to solve the task and different levels of cognitive effort they needed to use. We based the experiment on Hess' (1946) claim that pupils are sensitive indicators of mental effort; they dilate more when a person considers the task difficult than they would in case the person considered it easy. The size of the pupils exactly corresponds with the subjective perception: "difficult" tasks cause longer and more profound pupil dilatation.

We verified that objective difficulty is not the only important aspect for solving; subjective difficulty for individual students plays an important role. Cognitively more difficult tasks, from the objective point of view, can be solved faster by some students than objectively easier ones, especially in those cases where students got acquainted with the subject by solving previous tasks. In the experiment, this phenomenon manifested in some students solving a task with a high taxonomy level sooner than the previous task with lower taxonomy level. Pupil size reactions therefore indicate not only the level of mental activity of the student, but also the relation between their mental activity and level of difficulty of the task.

The subjective perception of task's difficulty has certainly been also affected by intelligence levels of students, their knowledge and understanding, personal characteristics and chance factors which cannot be eliminated. In this relation, factors affecting the students' ability to correctly comprehend the text can be mentioned, such as tension, uncertainty, temperament, fear of failure, etc.

The abovementioned findings show that the current form of the experiment served as the first insight into the issue of students solving tasks in relation to the change of their pupils size. The next phase will see a methodological design expanded with semi-structured interviews of the experimenter with the students and analysis of recorded video sessions. Furthermore we aim to validate the experiment by using a different study text and expanding the respondent sample.

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SUPPORTING OF SIMULATION AND VISUALISATION THROUGH ICT IN THE EDUCATIONAL PROCESS

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Abstract

Significant development of information and communication technologies and especially the Internet boom bring new possibilities in education of different school subjects at all levels of the educational process. Information technology has provided new innovations to sustain constructing an artificial educational environment by means of computers. Certain artificial environments sometimes go beyond natural environments, such as simulations and virtual reality, which is a sophisticated educational technology. A computer simulation, which enables essential functions of laboratory experiments to be carried out on a computer, is called a virtual laboratory. This simulation support aspect of visualisation in educational process in different school subjects and it is possible to use it in educational process in different study programs of teacher training at universities. Understanding of new notions through visualisation belongs to important factors in the constructivist educational approach. We would like for this reason to present some aspects of visualisation also through selected kinds of educational software (mostly open source). The article introduces suggestions for education in this area and deals with the methods, forms, and problems of this kind of education.

Keywords

simulations, e-learning platforms, virtual laboratory, teaching materials

Theoretical Background

Significant development of information and communication technologies and especially the Internet boom brings new possibilities in computer science education at all levels of the educational process. Information technology has provided new innovations to sustain constructing an artificial educational environment by means of computers. Certain artificial environments sometimes go beyond natural environments, such as simulations and virtual reality, which is a sophisticated educational technology (Látal, 2012).

Simulations are also important in mathematics and science education. They assist in understanding and visualizing of new concepts and arguments. Visualizations and simulations can rely not only on ideas of a particular subject and the movement, but also on represented schemes and structured diagrams that represent the relationship among the examinee. Mental image operations may be supplemented by actual test handling and generally in a particular handling and result (Gunčaga, Fulier, Eisenmann, 2008).

Computer simulations in science education often go into virtual reality applications. The virtual reality is distinguished by unique sorts of interaction, that responds to users' behaviours and actions. It is considered to be a new model of computer-based learning, that provides the individual learner with a wider range of scientific vision (Babateen, 2011).

Remotely controlled experiments are experiments that are assembled from real physical aids and devices, but can be controlled in real time via the Internet from anywhere in the world.

This (not new, but it is currently not fully exploited) type of experiments gives many people a very strong emotion, either very positive or very negative. Our goal is not to replace traditional school "face to face" experiments remotely controlled experiments, but to offer secondary school and university teachers and their students other alternative experimental work in technical subjects.

Virtual laboratory is a computer simulation, which enables essential functions of laboratory experiments to be carried out on a computer is called a virtual laboratory. They offer the opportunity to simulate real equipment and experiments.

The importance of visualization and simulation in mathematics education

In mathematics education it is important to represent and visualize various mathematical concepts, relationships and practices, respectively algorithms. Visualization is usually implemented through different models. The model may take the form of real mathematical device, but may also be implemented in a suitable virtual software environment. The virtual environment simulates either real environment or seemingly phenomena resembling reality and it are created with a computer. Benefits of using models in the teaching of mathematics are that the student can manipulate with the model. Handling real model is via haptics, virtual model manipulation takes place for example by virtual pen or computer mouse.

However, it is important for visualization of mathematical object or relation use appropriate and correct model. It often happens that poorly chosen model of representation of mathematical phenomenon or situation may result in not only a misunderstanding, but may also be able to create misconceptions. Detect and remove misconceptions is then a time consuming, difficult and complex process.

Haptic and virtual modelling has particular importance in the stages of cognitive processes in mathematics. About the pivotal role in the effective use of handling activities in mathematics education says the document Research on the Benefits of Manipulatives, which states that the correct understanding of mathematical concepts is necessary to pass three stages of learning. These stages, respectively levels of learning, are briefly characterized in the table (Table. 1).

Concrete stage	Representational stage	Abstract stage
A mathematical concept is introduced with manipulatives, students explore the concept using the manipulatives in purposeful activity	A mathematical concept is represented using pictures of some sort to stand for the concrete objects (the manipulatives) of the previous stage; students demonstrate how they can both visualize and communicate the concept at a pictorial level.	Mathematical symbols (numerals, operation signs, etc.) are used to express the concept in symbolic language; students demonstrate their understanding of the mathematical concept using the language of mathematics.

Tab. 1: Level of understanding of mathematical concepts (Research on the Benefits of Manipulatives)

The table shows that the representational stage is from the visualization point of view very important. Without this level a student can not work in mathematics at an abstract level.

Meaning of visualization especially in geometry confirms van Hiele theory, which defines and describes the level of geometric thinking. In this paper we will (in accordance with studies of Marchis, 2012; Mason, 1998; Musser, Burger, Peterson, 2001) number, name and describe levels as follows:

- „*Level 0 Visualization* - learners recognize shapes only according to their appearance, holistically, they often use prototypical example in order to identify them. Learners are unable recognize shapes in non-standard positions and sizes.
- *Level 1 Analysis* - students recognize and name geometric shapes based on their characteristics. Location and size does not cause any problems, but they do not see some of the common characteristics of different shapes. They do not distinguish between the characteristics that are necessary and sufficient to describe the shapes.
- *Level 2 Abstraction* - students understand the relationship among different sets of shapes and they can define inclusive relationships among them, they understand logical implications. They can formulate a very simple definition or justify their decisions.
- *Level 3 Deduction* - students are able to understand the principles of construction in geometry, they understand how to make proofs in geometry and they can autonomously formulate geometric proofs.
- *Level 4 Rigor* - learners understand Euclidean geometry and principles of non-Euclidean geometry models, they can use deductive reasoning to compare mathematical systems“ (Žilková, Gunčaga and Kopáčová, 2015).

The above levels are hierarchical and sequential. Not only in developing thinking of youngest children it is extremely important to pay attention to the level of visualization. Even in establishing and defining mathematical concepts for older pupils and students it is important to work on the level of visualization with the so-called models not models (models, non-models) the concept, relationship and procedures.

Materials for creating virtual laboratories in Science Education and methodology of work with them

During the last decades, the information and communication technology has witnessed a rapid development in all fields. The resources of knowledge became various and numerous. The course of science is obviously connected with technology, both cognitively and practically. Yet, educational professionals consider the importance of integrating information and communication technology in science learning, as to facilitate studying many scientific phenomena that cannot be studied experimentally due to its danger, or lack of time to complete the experiment. Furthermore, it will help the student in investigation and searching, which are considered the main aims of teaching science. (Al-Shaie, 2006, Dillon, 2007). The fields of internet-based learning are diverse, including virtual laboratories (see Fig. 1) of science, which are considered the main underpinning in practical electronic learning, seeing that virtual labs closely resemble real labs (Al-Baiati, 2006, Salamah, 2007).

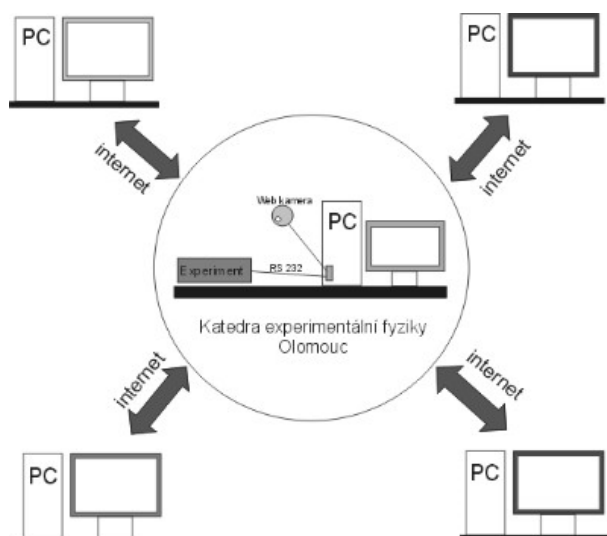


Fig. 1: Virtual lab (Látal, 2011)

Moreover, a technology-enriched environment would greatly enhance students' motivation and develop positive attitude towards the course. Subsequently, the academic achievement would be enhanced. Several studies emphasized the vital role of virtual labs in developing academic achievement, providing awareness of scientific concepts, and modifying misconceptions.

This is the scientific method, in which the artificial induces a storyline with predetermined conditions so that it can be under the same conditions repeated. During an ongoing experiment objectively monitor measurements using instruments interdependence of physical quantities under the influence of the smallest number of distractions. Experiment is the means of knowledge and also a specific form of practice. The results generalize to form physical law (usually described mathematical model), while the other attempts to verify accuracy. (Vybíral, 2006; Mechlová, 1999)

When real experiment is replaced by a computer model, the experiment therefore takes place in the form of a simulation. Virtual laboratories have emerged above all on the Internet (World Wide Web). However, these experimental virtual laboratories in JAVA format (and also those in VRML and Shock-wave-Format) mainly represent classic simulations, which are not intended to represent laboratory experiments in a realistic fashion. Simulations which attempt to represent the real laboratory experiments as closely as possible we call virtual labs.

Laboratory experiments can be described as virtual when the experiments are controlled not by direct manipulation of laboratory equipment, but by means of a computer, which is linked up to the actual laboratory equipment via a network (for instance, via the WWW). This type of virtual laboratory is called remote laboratory. Generally speaking, virtual laboratories, like simulations, are intended to transfer conceptual and procedural knowledge. Since this knowledge refers to the preparation, the performance and the evaluation of laboratory experiments, it is necessary to impart both background knowledge and also knowledge referring to actually carrying out the experiment. As with simulations in general, virtual labs can also facilitate a range of different learning processes: solution of (complex) problems; discovery of new content and new assessment of already known information by means of discovery learning; construction of general principles from experimental work and comparison of individual phenomena (inductive learning).

Materials for paper folding and its simulation in a dynamic geometry environment and methodology of work with them

Mathematics teacher has for creating appropriate models in geometry currently available dynamic geometric systems (DGS). Models produced in virtual dynamic geometry are characterized in that they are interactive and provide appropriate educational environment to experiment and to find connection between the examined mathematical phenomena. Creation of virtual and dynamic geometric constructions is also suitable for the control accuracy of the design process. Finished models created in DGS allows us to study, for example, a set of solutions of construction problems, which is changing based on the change of position and metric characteristics of the objects.

Creation and exploring of models interactive geometric constructions in conjunction with the simulation will be illustrated on geometric problems associated with paper folding. Geometric exercises in paper folding are interesting and practically useful. Similarly to Euclidean constructions, which are based on an axiomatic system, the paper folding has own rules and principles.

The Huzita – Hatori axioms or Huzita – Justin axioms (Bogomolny, 2015) are a set of rules related to the mathematical principles of paper folding, describing the operations that can be made when folding a piece of paper. The axioms assume that the operations are completed on a plane and that all folds are linear. The axioms are as follows:

- A1: Given two points $P1$ and $P2$, there is a unique fold that passes through both of them.*
- A2: Given two points $P1$ and $P2$, there is a unique fold that places $P1$ onto $P2$.*
- A3: Given two lines $k1$ and $k2$, there is a fold that places $k1$ onto $k2$.*
- A4: Given a point $P1$ and a line $k1$, there is a unique fold perpendicular to $k1$ that passes through point $P1$.*
- A5: Given two points $P1$ and $P2$ and a line $k1$, there is a fold that places $P1$ onto $k1$ and passes through $P2$.*
- A6: Given two points $P1$ and $P2$ and two lines $k1$ and $k2$, there is a fold that places $P1$ onto $k1$ and $P2$ onto $k2$.*
- A7: Given one point P and two lines $k1$ and $k2$, there is a fold that places P onto $k1$ and is perpendicular to $k2$.*

Preparation of an interactive and dynamic model to simulate paper folding requires a thorough knowledge of the characteristics identical views. When implementing the different steps of paper folding in an environment of DGS should be based on individual interpretations of Euclidean axioms. First we need to construct a model of rectangular paper with the possibility of changing its dimensions (especially because of the possibility of using interactivity and further experimentation and investigation). In a further process using tools "angle bisector", "perpendicular bisector" and construct an intersection. Illustration figures of built interactive models of set of axioms are shown in Fig. 2 - Fig. 5.

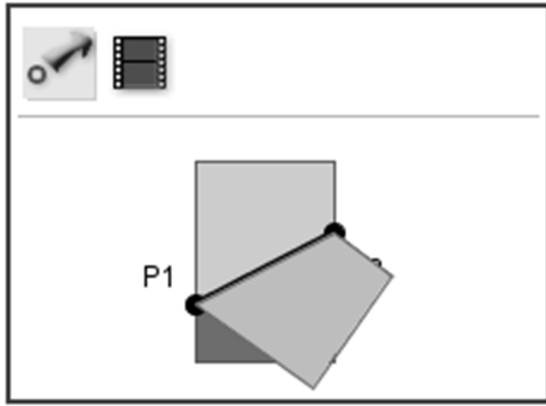


Fig. 2: Model of the axiom A1: Given two points $P1$ and $P2$, there is a unique fold that passes through both of them.

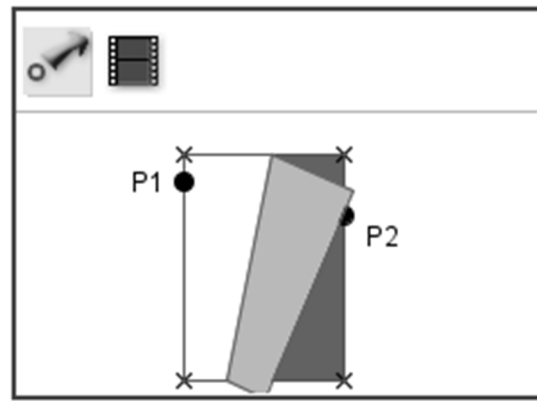


Fig. 3: Model of the axiom A2: Given two points $P1$ and $P2$, there is a unique fold that places $P1$ onto $P2$.

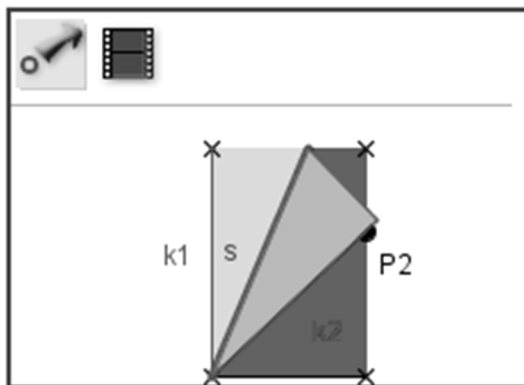


Fig. 4: Model of the axiom A3: Given two lines $k1$ and $k2$, there is a fold that places $k1$ onto $k2$.

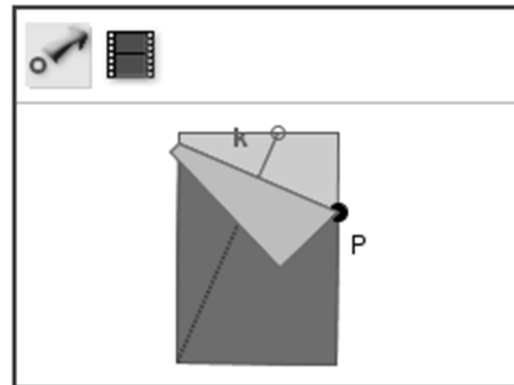


Fig. 5: Model of the axiom A4: Given a point $P1$ and a line $k1$, there is a unique fold perpendicular to $k1$ that passes through point $P1$.

Discussion and results

Geometric structures of mentioned axioms are actually very simple. But the transition from a manipulating activity of making fold for searching lines representing different folds in the planar design is not elementary. The advantages of combining the both methods (folding and constructing) in mathematics education is to develop the skills of students:

- to reflect the properties of geometric figures and properties of identical views;
- to acquire practical and theoretical experience and skills of reading and decrypting the original images and real models;
- to analyse folding procedure.

This means that it creates a space for the students:

- for formulating questions and searching for answers e.g. about the conditions of existence of searching objects,
- for verification of the properties of a geometric shapes and of properties of isometries, but especially
- for experimentation and simulation of dynamic interactive environment geometry.

Virtual laboratory as an educational technology provides an advanced individualized learning perfectly meets the educational needs and provides a high level of flexibility and freedom from constraints of time and place. One of the most important features of virtual reality is the

easily and continuous material update aiming to attain learning objectivity and interest (Al-Shanak, Doumi, 2009). With the increasing popularity of virtual educational technology, globally and locally, the development of virtual learning environment became an important field of science which has its own basics and principles.

The learner is constrained to the theoretical method in acquiring knowledge, rarely allowed to apply this knowledge practically. This is due to several reasons including; the lack of laboratory devices, the risks that may result from applying some scientific experiments, and the high cost of materials (Al-Radi, 2008). The above display demonstrates the need to apply virtual learning environment in teaching science.

Conclusion

One of the possible simulation in mathematics is paper folding. Through suitable applets in educational software it is possible to explain general principles. Paper folding is an unusual way to study some geometric properties, particularly of geometric shapes. An important principle in mathematics is to acquire "active mathematical experience" (Olson, 2015). Elegant addition to practical activities in the discovery, investigation and problem solving can be modelling through folding paper using of Euclidean geometry principles in a dynamic geometry environment and comparison of strategic approaches in problem solving.

Paper folding in dynamic geometry systems can be served as a tool for presentation of virtual reality in mathematics education. DGS is an environment for pupil's experiments and it is one of kind of virtual mathematical laboratory. Generally, one possible tool in science education is demonstration of experiment through virtual laboratory. How we described above, the virtual Lab Concept was defined as "laboratory experiment without real laboratory with its walls and doors. It enables the learner to link between the theoretical aspect and the practical one, without papers and pens. It is electronically programmed in computer in order to simulate the real experiments inside the real laboratories." (Harry, Edward, 2005).

Visualisation through simulation in science education helps pupils to understand new notions, relationships between them and incorporate this new knowledge in existing structure. It is important for development of different levels of children's thinking in science education. Simulation is possible to use in many school subjects of science education, for this reason it is possible to show interdisciplinary approach (see also the website <http://www.scientix.eu>). According to Camilleri (2012) the Internet provides teachers and students vast possibilities to look up information and help them with their homework's and works during the lessons.

According Poulouva, Cerna, Simonova (2014) a growing understanding of the learning and instructional affordances of e-learning technologies reflecting latest technological developments have enabled to design and investigate e-learning experience. There is much appreciation of learning principles, such as contextual, situated, augmented and collaborative among others. There is a large amount of studies reporting on how these principles can be effectively applied in the field. There are also new technologies continuously being implemented.

Real experiment is impossible to change through virtual experiment in educational process. The role of the virtual experiment is such supporting tool for better understanding of principles of demonstrated phenomena. If teacher hasn't possibility to realize real experiment, he/she can use virtual experiment using computer simulation.

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LIGHT SOURCE FOR PUPILS' EXPERIMENTS

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Abstract

General educational program for high school in Czech Republic does not contain photometry. We encounter with the concepts of light, illumination, lighting standards and protection of eye in our everyday life. The aim of this work is to create light source for pupils' experiments. This source will consist of RGB LED and UV LED. Teachers can make this source very easy and it is very cheap. Then the pupils can do various experiments with this source. For example they can demonstrate mixing of the colours, measure reflection and transmission of light. Also they can measure quality of sunglasses filter with the source. Pupils can try if some object is invisible in special light (for example blue object in red light). These experiments show photometry as interesting part of physics. Pupils use the modern equipment during measurement and appreciate that the task relate to their everyday life.

Keywords

Source of light, illuminance, spectrum, RGB model of mixing colour

Introduction

General educational program for high school does not contain photometry, a few interesting and problematic tasks were selected. Everybody encounter with the concepts of light, illuminance, luminous intensity and luminous flux in our everyday life. Everybody of us is currently trying to conserve energy. Therefore, everybody should know these terms. And we should be able to choose the appropriate source of light to our homes. The tasks of photometry for pupils' measurements are inspired by everyday life and using of modern sensors. Pupils do an experiment, they will be measured with the spectrometer SpectroVis Plus (or Spectral by Kvant), Light Sensor and Motion Detector by Vernier (Vernier, 2014) and then evaluate the measured data (dependence of illuminance on the distance from the light source; amounts of UV radiation transmitted through sunglasses) using some program such as Excel and create a protocol. The Light Sensor approximates the human eye in spectral response. This can be used for inverse square law experiments or for studying polarizers, reflectivity, or solar energy. Motion detectors measure distance ultrasonically to the closest object and create real-time motion graphs of position, velocity, and acceleration. (Vernier, Senzory, 2015)

Methods and materials

At Framework Educational Programme for high schools (Výzkumný ústav pedagogický v Praze, 2007) in thematic sections 4, pupils dealing with electromagnetic phenomena and light.

As the outputs are:

"pupil

- compares the spread of various kinds of electromagnetic waves in different environments,
- uses the laws of propagation of light in the environment to determine the characteristics,
- of display objects with simple optical systems curriculum,
- electromagnetic radiation - electromagnetic waves; spectrum of electromagnetic radiation,
- wave properties of light - propagation and the speed of light in different environments; constancy of the speed of light in inertial systems and some consequences of this law; laws,
- of reflection and refraction, index of refraction; optical spectrum; interference of light,
- optical imaging - reflection from planar and spherical mirror; refraction by thin lenses; viewing angle; eye as an optical system; magnifier". (Výzkumný ústav pedagogický v Praze, 2007)

Unfortunately, the photometry is not mentioned in any way. However, Lepil in his physics textbook for high schools Optics (Optika) (Lepil, a další, 1993) chapter "Colour of light", where explains the dispersion of white light in a prism, the colour of the light determines its spectral composition, and also mentions mixing additive and subtractive colours and their application in TV screens (RGB model) and in printers (CMY model). The second edition of this textbook (Lepil, 1996) contains about energy transfer radiation, at least mentions the terms illuminance (E), luminous flux (θ) and luminous intensity (I) and there are required relationships (1) and (2).

$$E = \frac{\Delta\theta}{\Delta S} \quad (1)$$

$$E = \frac{I \cdot \cos \alpha}{r^2} \quad (2)$$

In the third edition of the textbook (Lepil, 2002) photometric quantities are described in detail, especially the lighting. The text is supplemented by information about adequate lighting. The next chapter contains a description of the spectra of substances. However, this chapter does not include comparing the spectra of different light sources.

Light is the part of electromagnetic radiation in the wavelengths from 400 to 760 nm, an overview of electromagnetic waves is shown in Figure 1. In the human eye, the different frequencies of light produce different colour sensations. As we see from Figure 2, the human eye is most sensitive to yellow-green colour corresponding to a wavelength of 555 nm.

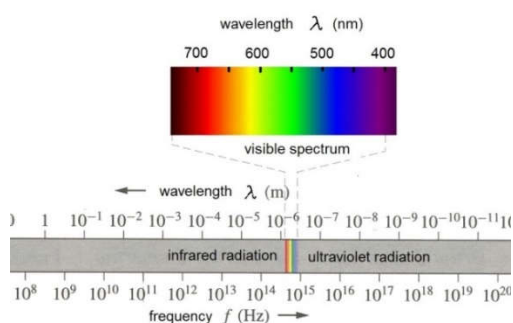


Fig. 1: Electromagnetic radiation

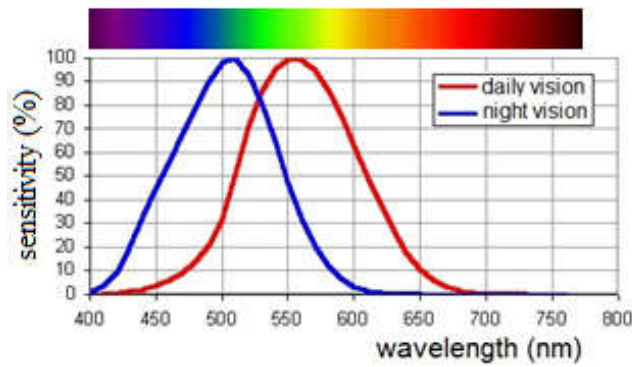


Fig. 2: Sensitivity of human eye

The assembled light source consists of RGB model (red, green, blue), it is an additive colour mixing using in televisions and monitors. These colours together create a white colour. There is also another model of colour mixing, this is a subtractive model of CMY (cyan, magenta, yellow), which mainly use the printer. These colors together create a black colour.

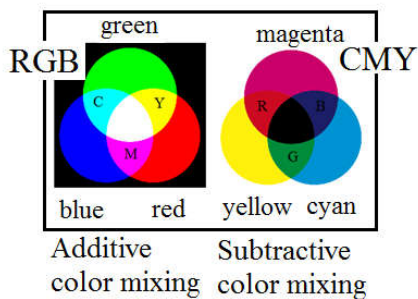


Fig. 3: Models of colour mixing: RGB model (additive) and CMY model (subtractive)

Results and Discussion

For the construction of radiation sources we need RGB LED, UV LED, wires, power supply - battery (Li-ion) 3.7 V, a resistor of resistance 22 Ω . In the RGB LED has centered red at 632 nm, green at 523 nm, and blue at 466 nm, see Figure 4. At the same time, we measured the light intensity at a distance of 10 cm from RGB LED: red 236 lux, green 93 lux and blue 192 lux.

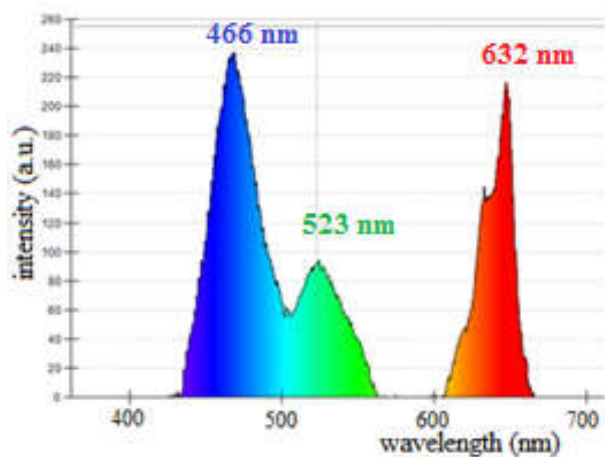


Fig. 4: Spectrum of RGB LED

Simply made source of radiation can also examine the light reflected from different objects or after passing through different filters as sunglasses. Imagine that it's dark, you have a blue item, e. g. a blue pillow and light up a room with a source of red light. What do you see? May be you can see contour of pillow, but you are not able to determine its color under this light. Also by using this source you will be able to measure quality UV filter of sunglasses and comparing quality of sunglasses. The Table 1 shows the approximate values of the reflectance of each color, and you can compare their reflectivity, and to use this knowledge when choosing a particular color in the room or in the appropriate selection of clothes on the way to highlight themselves especially at dusk, so you can avoid injury and prevent accidents on a road.

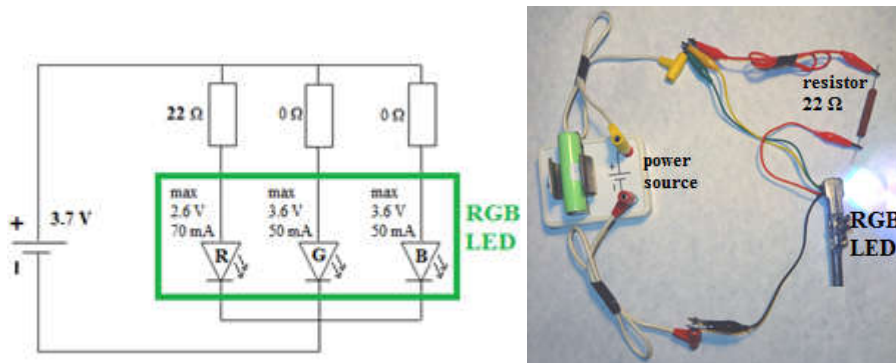


Fig. 5: Wiring diagram and real circuitry

Color of surface	Light reflectance
White	0.75 – 0.80
Yellow	0.50 – 0.70
Red	0.15 – 0.50
Green	0.05 – 0.65
Blue	0.05 – 0.60
Brown	0.12 – 0.25
Black	0.01 – 0.03

Tab. 1: Guide values of the reflectance of light - selection (ČSN 73 0580-1: 2007)

For now, the primary involvement was created according to scheme in order to test whether it works. It is planned to create an additional circuitry containing sliders for controlling radiation intensity for each color, including UV LED due to different intensities of color. We need the same intensity of color for the creation of white light. But it was found that RGB LED is not suitable, because it has not good spatial properties as it is seen on figure 6.

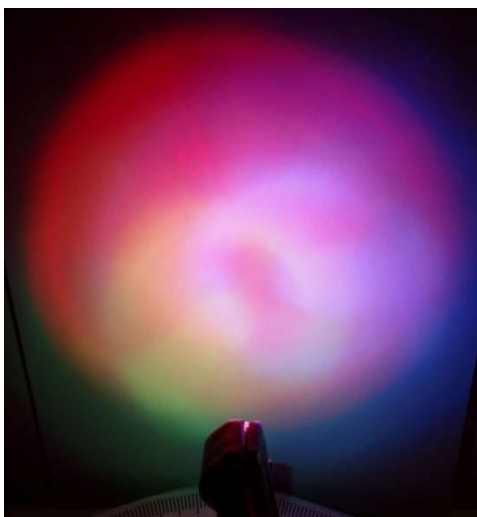


Fig. 6: Spatial properties of RGB LED

Now, on the basis of this information, we try to create better source of radiations. It consists of 3 LEDs (red LED, green LED and blue LED). These LEDs emit light better to space.

type	Wavelength [nm]	Voltage [V]	Electric current [mA]	Angle [°]
Red LED	645 - 655	3.2 – 3.8	350	120
Green LED	520 - 530	3.2 – 3.8	350	120
Blue LED	460 - 470	3.2 – 3.8	350	120

Tab. 2: Parameters of new LEDs

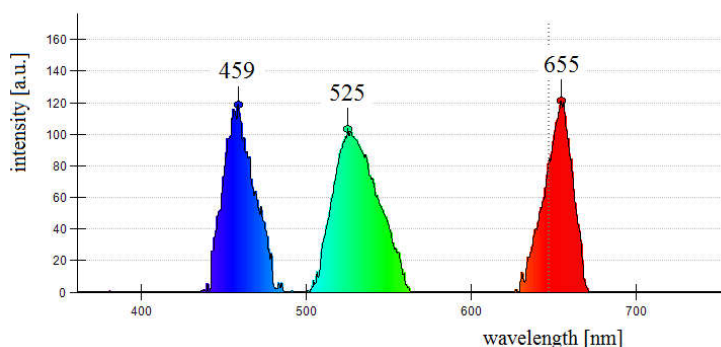


Fig.7: Verification of light wavelength

If we will have a suitable source of radiations then we will focus on creating worksheets with tasks for pupils who can use this radiation sources to measure. Pupils will work in group and learn cooperative in group. (MECHLOVÁ, a další, 2012; Mechlová E. , Výzkum skupinového vyučování ve fyzice na základní škole, 1984)

The aim is to create inexpensive, simple source of RGB + UV radiation, which is a great benefit for teaching pupils in elementary and secondary schools and yet not burden the school budget. It is suitable for demonstration and investigating phenomena in optics. For example pupils get the knowledge of color mixing; they learn about it with the two models: RGB (figure 8) and CMY.

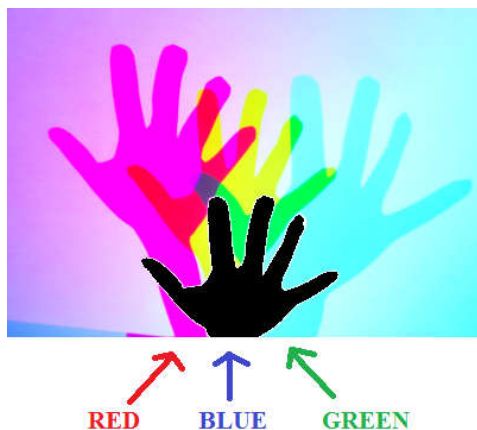


Fig.8: Demonstration of RGB model by using source of 3 LEDs (R, G, B)

Pupils learn that human sees in color because of each subject reflected the light to the eye. A color can be seen on dependence how the light is reflected from an object. So, these phenomena become more interesting, how pupils answered in the questionnaire.

Also pupils can measure dependence of illuminance on the distance from the light source. Pupils find that illuminance decreases with the square of the distance from the light source. Pupils can compare the measured values to the norm of illuminance

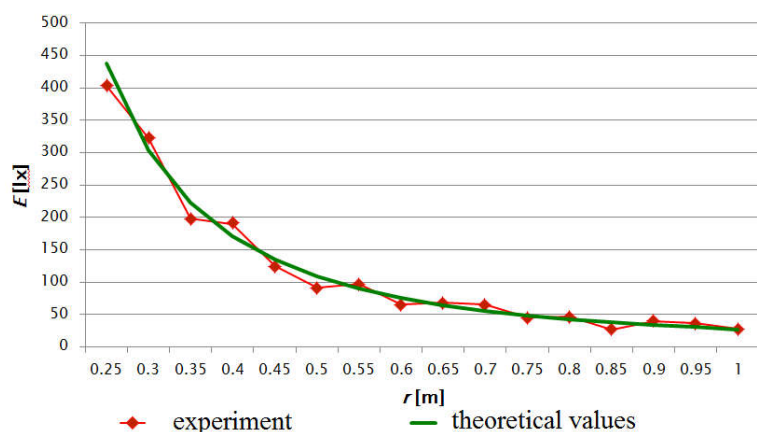


Fig. 9: Dependence of illuminance on the distance from the light source (graph was created by pupils 17 years old)

Conclusion

Photometry is interesting part of physics as follows from these experiments. Pupils appreciate the modern equipment during measurement and appreciate that the tasks relate to their everyday life. This radiation source can help to pupils to understanding common physics phenomena (colour vision; RGB model) and also help to do inquiry based experiments and cooperation in groups.

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SOCIAL MEDIA AS A MEANS OF UNIVERSITY STUDY SUPPORT

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Abstract

The study defines terms from the social media field within the scope of the electronic educational environment as well as social media and social networks as a means of study support at a university. The research on a representative sample of the University of Ostrava students, which was carried out within the scope of the 7th RP IRNet project, is aimed at the analysis of the current situation regarding the use of social media by the university students and at the differences in the use according to the form of study.

Keywords

Social media, social networking, support, study, university students

Introduction

Current digital technologies change how children relate to the world – they influence the process of acquiring and processing information, communication, self-expression and creativity. According to the current Eurostat statistics, 76% of the Czechs between the ages of 16 and 24 use social media. Larry Rosen (2010) introduces the term iGeneration, which he uses for the contemporary elementary and high school students. The iGeneration members are always online, take digital technologies for granted and they are an integral part of their lives. As far as the school instruction is concerned, the traditional concept of classroom teaching is beginning to change as the formal education and informal education are connected more than ever. We think that social media is one of the ways to make school and education more attractive to students – social media is their natural environment, it offers countless opportunities for the support of educational activities and teamwork, it encourages creativity and peer learning (by sharing skills, experience and ideas). And what is the situation at universities? Are social media and social networks used for education?

1 Social Media – what is it?

Both the professional and general public have become acquainted with the term social media. Mostly, the terms social media and social networks are considered to be synonyms. However, scientific publications offer several definitions. Bouda (2009) introduces several definitions from various authors who define social media as:

- Tools that “provide easy use of collaborative working spaces by using various communication tools”;
- A means that enables communication, which has a different purpose than the traditional media. Social media is based on interaction between people. The public feedback (be it in the form of commentaries or editing the original text or content) is the key element;

- All Internet media, which enable gathering of the like-minded groups of people and the discussion about various topics (Chris Nobl);
- The so-called new media, or media 2.0.

Wikipedia, the free encyclopedia, states that social media “are computer-mediated tools that allow people to create, share or exchange information, ideas, and pictures/videos in virtual communities and networks”. It falls within the subset of mass media. It consists of highly interactive platforms, which use mobile and web-based technologies to create user-generated content. Social media differs in many respects from traditional media. The main difference is that, unlike in the initial model where there was only one source, the information is distributed by many sources. Another major difference is the possibility of an immediate reaction, editing, comment or other modifications of the content.

The following definition, Wigmore (2015), stresses the importance of communication for the use of social media, “Social media is the collective of online communications channels dedicated to community-based input, interaction, content-sharing and collaboration. Websites and applications dedicated to forums, microblogging, social networking, social bookmarking, social curation, and wikis are among the different types of social media”.

The authors of the SMILE (Social Media in Learning & Education) project (2013) argue that generally speaking, social media contains at least some of the following characteristics:

- Social media challenges traditional models;
- Social media allows people to communicate;
- Social media allows people to collaborate;
- Social media gives people an audience;
- Social media services often remove hierarchy and are built from the bottom up;
- Social media is open and transparent.

Whether you have your own definition for social media or even disagree with some of the characteristics above, the one thing that everyone seems to agree on is that social media, social networks and the social web is moving from strength to strength. The term given to this by the website socialnomics is the ‘Social Media Revolution’. Socialnomics has also produced a viral YouTube video that provides a number of interesting facts and figures about the rise and growth of social media.

The facts include:

- If Facebook was a country it would be the world’s 3rd largest with more than 3x the size of the U.S. population;
- There were over 75 million more people playing Farmville than there were real farmers;
- A new member joins LinkedIn every second;
- 1 in 5 couples meet online.

The video concludes by stating that, ‘Social media isn’t a fad, it’s a fundamental.

2 Social media and education

Bouda (2009) refers to David Meerman Scott's scientific paper entitled "Asking the Right Questions about Social Media" when he argues that the media in the form of the mass-media touch every person and thus are omnipresent. The man encounters television, radio, the Internet or newspapers everywhere.

2.1 Social media

As far as social media is concerned, Bouda (2009) highlights three points:

1. We access information through social media as it is included in the search results of the Internet browsers.
2. Social media is present on the portals of Internet newspapers or on information portals.
3. If a person asks their friends for information, they are often provided with a link or a blog or other social media with a discussion on a particular topic.

Digital technologies are becoming more accessible to a number of teachers and students. It is only up to them which one they decide to use in their teaching and studying, respectively. Jelínek (2015) introduces the typology and overview of the new generation websites based on the study by Matt Bower from Macquarie University (Australia). The study helps both teachers and students organize educational tools and at the same time helps them choose the optimal tool for teaching and learning, respectively. The study divides the individual tools into 32 groups and 14 categories. These are tools based on discussion, tools for working with images, tools for working with sound, tools for working with video, tools for the creation of presentations, books, animations, social networks, web applications, tools for organization and sharing of materials, tools for working with data, tools for event logging, tools for the creation of tests, tools for 3D modeling and tutor tools.

2.2 Social Networks

Social networks are becoming an integral part of their users' lives. The main advantage of social networks lies in the fact that the users can communicate not only with people who live close to them, but also with people who live on the other side of the world. The interconnection of social networks and education is a current topic. As technology is playing an ever-important role in people's lives, this kind of education could have an enormous impact on the future image of the entire educational system. The use of social networks is on the rise as the number of users, and with it the potential for advertising and business plans, is increasing every year. As far as the future is concerned, social networks offer a vast number of opportunities – from influencing large interest groups (well-targeted advertising) to customized applications to the offer of services based on deduced behavior on the Web.

Jelínek (2015) argues that social networks are not used exclusively by teenagers as more and more adults are starting to use them. In the Czech Republic, approximately 50% of the Facebook users are aged between 20 and 35. This fact tells us that social networks are used not only by students but also by teachers (which makes the education process more attractive to both groups). The following are the social networks intended for the field of education: Twiducate, Class Tools, Edmodo.

Smetánková (2014) refers to the T.H.E. Journal (Technological Horizons in Education) when she claims that social media is a suitable educational tool. It extends the possibilities of learning outside of school and helps students become acquainted with real-life problems and situations (they can learn from one another and from experts). As a result, teachers can

incorporate new teaching methods into instruction. Moreover, being connected to social networks helps teachers in self-education.

3 Research on use of social media by University of Ostrava students

Research objectives

The subject of the research was the use of social media by university students. The goal of the research was to collect and analyze data about the current situation concerning the use of social media and learn whether it varies in various forms of study.

Research problem and research questions

The authors of the study formulated the basic research problem as follows: There are no relevant data concerning the University of Ostrava students' use of social media, which kinds of social media they know/use and what their needs and expectations are as far as this area is concerned. The formulated research problem was further specified by the following research questions:

1. How do students evaluate the need to cooperate when solving educational problems?
2. In which ways do students use social media within the scope of cooperation?
3. What is the reason for students' participation in virtual communities or social networks?
4. What motivates students to share the results of their activities in an electronic environment?

4 Research hypotheses

Corresponding research hypotheses were formulated on the basis of preliminary findings regarding university students' learning habits and their orientation in corresponding studies:

- H1: The daily attendance (DA) students evaluate the need to cooperate when solving educational problems differently than the combined study (CS) students;
- H2: The degree of the use of social networks is different for DA students and CS students;
- The DA students and CS students have different reasons for participating in virtual communities;
- The DA students and CS students have different motivation for sharing the results of their activities in an electronic environment.

4.1 Research file and data collecting

The students of the Pedagogical Faculty of the University of Ostrava, which is participating in the international research IRNet, which is being conducted within the scope of the 7th framework program in 2014-2017, were the research file of this research. All of the Faculty's students were asked through a bulk email to fill out a questionnaire, which was compiled by a consortium of project solvers. 171 (5.4%) out of the total number of 3161 students who studied at the Faculty in the 2014/15 academic year filled out the questionnaire in the Google electronic environment. Considering that students' participation in the questionnaire research was voluntary, the selection of respondents was random. Furthermore, considering the portion of the total number of students and the approximately same number of DA and CS students (1761 (55.7%) DA students and 1405 (44.3%) CS students are studying at the Faculty), the

sample can be considered representative. More detailed characteristics of the research file can be found in Chart 1.

Category	Count	%
Daily attendance students	100	58,5 %
Combined study students	71	41,5 %
Women	141	82,5 %
Men	30	17,5 %
BA students	99	57,9 %
Follow-up MA students	60	35,1 %
MA students	8	4,7 %
Ph.D. students	4	2,3 %
Students of teaching study programs	143	83,6 %
Students of non-teaching study programs	28	16,4 %
Students – advanced users	77	45 %
Students – intermediate users	89	52 %
Students – beginners	5	2,9 %
Total	171	100 %

Chart 1: Research file characteristics

A larger portion of women and students of teaching study programs in the research sample is determined by women's naturally greater interest in (the mostly feminized) teaching professions and the prevailing portion of teaching study programs at the Faculty. Moreover, in the sample the portions of students of all three levels of study correspond to the real portion as represented at the Faculty. More than half of the students consider themselves intermediate ICT users and only a small number consider themselves beginners.

The data collecting took place in April 2015. The students answered the questionnaire questions through the electronic system Google Questionnaire.

4.2 Results and their interpretation

The research results were calculated using Pearson's chi-squared test, the independence test and Fisher's exact test for a 2 x 2 contingency table.

4.2.1 Evaluation of the need to cooperate when solving educational problems

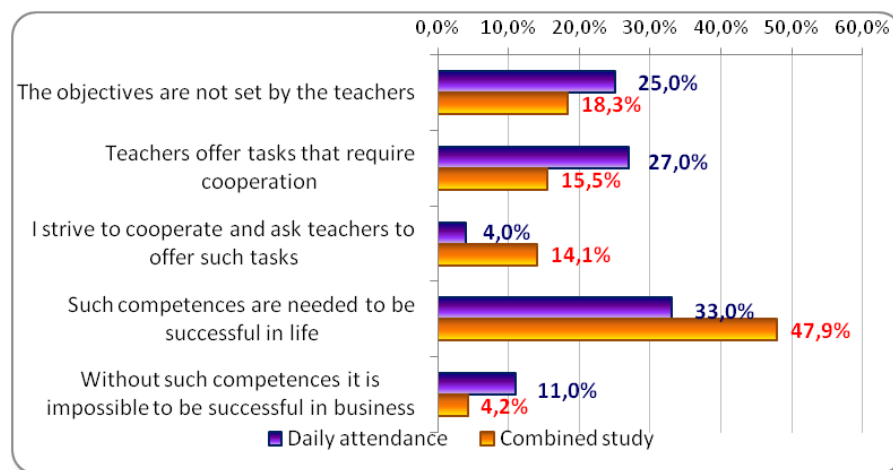
In this question the students evaluated the need to cooperate (when working in a group or a team) when solving an educational problem. The students were asked to choose one of the following answers:

- The need to cooperate should not be determined by the teacher;
- Teachers assign tasks that require cooperation;
- I strive to cooperate and ask teachers to assign tasks that require cooperation;

- Such competences are needed to be successful in life;
- Without such competences it is impossible to be successful in business.

Evaluation of the need to cooperate when solving educational problems		Daily attendance	Combined study	Total
The need to cooperate should not be determined by the teacher	Count	25	13	38
	%	25,0 %	18,3 %	22,2 %
Teachers assign tasks that require cooperation	Count	27	11	38
	%	27,0 %	15,5 %	22,2 %
I strive to cooperate and ask teachers to assign tasks that require cooperation	Count	4	10	14
	%	4,0 %	14,1 %	8,2 %
Such competences are needed to be successful in life	Count	33	34	67
	%	33,0 %	47,9 %	39,2 %
Without such competences it is impossible to be successful in business	Count	11	3	14
	%	11,0 %	4,2 %	8,2 %
Total	Count	100	71	171
	%	100,0 %	100,0 %	100,0 %

Chart 2: Evaluation of the need to cooperate when solving educational problems



Graph 1: Evaluation of the need to cooperate when solving educational problems

The data presented in Chart 2 and Graph 1, respectively show that the DA students mostly think that:

- The need to cooperate should not be determined by the teacher. In this particular case there is a 6.7% difference when compared to the CS students;
- Teachers assign tasks that require cooperation;
- The cooperation competence is very important in business; not having it makes it impossible to be successful in business.

The CS students, unlike the DA students, strive to cooperate and ask teachers to assign tasks that require cooperation. Moreover, they are convinced that cooperation is essential to be successful in life.

We can claim that the H1: The daily attendance (DA) students evaluate the need to cooperate when solving educational problems differently than the combined study (CS) students was confirmed.

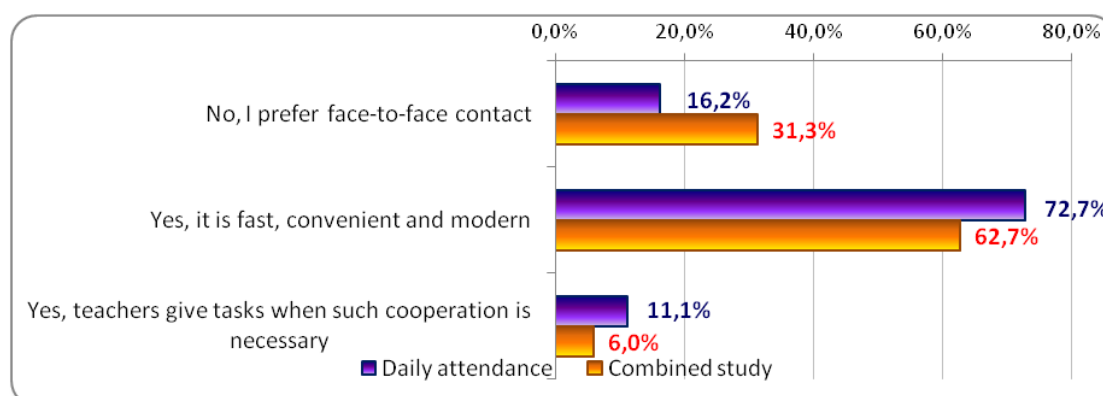
4.2.2 Students' use of Social Media

In order to learn whether or not the students use social media when studying, we asked them the following question: Do you use social services, e.g. social networks, for cooperation and teamwork? The students were asked to choose one of the following answers:

- No, I prefer face-to-face contact;
- No, teachers do not assign tasks that require interaction;
- Yes, it is fast, convenient and modern;
- Yes, teachers assign tasks that require cooperation.

Do you use social services for cooperation and teamwork?		Daily attendance	Combined study	Total
No, I prefer face-to-face contact	Count	16	21	37
	%	16,2 %	31,3 %	22,3 %
Yes, it is fast, convenient and modern	Count	72	42	114
	%	72,7 %	62,7 %	68,7 %
Yes, teachers assign tasks that require cooperation	Count	11	4	15
	%	11,1 %	6,0 %	9,0 %
Total	Count	99	67	166
	%	100,0 %	100,0 %	100,0 %

Chart 3: Students' use of social media



Graph 2: Students' use of social media

The data presented in Chart 3 and Graph 2, respectively show that the DA students mostly think that the use of social media is a fast, convenient and modern way of information sharing and that it helps solve tasks and is useful in cooperation. The difference is 10%. On the other hand, the CS students mostly prefer face-to-face communication. The difference is 15.1%.

The chi-squared test could not be used for this question because the conditions for its use were not fulfilled (25% of the expected frequencies was less than 5). As a result, it was necessary to remove the least represented variant: “No, teachers do not assign tasks that require interaction”. After conducting the independence test we can claim that the H2 cannot be confirmed as the significance exceeds the set limit – 5% (0.053), but only just. However, it can be expected that if we expanded the research file, the hypothesis would be fulfilled as the removed variant was answered only by the CS students.

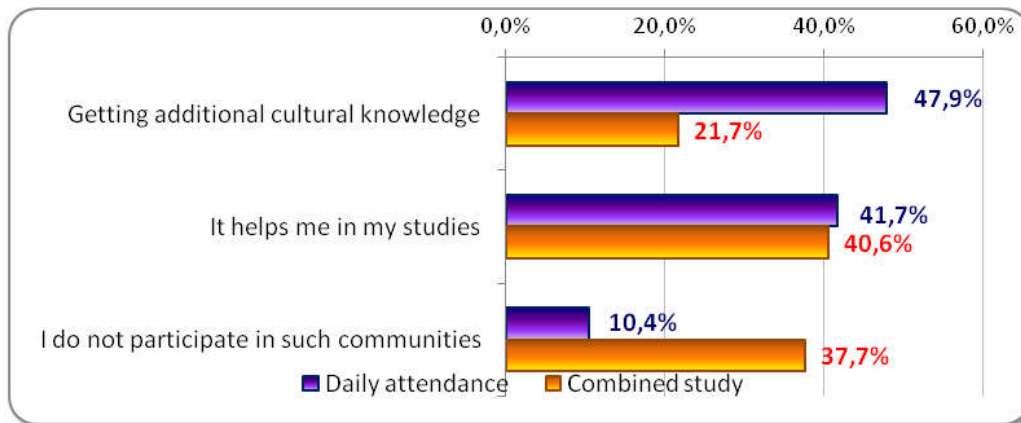
4.2.3 Main reasons for participation in social media

In order to learn the main reasons for students’ participation in social media, we asked them the following question: What is the main reason for your participation in student virtual communities (scientific, artistic, sports) on social networks or other Internet services? The students were asked to choose one of the following answers:

- Acquiring additional cultural knowledge (to learn about various events, to broaden my horizons, to have cultural experiences);
- It helps me in my studies (knowledge sharing, asking to help me solve a problem);
- Finding new friends
- Demonstrating my own experience, knowledge and achievements;
- Organization of my own events;
- I do not participate in such communities.

What is the main reason for your participation in student virtual communities on social networks?		Daily attendance	Combined study	Total
Acquiring additional cultural knowledge	Count	46	15	61
	%	47,9 %	21,7 %	37,0 %
It helps me in my studies	Count	40	28	68
	%	41,7 %	40,6 %	41,2 %
I do not participate in such communities	Count	10	26	36
	%	10,4 %	37,7 %	21,8 %
Total	Count	96	69	165
	%	100,0 %	100,0 %	100,0 %

Chart 4: Reasons for students’ participation in social media



Graph 3: Reasons for students' participation in social media

The data presented in Chart 4 and Graph 3, respectively show that the DA students tend to participate in student virtual communities in order to acquire additional cultural knowledge and because it helps them in their study. As far as the CS students are concerned, participating in student virtual communities helps them in their study. What is interesting is the rate of not participating in such communities – 37.7% of the CS students do not use social networks. On the other hand, only 10.4% of the DA students do not use social networks.

Similarly to the H2 testing, it was necessary to remove the least represented variants: “Finding new friends” and “Demonstrating my own experience, knowledge and achievements. As nobody chose the “Organization of my own events” answer, we tested the distribution of answers for the three remaining answers. The chi-squared result was 0.000 (statistically important), which means that the H3 can be confirmed.

4.2.4 Publishing student's results

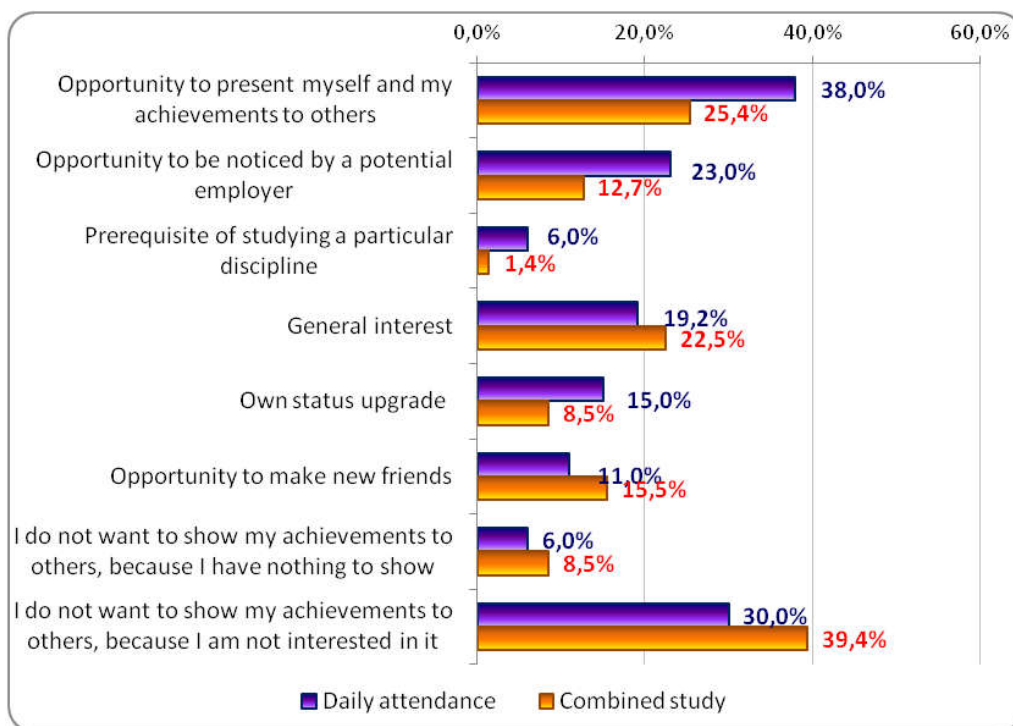
In order to learn students' motivation to publish their results, we asked them the following question: Choose the reasons which motivate you to publish the results of your academic, artistic or sports activities in the university electronic environment (on the university website, social networks, etc.).

Students answered each of the following questions Yes or No:

- Opportunity to present myself and my achievements to others;
- Opportunity to be noticed by a potential employer;
- It can help me acquire a scholarship;
- General interest;
- To upgrade my own status;
- Opportunity to make new friends;
- I do not want to share my achievements with others because I have nothing to show;
- I do not want to share my achievements with others because I am not interested in it.

Reasons for self-realization on the web	Daily attendance	Combined study	Chi-square sig.
Opportunity to present myself and my achievements to others	38,0 %	25,4 %	,082
Opportunity to be noticed by a potential employer	23,0 %	12,7 %	,088
It can help me acquire a scholarship	6,0 %	1,4 %	,241
General interest	19,2 %	22,5 %	,595
Own status upgrade	15,0 %	8,5 %	,199
Opportunity to make new friends	11,0 %	15,5 %	,387
I do not want to share my achievements with others because I have nothing to show	6,0 %	8,5 %	,557
I do not want to share my achievements with others because I am not interested in it	30,0 %	39,4 %	,199

Chart 5: Students' motivation for publishing their results



Graph 4: Students' motivation for publishing their results

The data presented in Chart 5 and Graph 4, respectively show that the DA students, unlike the CS students, present themselves and their achievements to others. They are also more interested in being noticed by a potential employer, acquiring a scholarship or upgrading their own status. 30% of the DA students do not share their achievements with others because they are not interested in it. 39.4% of the CS students (which was the largest portion of their answers) had the same answer. Only 25.4% of them are interested in sharing their achievements with others and 12.7% of them does so because they hope to be noticed by a potential employer.

The hypothesis cannot be accepted for any of the 8 parts of this question. Due to a large number of the low expected frequencies, Fisher's exact test for a 2 x 2 contingency table was used in two cases.

Conclusion

The questionnaire results show that the use of social networks is a phenomenon, which should be used purposefully. Therefore, it would be interesting to find out which kind of education the users prefer and how much time they are willing to spend on it. The popularity of social networks among students and the time they spend there every day raises a question whether they could be used for formal education. Nowadays, Czech universities have their Facebook profiles which they use mainly for marketing purposes. However, the situation abroad is different. A number of researches are being conducted, one of which is aimed at the potential of social networks and their use to improve communication between teachers and students, cooperation of students and the greater involvement of students in school's activities.

Education is changing with the new technologies. The majority of teachers accepts these changes and tries to enrich their teaching with modern didactic instruments. However, the times are changing and the question is whether social networks are fashionable and thus are going to disappear, or whether they have larger potential from the educational viewpoint. The already published foreign studies and researches show the contribution of social networks and blogs. They do so, however, in a very careful manner – as they did 10-15 years ago in the case of eLearning, which is now essential for almost every university offering combined study programs. As far as social networks are concerned, a similar trend can be expected (at least abroad). Why do we not blog and use social networks in education as well? One of the reasons can be the system for evaluation of academicians, which is common at both public and private universities – evaluation points being awarded for papers in reviewed or impacted journals. This results in teachers' reluctance to publish their own ideas, opinions or parts of their researches at academic conferences or on their blogs or social network where it would be available to their students. Another reason might be the fact that the teachers are not familiar with the latest technologies, the unwillingness to present their opinions (which is rooted in the past) or the fear of being confronted by anonymous audiences, which is common on the Internet. Despite the stated disadvantages, the public publishing on the Internet has a potential that needs to be explored and used.

Acknowledgments

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UNUSUAL CONCEPT OF ICT IN ASTRONOMY

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Abstract

Based on the Educational Framework Programme, students in the upper grades of grammar schools should be able to handle spreadsheets – mainly create tables, compare data and use simple formulas – and high school students should be able to complete tasks using more advanced features. During my research on a significant amount of high school and university students I obtained results that did not show the above-mentioned skills. This paper contains several issues and possible solutions to rectifying them, using innovative concepts of ICT in Physics lessons, especially those focused on astronomy. Real science data – astronomical objects in catalogues – is used in the proposed concepts. A comparison of different worksheet approaches will be detailed – the first will focus more on routine jobs with ICT applications, while the second approach will be more oriented towards physics. The result is particular, more or less there is no important difference.

Keywords

astronomy, spreadsheet, catalogue, knowledge, worksheet, star, HR diagram

Introduction

The ability to read graphs and their proper interpretation is an important part of the fundamental knowledge of an educated person should possess. However, previously prepared output e.g. as a graph/diagram is not the only area of interest. Use of advanced functions of software involving spreadsheets is very important as nowadays most fields of work require analysis, calculation, sorting and/or visualising data.

The Educational Framework Programme for Grammar Schools contains the following information in the Educational Area of Information & Communication Technologies: an expected outcome is that the student will be able to ‘process and present the outcomes of his/her work while using advanced functions of application software, multimedia technologies and the internet’. An example of such work are spreadsheets, data export and import, etc. If relevant data and spreadsheets are available, meaningful work with graphs could be an attractive issue. It can also help students improve their knowledge of the software and fulfil the requirements of the Educational Framework Programme.

One interesting source for real data could be catalogues of astronomical objects. This idea was also shortly discussed by team of O’Flaherty, Brumfitt and Lawton in 2007 during International Astronomical Union Symposium. They said that the HIPPARCOS catalogue is an ideal source of data for classwork, since it provides real data illustrating fundamental astronomical concepts in a simple and easily manipulated format. Another source of data can be the Henry Draper (HD) catalogue, as it is mentioned in Sowell (2007) and his team’s article. There are two interesting items: construction of an H–R diagram, where areas of the open circles scale to the number of stars per spectral type and luminosity class; and H–R diagrams of the HD stars produced for various distances. Finally I would like to mention Oostra’s article from 2006. His goal when teaching astronomy was to have the students learn

from their own experience. One of the methods he used utilised online catalogues of astronomical objects. As of July 2015 we have more than 13,770 various catalogues of astronomical objects available at Vizier Service of Strasbourg Astronomical Data Center (Centre de Données astronomiques de Strasbourg). From this vast amount of catalogues I chose just a few of them – stars, minor planets and deep-sky objects. These few catalogues amount to over 680,000 objects and the total volume of data is about 200 MB, which is regularly updated and stored in the Astronomia database (astronomia.zcu.cz). Catalogues are usually designed for professionals, but can also be used by students if the teacher provides sufficient guidance and the data is processed as various and understandable graphs/pictures/plots.

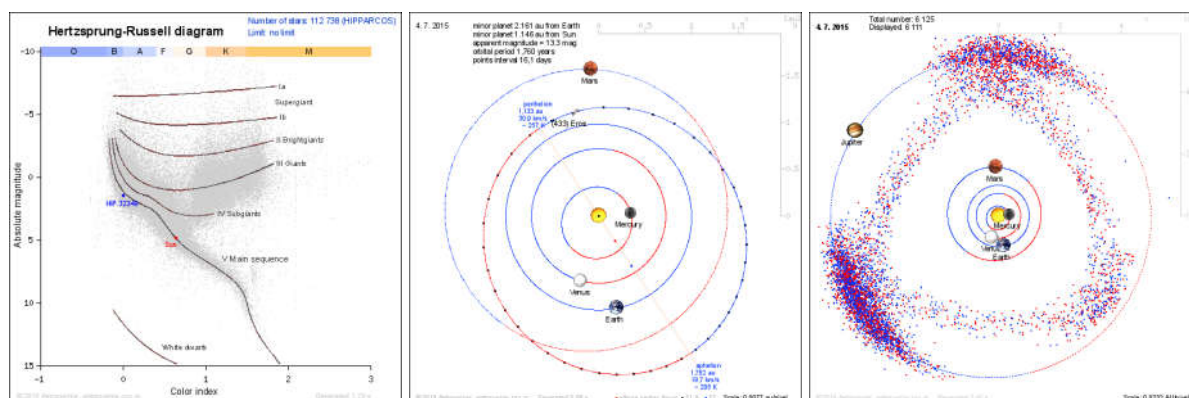


Fig. 1: Examples of various data outputs from catalogues of astronomical objects (left to right): Hertzsprung–Russell diagram of all stars from the HIPPARCOS catalogue, location of one selected minor planet in the Solar System used also for the demonstration of Kepler’s Laws, location of two groups of minor planets in the Solar System.

Worksheets with Astronomical Topics

I carried out a descriptive research with the following four research questions based on careful analysis of theoretical findings in this field:

1. How many students can meaningfully use information from the internet due to the given instructions?
2. How many students can use computer technologies to solve practical exercises?
3. How do students perceive the complexity/usefulness of different kinds of tasks?
4. How many students find exercises based on catalogues of astronomical objects interesting/useful?

Due to the descriptive nature of the research, no particular hypotheses were formulated. For evaluating of these research questions I prepared two groups of worksheets (see fig.2) with astronomical topics covered by catalogues of astronomical objects. Each part of the worksheet (for both groups) is complemented by sub-questions that deepen the knowledge of students and represents welcome feedback for teachers, and also for me for further analysis of the data related to the aforementioned research questions.

H-R DIAGRAM II

WORKSHEET

Name: _____
School, class: _____
Date: _____

1 Advanced Search of HIPPARCOS Catalogue of Stars

Explore the Advanced search of the HIPPARCOS Catalogue of Stars available on the webpage Astronomia (astronomia.zcu.cz → Catalogues...in education → HIPPARCOS and SIMBAD catalogues). Note: Consider mainly the apparent magnitude (Vmag) and parallax (Pia) that are important to construct Hertzsprung–Russell (H–R) diagram.

What is the range of apparent magnitudes (Vmag) of stars stored in the HIPPARCOS Catalogue of Stars?

Find an answer!

2 Constellations and List of Stars

Choose one constellation (possible to use the auto-complete function) and view a list of stars from the catalogue sorted by magnitude from brightest to dimmest.

Which constellation did you choose? What is the designation and name of the two brightest stars of your chosen constellation? What are their apparent magnitudes?

Find an answer!

3 Three Stars, Stars Location on H-R Diagram and Stars Type

Select three stars from the above list of stars. Using the web application on Astronomia pages find the location of selected stars on H-R diagram and determine their type. Decide whether the star is brighter than the Sun or not.

Which stars did you choose? What is the type of selected stars? Decide whether selected stars are brighter than the Sun or not. Fill in the table below.

Designation (name) of star	Type of star	Absolute magnitude
HIP		
HIP		
HIP		

Find an answer!

4 A Comparison of H-R Diagrams

Display an H-R diagram for stars within 100 pc (nearby stars).
Display an H-R diagram for stars from 100 pc to 400 pc (distant stars).

Describe each area of both H-R diagrams.
Are there differences between the H-R diagrams of nearby and distant stars? Why? Explain the reason(s).
Note: Compare each area of both H-R diagrams; find which area is missing or which one is more expressive. Also, consider the values on the vertical axis.

Find an answer!

Conclusion

Describe: how did you solve this task, mention problematic areas, all difficulties of this task. Do you have any suggestions on how to improve it?

Give your opinion!

1

Next page...

2

Fig. 2: Illustration of a worksheet for the construction of Hertzsprung–Russell diagrams, full version available on Astronomia web pages in the Catalogues in Education section.

The first group of worksheets uses raw data from the catalogue of stars (HIPPARCOS). The first one is aimed at finding the brightest stars in the night sky. The second one contains procedures to construct the Hertzsprung–Russell diagrams (HRD) – see fig. 3. This task should be divided into two parts: the construction of the first HRD (for nearby stars, up to 100 pc) can be done with support from the teacher. He/she can advise students and show them the procedure. Whether student understand it can be tested in the second part where students attempt to construct a HRD for distant stars with distance from 100 pc to 400 pc. The second part is more complicated due to some limitations of frequently used spreadsheets. This first group of worksheets is more suitable for ICT lessons, due to the fact that spreadsheets play a key role in this type of exercise.

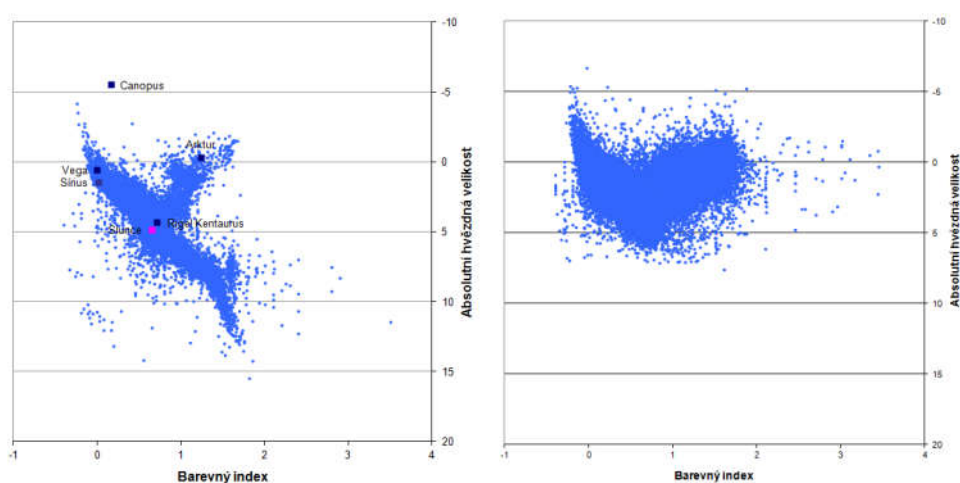


Fig. 3: Hertzsprung–Russell diagrams constructed from raw data from the HIPPARCOS catalogue of stars, on the left for nearby stars within 100 pc also with location of five brightness stars plus the Sun, on the right for distant stars with distance from 100 pc to 400 pc.

The second group of worksheets is created based on interactive online web applications in the Astronomia Multimedia Textbook that uses the same raw data from the catalogues of astronomical objects as the first group, but does a lot of routine and tedious activities and thereby simplifies operations the students do on the computer. I have prepared several worksheets to cover the following astronomical topics: HRD, minor planets parameter analysis, Kepler's laws and the path of the Sun below the horizon including deep-sky objects, etc. This group contains more scientific information and is therefore suitable for Physics lessons, because spreadsheets are not really required for solving these exercises. The key role is played by the internet browser and the students' knowledge.

Data analysis and results

I conducted two research projects in 2011 (exercises based on raw data processing; in sum: 25 students from several secondary schools in the Plzeň and Karlovy Vary regions, 53 university students of two general modules "Astronomy for All" and "Astronomy and the Internet") and in 2012 (exercises based on online web applications; in sum: 49 pupils from grammar schools in the Plzeň region, 204 university students of one general module "Astronomy for All"). Data for analysis were received mainly from worksheet analysis as an objective method and partly from a short questionnaire as a subjective method.

Question 1: To find an answer to the first question "How many students are able to meaningfully use information on the internet based on the given instructions?" I used data from all worksheets (292 participants) and I determined at least 50% success rate as a criterion for the meaningful use mentioned in the research question. The average success rate was only 46 %; just 5 participants had achieved more than 90 %. In total, 110 participants exhibit success rate at least 50 % (this number equals to 38 % of all participants, see fig. 4). Using 95% confidence interval, I found that 32 – 43 % of students are able to meaningfully use the information from the internet due to the given instructions. The supplementary question should be: Why? Is there any correlation with the unpopularity of worksheets? It would be nice to do further research with another, more interesting, method.

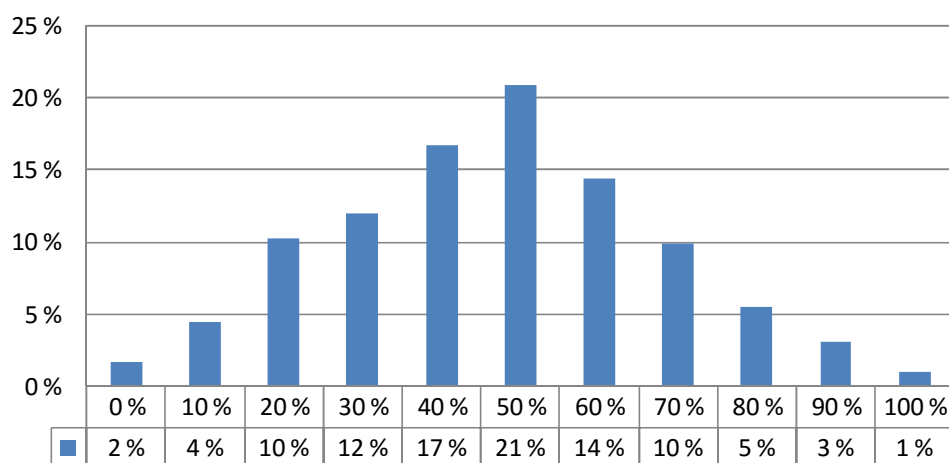


Fig. 4: Completeness of filling (in percentage on horizontal axis) of worksheets by students

Question 2: This question is related to "solving of practical exercises by using computer technologies". The main premise was that if a student can solve it (easily), the exercise should be simple for him/her. I used subjective rating (complexity) of the exercise from the questionnaire. The proportion of respondents reporting these practical exercises as simple or relatively simple (i.e. rating 1 or 2) was only 31 % (95% confidence interval was 25 – 37 %).

The another task was to compare the distribution of answers to a normal distribution with an average value of 3 with standard deviation 1.1, see fig. 5. The critical value of χ^2 of distribution is 9.483 for probability $\alpha = 0.05$ and number of degrees of freedom $k = 4$. The critical value was not exceeded ($6.961 < 9.483$); the p -value for this test is 0.138. This means the exercise rating could have the same distribution of answers (simple = 1, complex = 5) as a normal distribution with average value equal to 3 with standard deviation 1.1.

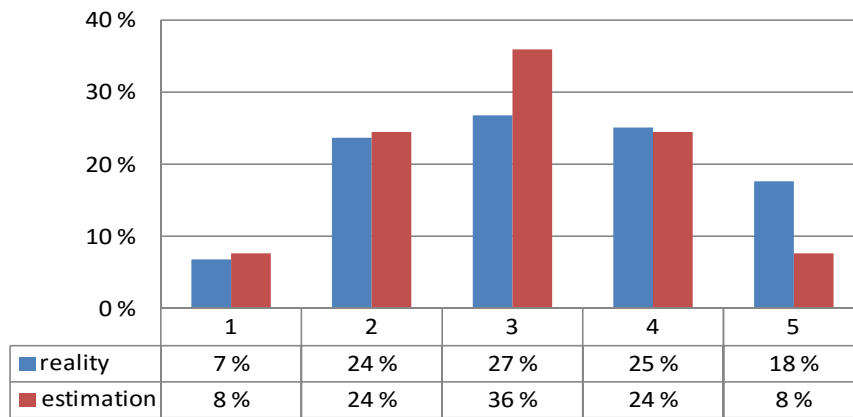


Fig. 5: Comparison of the distribution of answers to simplicity of exercises (“reality” in blue) to a normal distribution with an average value of 3 (“estimation” in red); 1 = simple, 5 = complex

Question 3: Surprising results came from the third question related to perception of the complexity/usefulness of different kinds of tasks. I compared the perceived complexity and usefulness between the group 1 working on exercises based on raw data processing (64 participants) and the group 2 working on exercises based on online web applications (176 participants), see fig. 6. I used two-sample t-tests with unequal variances for this comparison. The critical value of the test is 1.980 for the significance level of $\alpha = 0.05$. The critical value was not exceeded neither in the case of complexity nor in the case of usefulness (0.803 for complexity/0.429 for usefulness < 1.980); the p -value for this test was 0.424/0.669 (for complexity/for usefulness). Both types of exercises have a similar ambitiousness (difficulty/simplicity, in general as a question of time, knowledge etc.) – there are no significant differences between these two groups of participants, meaning also two types of worksheets. The question again should be: Why? What is the reason behind the low ability of participants to solve physics examples? I expected the task more related to spreadsheets would be less attractive and more challenging for participants than the task with already prepared diagrams and their processing.

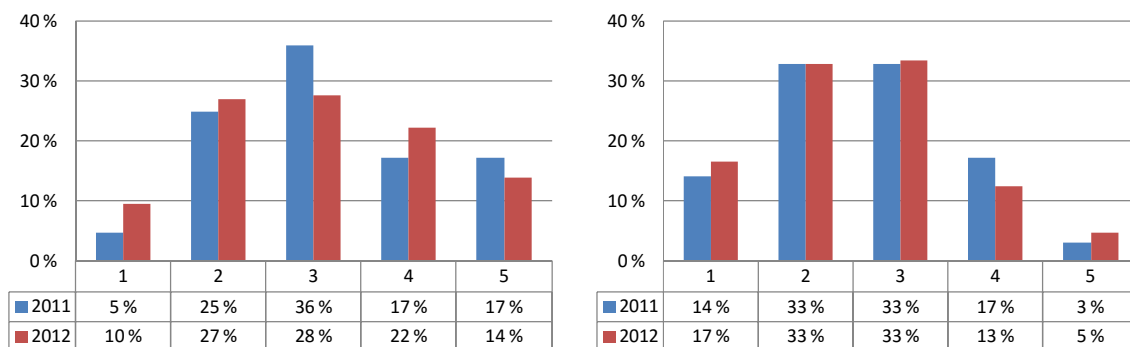


Fig. 6: Comparison of the complexity (left)/usefulness (right) of different kinds of tasks – exercises based on raw data processing (2011) and based on online web applications (2012); 1 = simple/usefulness, 5 = complex/not usefulness

Question 4: The final question tried to find out how interesting/useful exercises based on catalogues of astronomical objects are. By statistical analysis (95% confidence interval) of subjective answers about usefulness of lessons with worksheets, I found out that only 42 – 55 % of students found these lessons useful or almost useful. As to how they felt about the lessons, exercises based on raw data processing are more interesting for students (72 % of students marked 1 or 2) than exercises based on online web applications (54 % of students marked 1 or 2), see fig. 7.

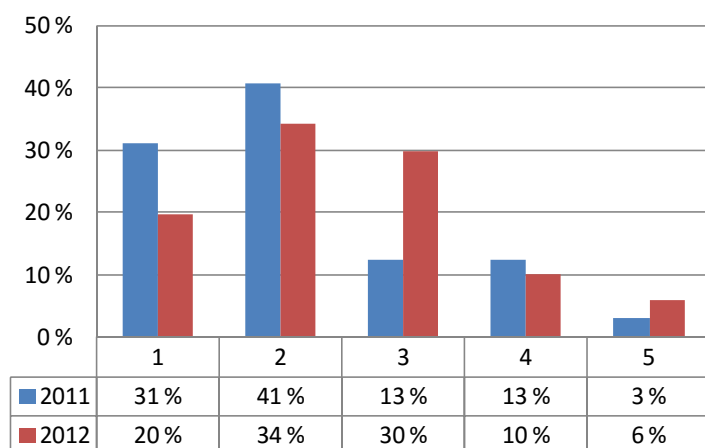


Fig. 7: Comparison of the interesting of different kinds of tasks – exercises based on raw data processing (2011) and based on online web applications (2012); 1 = very interesting, 5 = not interesting

There is a way of making this more attractive for students. However, this proves more difficult for conducting a subsequent analysis. I tried this method during an event called Physics Camp (as part of the Gifted Pupils Support project in the Plzeň region) in 2013. I had prepared various astronomical questions in advance and pupils found correct answers with the help of online web applications.

Conclusion

What is unusual about this concept of using worksheets with astronomical topics? Firstly, it ties together the fields of Physics (Astronomy) and ICT. It can help both subjects and increase the number of already limited hours for topics in technical education. The described exercises use real data from satellites (or other ground projects) without any exception or special pre-processing including all errors and limitations; as it is usual in our life. Students can evaluate all results/outputs, because of real data usage, especially in terms of physics consequences – whether or not they are realistic.

Secondly, it is not possible to easily solve this type of worksheet without a computer and access to the internet, especially to Astronomia web pages. One dissatisfying comment from a university student was: *“It is not possible to find answers on Wikipedia”*. Go ahead! This answer finally confirmed that it is very important to have this kind of exercise. Students have to do some activities by themselves to find correct answers, not only surf on Google, Wikipedia, etc. and then use the typically utilised method of “copy-paste”.

These exercises utilize the internet browser and spreadsheets in an unusual and interesting way and could be used as one of the methods that would help reach expected outcomes in the Educational Framework Programme in the Educational Area of Information and Communication Technologies.

I found that 32 – 43 % of students are able to meaningfully use the information from the internet due to the given instructions. Exercise rating have the same distribution of answers as a normal distribution with average value equal to 3 with standard deviation 1.1. Both types of exercises have a similar ambitiousness. On the other hand exercises based on raw data processing are more interesting for students than exercises based on online web applications.

If you have any experiences with these worksheets, applications, or have any comments, ideas or suggestions, please, let me know.

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WAYS TO SHARE MATERIALS BETWEEN TEACHER AND STUDENT

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Abstract

Ways of using ICT technology is changing. Since the original work on one computer we are moving to a model using cloud services. Related to this is also the method of searching and information sharing between student and teacher is changing. The work compares preferences of teachers and students in relation to work with information and deals with possible changes in the way teachers work with Web applications.

Keywords

school, cloud services, computer, publishing, material, web 2.0

The form of work with ICT

A relatively long time has been the basis of the concept of ICT work computer, often shared by more than one teacher to each other. It was a sufficiently powerful tool connected to the network and the Internet and its typical use was preparing teachers for an lesson and access to school information system. A similar model then be applied in building computer classrooms for students. For each student was a job with a classic desktop computer, student had an account in the school domain, and his work was almost always limited physical access to the school computer network.

This approach is also traceable in the final regular reports of the Czech School Inspection and the Ministry of Education, where one of the main monitored parameters of was absolute number of computers at school and sharing ratio between students, teachers and administrative staff of the school. There is always an emphasis on the number of devices, not on their actual usage. As an example, you can use Report of the state of ICT equipment Czech schools in 2006 prepared by the Ministry of Education and Sports of the Czech Republic as an outcome of the project SIPVZ. This report contains statistics of 97.66% Czech schools, so it can be considered sufficiently meaningful. This report provides information on the following events:

- numbers of computers and their location;
- method of connecting to the Internet;
- the real and the possible connectivity to the Internet;
- level of education of heads of schools;
- numbers of presentation technology.

In the report we can not find any information about the actual use of technology. Only in CSI report appears one sentence that the most common form of the use of ICT is using the educational applications.

The aim of this article is not to analyze the development of the use of ICT tools in schools. If we make an imaginary time leap into 2015, we can see very significant shift away from work with a particular device to move to so-called. Cloud environment. It is no longer important the

ownership or access to a specific device, but the availability of an Internet connection and access to any ICT equipment. Absolutely commonly used term Web 2.0, which changes the understanding of the Internet from a simple source of information on space for sharing and collaboration. It blurs a difference between operating systems and devices, and there is a uniform control of tools through a Web interface. Comes a huge development of Web applications that allows work through the Web client on a Web server. (Churchill, 2009)

From the perspective of teacher comes a very significant change in the way of work with ICT tools. In the original model, the teacher is bound to one particular computer or to an account in the school domain and work-related activity is limited in time and stay at work (school). When working with Web 2.0 tools on the mobile device is all activities limited only by availability of Internet connection. Thanks to Web-based applications, the teacher can communicate with students and parents, prepare a materials into teaching and instantly share them, thus strongly supports teaching model 24/7.

For the purpose of this work was performed two questionnaire surveys. The first questionnaire survey was conducted among teachers from 2nd primary and secondary schools. This survey was aimed at mapping the the current way of working in various activities. Questionnaire included 72 teachers who answered anonymously via an online questionnaire. A second survey was designed for students and students. The group was composed from students 8th grade elementary school (26) and second year of secondary school students (25). The survey was focused on the way of finding information and type of preferred method of transfer materials between teacher and student.

Preparing and publishing materials

The basic activity of the teacher is preparation of teaching materials and making them available to students. This may be their own materials, but also links to other resources. While today's students quite common in the study use the Internet, teachers are getting used to prepare materials in printed form. The 93.75 % of teachers said they have their own teaching materials. Only one teacher said that does not use ICT tools for preparation. For the transmission of materials to students is mostly used email (56 %), or printed material (54 %). The possibility of publishing, sharing and use of LMS uses only a small percentage of teachers.

Survey results are shown in Table 1.

In lessons I use some form my own materials (worksheets, summaries of the information, a compilation of other materials)	
Yes	45
No	3
What materials do I prepare (you can choose more than one)	
Worksheets	26
A summary of the curriculum, or missing information from textbooks	22
Own comprehensive material	12
Other	5
Material I prepare (you can choose more than one)	
Using the ICT	48
Using online environment (Google Docs, MS Office online)	14
My materials are stored in the cloud (Google Drive, Dropbox, ...)	21

I do not use the ICT tools	1
I give the materials to students using (you can choose more than one)	
Email	27
Social network	3
Sharing using cloud service (Dropbox, Google)	9
Publishing on my own web site	4
Using LMS (Moodle)	6
Printed	26

Tab. 1: Questionnaire for teachers

Other groups surveyed was students. Questioning students were 8th grade elementary school (26) and second year of secondary school pupils (25). The aim of the questionnaire was to find their way to search for information and preferred method of obtaining materials from the teacher. The results are given in Table 2.

When I find the unknown term during the study, I find the it for		
	ZŠ	SŠ
In Textbook	2	7
In my notes from lesson	1	6
In material, which I obtained from teacher	4	12
On Internet	24	25
Asking on social network	15	14
Preferred way to obtain the material from teacher		
Printed	20	7
E-mail	18	19
Sharing (Dropbox, Google, atp.)	4	8
Download from teacher's website (or school website)	20	18
Download from LMS	0	3
Using the social network	12	15

Tab. 2: Questionnaire for students

From Table 2 it is evident that students for study use electronic resources in the vast majority. But it is interesting that primary school students prefer to obtain materials in printed form, but no longer work with them. In my opinion, there is a different way of thinking reflected generation of teachers and students. At the primary school students are still taught to work with printed material, they themselves already have, adopted a completely different way of getting information. Although students are encouraged to entries in the workbook, they do not use them in homework. For students of secondary schools, the situation is slightly different. Although the search for information clearly dominates the Internet, students can probably beginning to realize the importance of the summary obtained information in their notes as well as materials from the teacher and they work with them often.

In the case of the transfer of materials dominate e-mail and downloading from the Internet. In the case of primary schools again we see a high preference for printed material. Very low preference occurred in LMS and share via cloud services. Here, however, I assume a high dependence on existing experience of pupils and teachers how to work. In the case of LMS is

usually required the cooperation of teachers and pupils. For sharing using conventional cloud services need to either transfer reference to pupils or shared folder sharing with a group students. These are undoubtedly obstacles to wider use of these two methods of transmitting materials.

We can observe an interesting fact. Despite the fact that teachers almost do not use the option to publish their materials on own website or the website of the school, students should acquire materials that possibility greatly appreciated. The same situation is with social networks.

Tools for publishing own materials

At the beginning, I dealt with a different way of working with ICT tools earlier and now. From both questionnaires is seeing a significant shift to the use of the Web and Web applications. Publishing materials on the Web site eliminates the necessity students to work on a particular computer. Material from the site can be obtained repeatedly from any connected device - computer, tablet or mobile phone. Even the teacher has the option to access from any computer to their published materials and using online tools it can also used for editing. While online tools for preparing materials are already among teachers known (see Tab. 1), the possibility of publishing and sharing are used considerably less. Tools for creating Web sites are not sufficiently known among teachers and most teachers are afraid of technical demands of creation.

Currently, there are Web tools that allow creating own website without any technical knowledge. Let us mention Webnode tools, Weebly and WordPress. (Egan, 2012, Lackie, 2008). Any of these tools can create own web presentation that can contain a structured set of pages, embedded files, photographs and galleries, as well as links to other sites, such as links to shared files and other Web services.

Conclusion

It is obvious that the means of searching and sharing information at schools have changed drastically. Its mostly the teachers who need to accept this change and adapt the way they communicate with pupils. Majority of teachers share teaching materials with their students via e-mails or even in printed form. Students, however, mostly prefer to have the opportunity to download the documents from the internet any time. Thanks to the Web 2.0 tools, posting the documents at a webpage is easy and it is necessary that teachers are trained to do so.

Acknowledgments

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VIRTUAL TOOLS LABONLINE FOR INCREASING THE PRACTICAL SKILLS OF CREATING SQL-QUERIES WHILE TEACHING IT-STUDENTS OF UKRAINE

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Abstract

In the work weaknesses of the process of getting IT-students' practical skills and abilities on the example of DSTU have been determined. The functional requirements to learning informational means have been stated. The structure of virtual learning tools, called LabOnLine, implemented as a module of electronic learning system is presented as a structural scheme. The usage of LabOnLine for the discipline "database" and its laboratory work "creation of SQL-queries" is considered as an example. In the work the roles of users and their actions allowed by the mechanism of access rights distribution have been determined. The functional models of processes of using the learning tools are presented as graphical notes. Main elements of graphic web-interface allowing to implement the given functional of a learning module have been described. The effectiveness of using the developed virtual tools for increasing the quality of getting practical skills by DSTU's IT-students has been substantiated in the work.

Keywords

Instructing modules, e-learning system, virtual tools, information technologies

Introduction

At present the usage of information technologies and a computer as means of educational activity is specific for the learning system and getting knowledge. The basis of the educational medium including IT is a learning information system, which controls the study and partially functions as a teacher (Volery, Lord, 2000).

The specificity of learning and peculiarities of getting professional skills provide the learning systems developers with the challenge of implementing professionally directed programs, whose priority is practical knowledge and skills. The following components can be marked in a learning educational system:

- ✓ instructive materials in text, graphical, animation and multimedia forms;
- ✓ scheme of instruction;
- ✓ tasks for self-control and check of knowledge received.

The main difficulty of introducing the instructing informational system is in implementing the module of getting practical skills and abilities, which is an urgent problem for engineering and practically-oriented specialties (Johnson, Reisslein, Reisslein, 2014).

The state of issue in Ukraine and in Dneprodzerzhinsk State Technical University (DSTU)

The initial provisions of “The concept of distance education development in Ukraine” December 20, 2000 were laid as a basis of Ukraine executive power’s regulatory enactments, which regulate the process, participants and ways of distance education’s implementation into the educational institutions of the country, namely:

- ✓ Order No. 293 July 7, 2000 of Ministry of Education and Science of Ukraine “Establishment of Ukrainian Center of Distance Education”;
- ✓ Act of Cabinet of Ministers of Ukraine, September 23, 2003 “Program of distance education system development for 2004-2006”;
- ✓ Order No. 40 January 21, 2004 of Ministry of Education and Science of Ukraine “Enacting provision on distance education”;
- ✓ Decision of Board of Ministry of Education and Science of Ukraine, June 23, 2005 “State and prospective of the distance education development in Ukraine”.

Despite the number of regulatory documents on distance education, in reality the development of innovative approaches in Ukraine’s education faces the hurdles in the field of state policy in IT application and innovations in education, where main of them are the following (Zavgorodniy, Yalovaya, Yashina, Sadovoy, Romanuha, 2014):

- ✓ absence of regulatory enactments setting the national standards, requirements and evaluation criteria for the effectiveness of electronic and distance learning system usage;
- ✓ absence of the acts of Ministry of Education and Science of Ukraine in terms of the place and the role of electronic learning systems, their possible or necessary usage along with traditional education for personalization of educational process as well as the increase of students’ satisfaction with the process of getting knowledge;
- ✓ insufficient financing for innovations in the field of education, establishing modern technical infrastructure ensuring the development, implementation and usage of distance and electronic learning.

Despite the stated above, higher educational institutions of Ukraine and DSTU particularly are seeking to implement innovations in education.

Research objectives

The aim of the work is to substantiate the opportunity to increase the quality of practical skills acquisition for students of direction “software engineering” in DSTU on account of using the developed virtual tools of getting practical skills called LabOnLine. Further, we’ll use this name. In the work there is an example of making the module of electronic learning system and its application for teaching to create SQL-queries within the frames of discipline “databases”. It’s also necessary to describe a functional model for the process of using LabOnLine, to present the structure of instructing module with stressing the roles of users and displaying functional requirements to the system’s web-interface in the work.

Results

The main problem of training students in Ukraine is in the following. By law each higher educational institution can allocate up to 70 % of educational hours for full-time students and up to 90 % for part-time ones for individual work. The remaining hours are calculated as a

class load of a discipline and consist of lecture and practical classes in the ratio stated by the educational institution.

Thus for instance, 252 educational hours are given out for training students in “software engineering” for a normative discipline “databases”, out of which 102 hours are assigned for class work with a teacher (68 hours for lectures and 34 ones for laboratory work), and 150 hours are for a student’s individual work. IT students’ training in this discipline must meet the following requirements of practical direction:

- ✓ ability to carry out a system analysis of a problem data domain;
- ✓ ability to form a data domain’s infological model with the account of data normalization rules;
- ✓ ability to choose optimal program means and technologies for implementing a physical model database (DB);
- ✓ ability to produce a qualitative program code providing the implementation of database processing mechanisms: procedures of work with DB, procedures with data of CRUD types, SQL-queries etc.

The real academic hours’ distribution raises the following issues for teachers:

- ✓ how to motivate students to learning activity within the frames of hours for individual training;
- ✓ what ways of developing and implementing the elements of electronic learning into the educational process, as well as distance acquirement of knowledge and skills;
- ✓ how to provide a high level of professional practical training at such a small number of hours allocated.

Functional requirements are put forward to LabOnLine

One of the ways to solve the problem can be the usage of additional informational means available at a distant mode, which would let increase the level of practical skills and abilities gained for the students of both full-time and part-time education.

Let’s consider LabOnLine’s using for carrying out the laboratory classes in discipline “databases” in a more detailed way. The virtual tools must be a cohesion of program and technical means assigned for professional training and mastering specialists’ qualification. Elaborated LabOnLine meets the system characteristics of individual learning of trainer type. And the main purpose of its application isn’t in getting theoretical knowledge but in gaining practical skills according to the discipline requirements. The main criterion of its effectiveness is the level of knowledge and skills obtained, as well as educational effectiveness as a whole (Grycenko, Kydryavceva, Kolos, 2004). The module must be implemented as a combination of training and apprenticeship programs with the following main requirements:

- ✓ a minimally set level of theoretical training of students;
- ✓ practicing skills and abilities in the mode question – answer;
- ✓ presence of meaningful dialogue with a user. Each action of a student must be accompanied with comments, hints, algorithms of solving typical tasks;
- ✓ possibility to construct an adaptive-individual scheme of learning based on the available knowledge of a student;
- ✓ implementation of different ways and forms of presenting practically oriented tasks;

- ✓ motivation and the sustenance of students' cognitive activity while achieving educational purposes;
- ✓ existence of pedagogically substantiated feedback with the system, rendering assistance in solving the tasks stated and detailed information in terms of mistakes made;
- ✓ existence of different mechanisms of evaluation and self-evaluation of the knowledge and skills gained;
- ✓ pedagogically substantiated determination of learning activity, which on the one hand, lets control the process of learning in accordance with the syllabus established, and on the other hand, doesn't violate the field of student's independence.

Structure and distribution of users' rights

LabOnLine's content is structured based on the given natural structural dependencies of data domain objects. The discipline is presented as an aggregate essence of such objects as: laboratory works, practical tasks, prompts, template solutions and theoretical data. The module of a student's practical training contains all laboratory tasks foreseen for the discipline. There are a brief theoretical basis and a set of practical tasks for each laboratory class. The number of laboratory works and practical tasks in each of them is given by the teacher. The teacher describes several hints, examples or recommendations for each task depending on its complexity (fig.1). The hints give responses to typical mistakes, which may arise during performing the task, and ways of solving them.

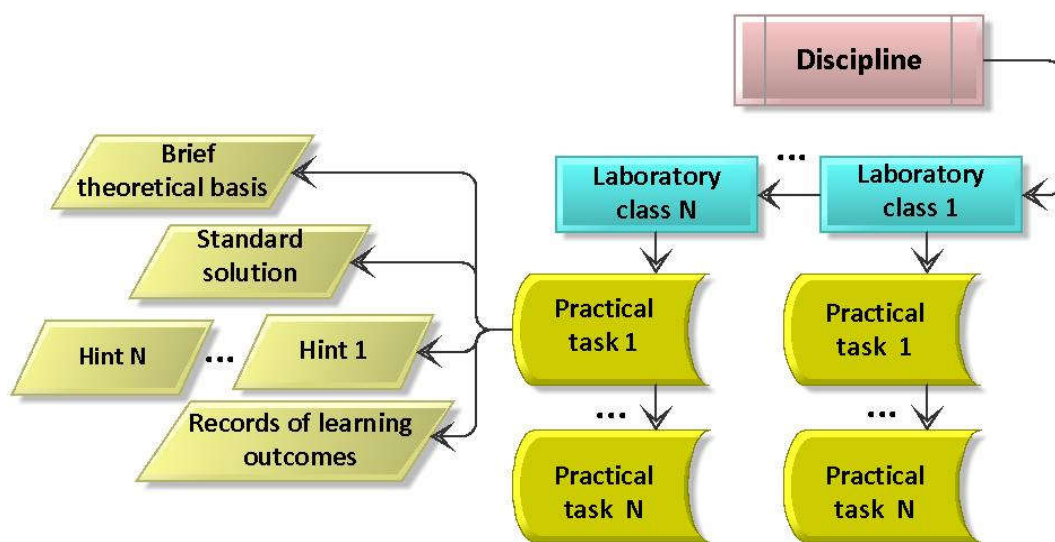


Fig. 1: Structure of learning module

The combined scenario of automated learning consisting of program-controlling and logically-controlled part has been chosen for LabOnLine. The program-controlling component lets set the way, sequence of issue and learning material structure in the very module. The composition and logically-structural scheme of classes and tasks is determined by the teacher on the stage of educational materials development. A logically-controlled part of the education scenario provides a student with the opportunity to choose an interesting laboratory class or a practical task as well as to take an independent decision on the necessity to get theoretical data or prompts from the system.

In the learning module there have been implemented the functions of the control over typical semantic and syntactic errors of discipline “database”. Syntactic mistakes are a wrong writing of a program code. The syntactic control of the response is in setting the correspondence between the data gained from the student and the complex of syntactic rules of language SQL. Semantic mistakes are misunderstanding of the task, mistakes in normalization or logic of designing DB. The peculiarity of LabOnLine is the comparison of not syntactic correspondence of the student’s response to a standard solution but in comparing a set of results of the student’s selection and the one of a correct query. The semantic mistakes’ control lets avoid the situation when a correct program code written by the student, which differs from a standard result only in a syntactic construction, is interpreted as a wrong by the system. The student also has an opportunity to practice different variants of logic of creating SQL-queries. Within the module frames there occurs the evaluation of laboratory works’ quality based on the number of points earned.

In the frames of LabOnLine three user’s roles are foreseen: an administrator, a teacher and a student. Depending on the role main actions of users are the following:

- ✓ administrator: system configuration, the control over work capacity and fixing of system work as a whole, testing of new models, administering DB, controlling over the access rights, publication of educational materials in the system;
- ✓ teacher: creation of educational materials in a mode defined, determination of the list of laboratory classes, practical tasks, hints and managing impact for the educational process, the determination of evaluations for each task, setting of a complexity level, general control over the educational activity;
- ✓ student: learning of educational materials.

LabOnLine’s functional model

A functional model of LabOnLine can be presented as a set of implemented system and learning functions for each role of a user (table 1).

Role of a user	Functions of virtual tools
Administrator	User’s authorization
	Adding and editing of the laboratory classes’ subjects, setting of number of practical tasks within the frames of each laboratory task
	Adding and editing of practical tasks and setting of points’ number for the task performed
	Adding and editing of a standard performance for a practical task
Teacher	User’s authorization
	Selection of learning outcomes in a given discipline, group, student
Student	User’s authorization
	Submission of navigation mechanisms in laboratory classes and practical tasks of a discipline
	Display of the task condition in a view of a web-form
	Provision of a user’s meaningful dialogue with a system
	Display of control elements for inputting the response
	Provision of staged performing of laboratory class tasks
	Provision of the check and the evaluation of the response done by the student

	Submission of the necessary assistance and hints
	Demonstration of standard performance of a practical task
	Fixing of data on the way and results of carrying out a practical task, their registering in the records

Tab. 1: Distribution of system's functions in users' roles

The rendering of functions of editing educational materials to an administrator gives an opportunity to minimize requirements to IT-competences of the teacher and the ones of the system stability to the mistakes of users' input. The teacher will face the task of forming instructing materials: the structure of laboratory classes, practical tasks, responses, hints. The educational materials must be electronic according to a given template and be passed to the administrator for placing in the system. The following operations of the administrator within the frames of LabOnLine can be marked: adding new, erasing old and editing existing educational materials. The results of operations with data are reflected in database. At getting the application for placing or changing the educational material content the administrator has to perform functional actions with the system, whose scheme is in figure 2.

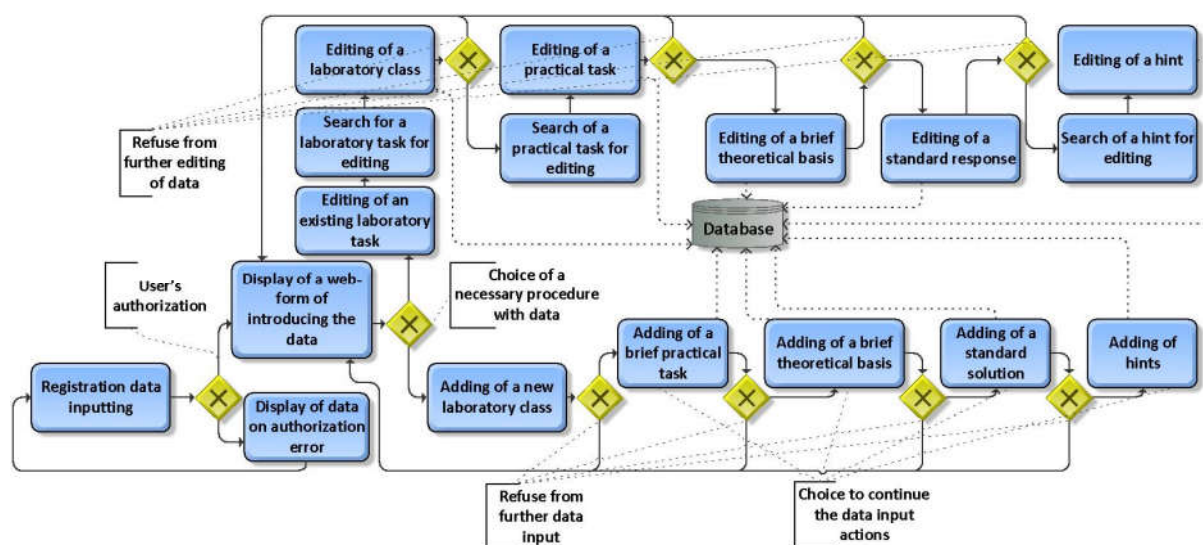


Fig. 2: Functional model for the control process over educational materials

The functional model for the process of acquirement of practical skills by students is in figure 3. After the authorization a student has a possibility to choose a necessary laboratory work and a practical task to perform. If necessary the student can use a brief theoretical basis or proceed to making a practical task. Having received the task, the student can introduce the result of the work; there is no time limit. If the student's result coincides with a standard, the notification is issued, the record result is made in a DB, and the student can move on to a further practical task. If the error is semantic (a correct enquiry structure but the enquiry doesn't solve the task stated), then a correct selection's structure is offered to a student as a hint. If the error is syntactic (the code of query is wrong), the student gets the error notification with the text of comments.

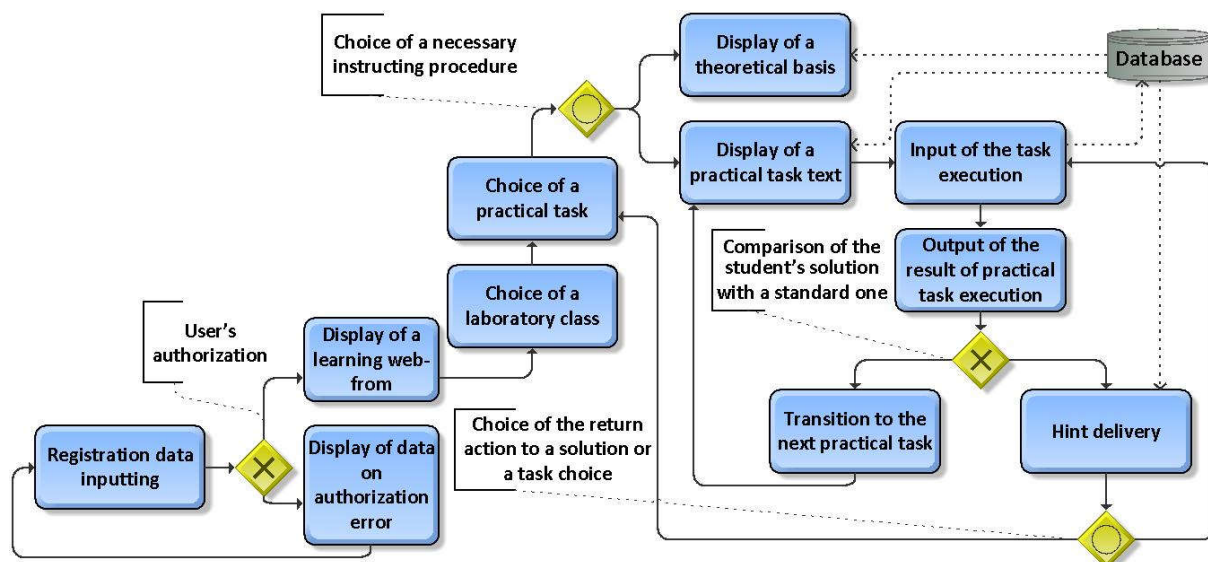


Fig. 3: Functional model for the process of student's getting practical skills

Structure of the web-interface and software of LabOnLine

LabOnLine's web-interface was worked out with considering the demands of intelligibility, easiness in development, decrease in user's sensitivity to errors. The web-forms' interface is different for each user's role though they are made in a uniform style and with considering the demands to unify the dialogue with a user. At working out the scheme of the dialogue between a student and a learning module the criteria of the interface effectiveness and psychological principles of student-computer interaction were taken into account, namely:

- ✓ engagement of student into a dialogue took place only at the moment of substantiated necessity so as not to violate the progress of cognitive activity.
- ✓ emergence of system messages doesn't violate an inner dialogue of the student and the field of his independence;
- ✓ student has the opportunity to address the prompts individually at the moment when he acknowledges the error and agrees to get assistance. The system's prompts were organized with considering that they mustn't be intrusive but sufficient for supporting educational activity.

Main elements of the user's interface are navigation menu (set of hyperlinks for choosing laboratory works and practical tasks), elements of tasks' display, elements of a student response input, elements of issuing the hints, elements of delivering practical task performance results, elements of displaying report data, and elements of inputting the indexes of educational material search.

The software of LabOnLine is implemented by means of programming language PHP5.4 at using MySQL Server 5.0.51. All data processing is done with the usage of server treatment of data; the client only functions as a user interface provider. The application of a "thin user" lets provide the implementation of a distance learning main principle – "to learn wherever and whenever" (Fisher, Exley, 2014). In order to use LabOnLine it is sufficient for the student to have an internet access and technical means of interaction with a system: a computer, a smartphone, and a tablet. Besides, it's a top priority that there is no need to set special software or a program platform for supporting the learning module work.

The software developed meets the requirements of a qualitative program code, main of which are:

- ✓ independence from the equipment and program platforms;
- ✓ distribution of processes and their autonomy;
- ✓ scaling and flexibility;
- ✓ ability to integrate and widen.

Conclusion

Reduction in amount of educational disciplines' credits and constant reduction of auditorium load hours at higher education institutions of Ukraine set the task for the teachers to maintain a high level of professional training of students and their motives to self-education within the characteristics of disciplines, specialties and directions of education. The usage of educating IT, systems of distance and electronic learning, all-possible learning modules and virtual laboratories can be an effective tool in achieving these aims. The normative acts, standards and evaluation criteria used in the process of implementing the systems of electronic and distance education are considered in the article. The authors offered to use the virtual learning tools called LabOnLine for increasing the level of gaining practical skills and abilities for IT-students in the direction "software engineering" in DSTU. In the work the functional models of the process of controlling the educational materials and the one of getting practical skills by the students have been described. The peculiarities of LabOnLine, its web-interface, features of administering, functions and roles of users with the account of differentiation of access rights have been considered. In further scientific works authors are planning to reflect the results of numerous estimation of the effectiveness of using the developed learning tools by means of approbation for the full-time, reduced and part-time students.

Acknowledgments

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ACTIVITIES IN GRAPHICAL EDITOR FOR VISUALLY IMPAIRED PRIMARY SCHOOL PUPILS

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Abstract

Work with graphics is important part of Informatics in primary school. In this article, we describe graded activities and methodical material for “Work with graphics”, which can be used also with visually impaired primary school pupils. We describe some of them focused on developing skills for work with graphics and for developing algorithmic thinking, too. We analyse activities and suggest its assessment. Based on this analysis we propose improvements of tasks. For our pupils, we chose graphical editor Revelation Natural Art, which was adjusted according to specific needs of our pupils. In this article we also describe this adjustment.

Keywords

work with graphics, Revelation Natural Art, visual disability

Introduction

Goal of the article is to create and verify methodical material for “Work with graphics” for pupils with visual impairment. We don’t put emphasis on development aesthetics but we put it on development of algorithmic thinking because we consider it important in informatics.

In the first part of article, we discuss problematic of visually impaired pupils, we define basic types of visually impairment and describe magnifiers for visually impaired pupils. Later, we describe graphical editor Revelation Natural Art and its adjustment, which we have made for our pupils. In the next part of article we describe our activities. We offer our experiences with verifying these activities with the group of visually impaired pupils. In the last part of article, we propose improvements of activities.

Visual impairment

In general, we can divide visual impairment into three main groups: total blindness, low vision and disorder of color perception (Jašková, 2011). In this article, we focus on low vision, because it’s important in term of our observed group. Low vision pupils are children that have heavy visual disorder and have to use special aid to learn.

Some of them needs to use some sort of magnifying software to work with computer. Magnifiers are softwares that can make work with computer easier for low vision person, because these softwares can larger screen content several times according to user’s needs. Our pupils usually use two to six levels of magnification. Magnifiers also provide inverse colors function that can be useful for some low vision pupils. Example of magnifier is free software DesktopZoom (Regec, 2010). Our pupils use software ZoomText.

Revelation Natural Art

Revelation Natural Art provides the possibility to customize settings in chosen interface. This customization is easy to use and it allows user to add or remove tools, increase or decrease tool button size, create new toolbars and other useful customization according to user's needs. Steps how to customize interface are listed in Revelation Natural Art Reference Guide (Kalaš et al., 2006).

In our customization, we removed some tools that were surplus for our activities. Then we were able to increase tool button size for those tools, which were useful for us. If there was original number of tools, environment of editor should be confusing during using magnifier. We wanted to reduce using magnifier, because if pupils use higher level of magnification, they see only part of environment, so they can easy lose overview about their work.

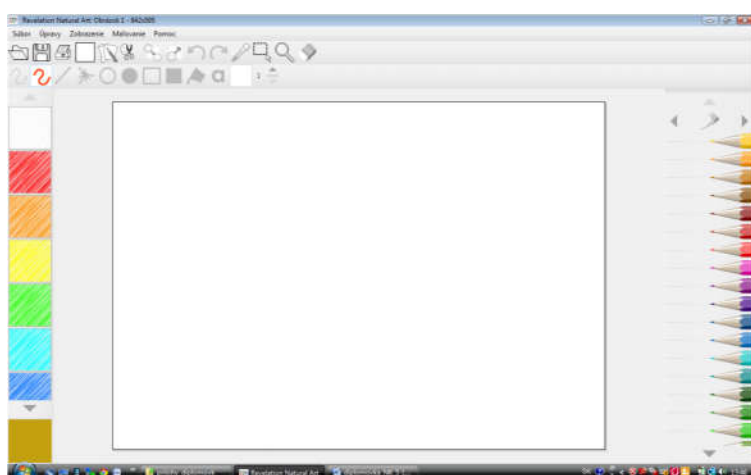


Fig. 1: Customized environment of Revelation Natural Art

Activities

In this part we focus on the activities that we proposed due to requirement of state education programme for second grade of elementary school (ISCED 2). We proposed and verified eleven activities. Seven of them were part of bachelor thesis and were an introduction to the work with graphics, the next four activities followed to them in the incoming grade and were a part of diploma thesis. In the paper we choose three graded activities, which were offered as a continuation to the initial activities. In the first activity we describe the whole methodical process together with assessment of the activity, in the next two activities we describe only the basic data. The complete methodical materials to these activities are part of diploma thesis (Kováčová, 2014).

First activity: Draw picture according to instructions

We recommend to use this activity as an opening activity oriented to the use of geometrical figures. At first we can talk with the students, if they already have the experience with the description of the process of the activity that they had to follow. If yes, pupils should describe the activity and why they had to lead the instructions. We ask them, if they could skip some steps and what might happen if they would skip them or changed the order.

For motivation we can tell pupils that in the local ZOO a baby tiger was born. We were asked by the ZOO to draw a poster that will inform the visitors before the entry about this happy event. To make it easier for us, we got the instructions for drawing the tiger.

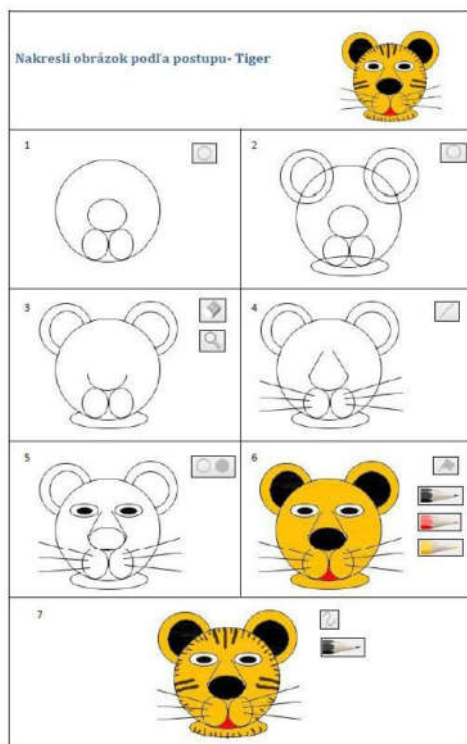


Fig. 2: Worksheet to draw tiger

Afterward we give a worksheets to the pupils. We chose the same worksheet for all of them but it's also possible to use different sheets for some pupils. We explain the pupils, what their task is- in the graphical editor Revelation Natural Art, they are supposed to make a picture, following the instructions written on the worksheet. We tell pupils, that in a case of mistake they can use the button back and we also emphasise that they don't have to try to make the completely same picture. With the using of mentioned tools of the graphical editor some abnormalities can happen but they are not mistakes for us. It doesn't matter if a student will draw longer line or a bigger circle. In a case of some questions teacher is answering and giving an advice what they are supposed to do.

After the end of the activity the teacher could discuss with the students about the difficulties in the activity and if the instructions were clear enough. As assessment we recommend individual discussion with pupils. Teacher should highlights of pupils work but also remind them their mistakes.

Second activity: What tools were used?

The goal of the second activity is to add missing tools icon in steps of worksheet. Pupils should analyse steps in worksheet and practise working with areas, because it's necessary if they want to do this activity. Motivation in this activity is help to their teacher. The teacher likes the instructions for drawing that she got from the employees of the ZOO. She decided to make instructions for their students for drawing a cat. But she forgot that she has to mention

which tool is needed to use for drawing the concrete step. Pupils are asked to help her to complete these worksheets. We recommend to do this activity similar as the first one.

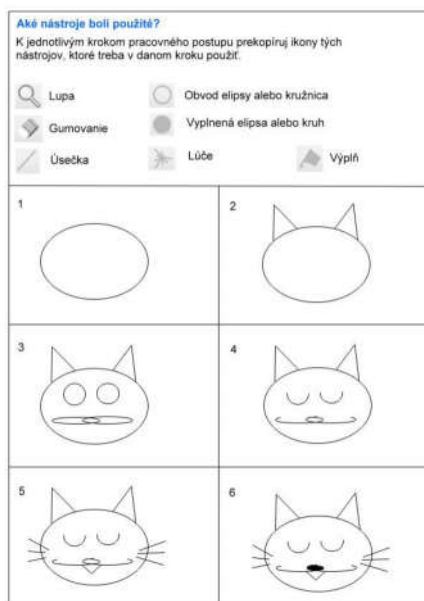


Fig. 3: Worksheet for activity What tools were used?

Third activity: Create worksheet for classmate

Goal of third activity is to create new worksheet for another pupil, according to which the pupil will be able to draw some picture. Pupils are asked to create these worksheets for younger pupils, what is strong motivation moment. Pictures are prepared by teacher and at the beginning of work, they have to choose one of them. We prepared template of worksheet, so pupils should copy steps of drawing to individual parts in worksheet. We recommend to use only one or two tools in one step. Pupils work individually, teacher only help them if they have some problem. Teacher must emphasize, that worksheets have to be comprehensible, because they will be used by younger pupils.

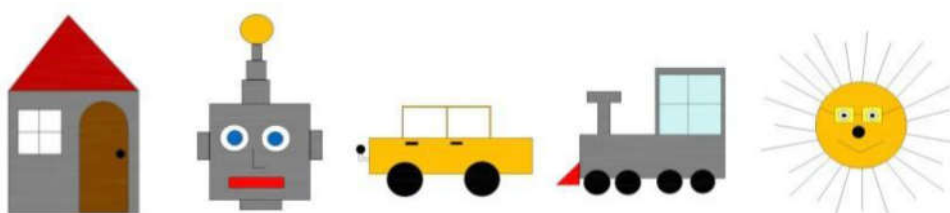


Fig. 4: Pictures, for which pupils create worksheets

Important part of assessment in this activity should be self-assessment, because pupils will see, how another one work with their worksheets. Teacher should give pupils time to comment their worksheets and speak about problems, which they have seen when another pupil used their worksheets. Of course, teacher should tell to each student, what was good at worksheets and what should be fixed.

Verification of activities

We verified created activities with group of low vision pupils of seventh class of special primary school for visually impaired pupils. Because of pupils anonymity, we won't list their names. There were five pupils in this group. One of them used magnifier, but only when she needed it, so it wasn't constantly. The others didn't need any special tools, but they were available if they wanted to use some of them.

First activity: Draw picture according to instructions

After verification of first activity we found out these facts:

- Time for this activity was not correctly defined. Only two pupils done this activity in our defined time (20 minutes), but the others had problem with drawing circle. It was really difficult for them to realize, that the point from what they started to draw circle is not the middle point of circle, but the left top of square, what encloses circle. Because of this fact, they had to use back button more than we thought. They also wanted to draw circles as accurate as possible.
- Time for activity was also raised by using Eraser tool, what was new for our pupils. It was necessary to explain, how this tool works.
- We had to repeat pupils, that they really didn't have exactly the same picture as in the worksheet. They wanted to draw the same length lines or the same large circles. But that was not the goal of activity.
- We discussed this activity with pupils and they said, that they really found difficult to draw circles, because they didn't know, how to draw it as large as they wanted. One pupil said, that he is not so patient to do this activity. Despite of these facts, we consider this activity suitable for our pupil's skills.
- We recommend to reserve more time for this activity.



Fig. 5: Tiger by pupil A (on the left), tiger by pupil B (in the middle), tiger by pupil C (on the right)

Figure 5 illustrates three tigers drawn by pupil A, pupil B and pupil C. We can see that pupil A didn't want to use Eraser tool. Maybe this is reason why this pupil draw tiger's ears differently than in worksheet. We can see absence of this tool also in tiger's neck.

Pictures of pupil B and pupil C we consider as correct despite of wrong color of tiger. This fact is not important, because some low vision pupils can have problem with color perception and using accurate color was not goal of this activity. It's more important that they kept right sequence of steps in worksheet and right use of tools.

Later we verified this activity also with pupils in sixth and ninth class of the same primary school, but they were the same problems. Only one difference is, that some of older pupils used inverse colors and all of them used magnifier.

Second activity: What tools were used?

- Time for this activity was correctly defined.
- We can say that most students done this activity very successfully and they managed to add tools icons correctly.
- When all worksheets were done, we asked pupils to try draw picture by their worksheets. Those pupils who made some mistake in worksheet were able to find these mistakes and correct them.
- The most common mistake was exchange of Rays tool and Segment tool in drawing cat's whisker. The next common mistake was omission of Eraser tool. One pupil tried to use freehand drawing by Line tool, because he didn't want to use Eraser, but after teachers recommendation he used tools listed in worksheet header (Line tool wasn't listed).

Third activity: Create worksheet for classmate

We found out that pupils wanted to use only few steps despite of our recommendations. Although we appreciate created worksheets and we consider them to be useful and valuable. In the figure 6 on the right side (House) we can see, that pupil used something extra, what wasn't said. She added text next to tools icon, what shows, how many times it's necessary to use this tool. This is not wrong, but tool "Text" wasn't listed in the worksheet header, so it should not be used. We think it's important to remind pupils that they can use only these tools, which are listed in worksheet and if they want to use the same tool multiply, they have to do it in more steps.

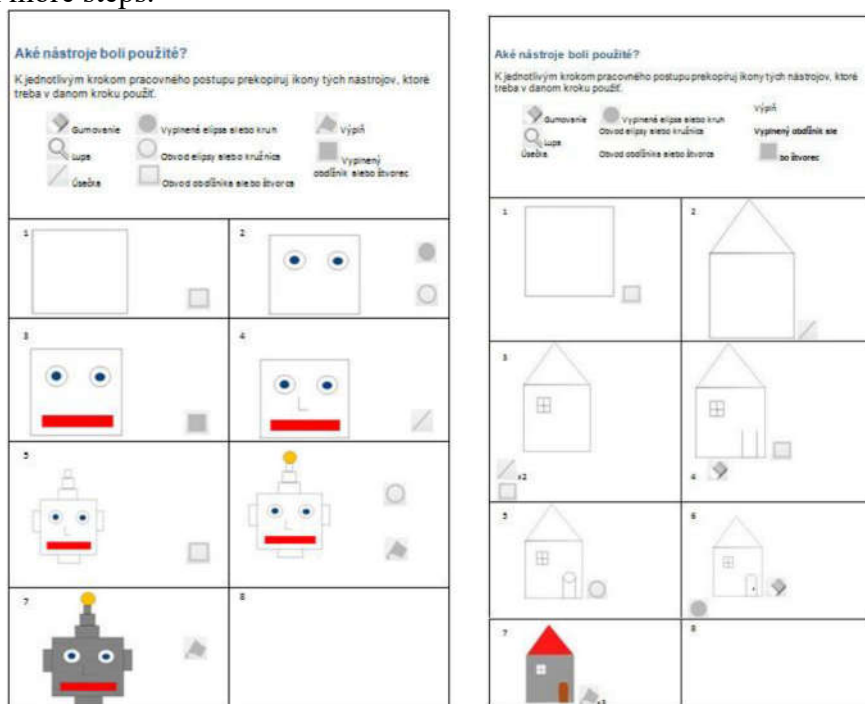


Fig. 6: Worksheet Robot (on the left) and worksheet House (on the right)

Conclusion

Our activities were focused on development of algorithmic thinking by doing some sequence of steps and by creating new sequence of steps. We offer methodical material for teacher, because they need to know, how to work with our activities. There activities were verified in school with low vision primary school pupils in seventh grade, one of activities was verified also with pupils in another grades of primary school. We gained various aspects on activities. We also made suitable customization of graphical editor Revelation Natural Art that was very useful for some pupils to reduce magnification and thus increase comfort in work with graphics. We believe that this material will be useful for teachers who want to teach graphics interesting and attractive.

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DEVELOPMENT OF INQUIRY SKILLS IN TEACHING LINEAR DEPENDENCE

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Abstract

The skills focused on the interpretation of data from tables and graphs and the ability to apply functions to solve problems were an important area for testing mathematical literacy in The OECD's Programme for International Student Assessment (OECD PISA) 2012. Lack of skills in the use of functions causes problems in mathematical modelling of real situations. Our research is currently focused on developing inquiry skills of students in mathematics and diagnosing the level of their development. Inquiry based science education (IBSE) could bring improving of understanding of mathematical knowledge and could increase the activity of students in learning. In the paper, we present our first experience with testing the level of development of selected inquiry skills of students. We focus on the evaluation of tasks requiring working with different representations of data and understanding of linear dependence. The paper presents also interactive learning activities that are part of our innovative methods based on applying inquiry approach to teaching linear function.

Keywords

Inquiry skills, mathematics teaching, linear dependence, modelling, interactive activities.

Introduction

The ability to apply the acquired knowledge to solve problems is an important mathematical competence. The development of students' abilities to solve problems requires the use of different representations of data and various types of models to express relationships between variables. Acquisition of skills in the use of simple arithmetic and graphical models is the first step in developing students' ability to use modelling in problem solving. Working with simple models provides students with skills to understand and use algebraic models, which requires the identification of variables and expression of relationships between variables using equations, inequalities and functions.

Simple functional dependencies, such as direct and inverse proportion, are already included in teaching mathematics in the primary school. The direct proportion is a special type of linear dependence between quantities. Solving problems on linear relationship should also include the creation of tables and graphs through which various real life situations could be modelled. Suitable topics are for example tasks on motion and tasks from financial mathematics. Lack of experience in designing and interpreting charts and graphs can cause problems in understanding of symbolic representations of functional dependencies between variables.

Selected results of testing mathematical skills in PISA 2012

The monitoring of mathematical literacy is the aim of several international assessments, for example TIMSS (Trends in International Mathematics and Science Study), OECD PISA. An important area of testing within PISA 2012 was solving tasks focused on the use of functions.

The results from PISA 2012 show a reduction in the level of students' mathematical literacy in Slovakia (NÚCEM, 2013). Slovakia has for the first time since 2003 fallen significantly below the OECD average. Selected results show that Slovak students have gaps in working with tables and graphs and have difficulties in understanding and using functional dependencies.

Students should use the knowledge of linear function, for example, to solve tasks in the area of finance. As an example, we chose the task DVD Rental (OECD, 2013): *Jenn works at a store that rents DVDs and computer games. At this store the annual membership fee costs 10 zeds. The DVD rental fee for members is 2,50 zeds and the fee for non-members is 3,20 zeds. What is the minimum number of DVDs a member needs to rent so as to cover the cost of the membership fee?* To solve this task students can use linear functions $f: y = 2,5x + 10$ and $g: y = 3,2x$ and find x , for which the values of both functions are equal.

Students also have difficulties in understanding the symbolic representation of the relationships between variables. As an example, we chose the task about drip rate of infusion. A formula for the calculation of the drip rate, D , in drops per minute for infusions is:

$$D = \frac{dv}{60n}$$

d is the drop factor measured in drops per millilitre (mL), v is the volume in mL of the infusion, n is the number of hours the infusion is required to run.

29,6% of Slovak students calculated the value of the variable v for the specific values of the variables D , d , n correctly. Only 18,1% of Slovak students solved the task focused on a verbal description of the relationship how D changes if n is doubled but d and v do not change correctly.

The project focused on inquiry approaches to teaching of mathematics, physics, and informatics

Lack of skills in the use of mathematical knowledge in solving problems can be caused by students' lack of experience with the use of simple models for the acquisition of mathematical concepts and relationships. The low level of development of the modelling competence is often evoked by passivity of students in memory-oriented transmission approach to education. The innovation of "Science and Mathematics Education" is emphasized in recent documents of the European educational agencies, such as Eurydice (Eurydice, 2011).

Efforts to implement inquiry based science education (IBSE) to school practice is reflected in the wide range of international projects supported at the level of the European Commission, or in smaller projects supported by national research agencies. In 2013, we obtained a project supported by the Agency for the promotion of research and development focused on the research on the efficiency of innovative teaching methods in mathematics, physics and informatics education. The main objective of the project is testing of innovative teaching strategies and methods in mathematics, physics and informatics education and to assess their impact on the development of students' inquiry skills and conceptual understanding. The first phase of the project solving was devoted to design innovative lesson plans for applying inquiry approaches to the teaching of the selected topics in the 1st and 2nd year of secondary school. Teachers at partner schools tested the prepared methodological and teaching materials in real school conditions in the school year 2014/2015. The teachers were given the chance to try out the prepared teaching and learning materials based on the IBSE and to test the usability of the materials for supporting the active learning. The pedagogical experiment is planned to be conducted in the school year 2015/2016.

Creation of the conditions for the application of inquiry approaches to learning involves also designing and implementing a stimulating learning environment in which students can experiment and explore the properties of objects and relationships between quantities. In our project, we produced a variety of motivational tasks, interactive demonstrations and worksheets which should stimulate an exploration of mathematical patterns. Students can also use interactive learning activities which allow active work with data and different models and provide feedback on their learning results. To implement these learning activities, we used mainly the dynamic geometric system Geogebra and spreadsheet MS Excel.

An important indicator of the effectiveness of innovative methods is their effect on the development of inquiry skills of students. There are several classifications and schemes characterizing inquiry skills. As a convenient basis for classification and development of inquiry skills in mathematics, physics and informatics, we have chosen the scheme of inquiry skills (Van Den Berg, 2013) which issues from classifications created by Tamir, Lunetta (Tamir, Lunetta, 1981) and Fradd, Lee, Sutman, Saxton (Fradd et al., 2001). This scheme characterizes two basic methods of developing inquiry skills based on experiment or work with a model. Creation and use of models are important factors for application of inquiry approach to learning in mathematics.

This scheme contains five basic categories which are further elaborated in specific inquiry skills. We present the selected skills associated with modelling.

1. Determining the problem and planning of the experiment / model:

- to formulate a question, hypothesis,
- to propose a model,
- to develop a procedure to test the hypothesis.

2. Making the experiment / modelling:

- to construct the model,
- to record results.

3. Analysis and interpretation of the experiment / model:

- to transform the results into transparent tables, graphs,
- to interpret results and discuss the suitability / limitations of the modelling process,
- to express relationships between variables.

4. Sharing and presentation:

- to present results,
- to find appropriate arguments to justify relations.

5. Application and further exploitation:

- to make hypotheses for further investigation,
- to apply modelling procedures to new problems.

We plan to give a pre-test in experimental classrooms at the beginning of our pedagogical experiment to assess the level of development of selected inquiry skills of students. The first trial version of the pre-test has already been given in the classroom in which the prepared lesson plans and teaching materials have not been used before. It was focused mainly on

diagnosing the inquiry skills from the first and third categories of the above shown scheme and on testing the clarity of the tasks and formulation of options for answers.

The first version of the pre-test contained thirteen tasks. We tried it in one classroom with 22 students in the first year at secondary school. All tasks contained five possible answers, of which just one was correct. For illustration, we present two tasks from the pre-test focused on the application of the knowledge of linear dependence. The first task was used to diagnose the skills to interpret the relationships expressed in the form of symbolic notations.

Task 1: Given the functions $f(x) = x + 3$ and $g(x) = 2x + 3$ defined on the set of real numbers. Choose the correct statement for given functions f, g .

- a) All the values of the functions f, g are rational numbers. (0)*
- b) There is a real number a , for which the equality $f(a) = g(a)$ is true. (11)*
- c) All the values of functions f, g are positive. (2)*
- d) For each real number x the value of $f(x)$ is less than the value of $g(x)$. (8)*
- e) For each real number x the value of $f(x)$ is greater than the value of $g(x)$. (1)*

The numbers written behind the individual choices for answer represent the number of students that chose the given answer. 50% of students solved this task correctly. It can be assumed that the selection of the choice d) is induced by incorrect students' idea that $2x$ must be more than x for each real number x .

The second task was used for diagnosing the rate of skills development to express relationships between variables using symbolic notations.

Task 2: Peter pays 18 EUR per night in camp on a trip to the mountains. Last year, he camped on average 4 nights per month. This year he bought in a national park season-ticket for 70 EUR, which allows him to obtain a 50% discount for 24 nights in camp for the entire year. Let x be the number of nights that he spent in the camp this year. When Peter says to us the total amount of overnight accommodations at the camp, which of the following equations we could use to calculate x ?

- a) $0,5 \cdot 18x = 862$ (0)*
- b) $0,5 \cdot 18x + 70 = 862$ (4)*
- c) $18x - 0,5 \cdot 24x = 862$ (4)*
- d) $18x - 0,5 \cdot 24x + 70 = 862$ (9)*
- e) $18x - 0,5 \cdot 18 \cdot 24 + 70 = 862$ (5)*

Only 22,7% of students solved this task correctly. The average score in the test was 45,98%. This relatively low score points to the fact that some students' inquiry skills are developed on a low level. Our testing has pointed out the difficulties of students with interpretation and creation of symbolic notations expressing the relationships between variables, with making hypotheses and with finding the appropriate arguments to justify the validity of hypotheses.

Interactive learning activities to investigate the linear dependence

Lack of skills and students' misconceptions, which we specified using the results of international measurements and research studies (for example Marshall, 2013), have been taken into account in the design of appropriate activities and lesson plans enabling the application of inquiry approaches to teaching mathematics. We chose several interactive learning activities to illustrate the proposed inquiry approaches to learning linear function.

An interactive activity to the uniform linear motion is used to investigate direct proportion which is a special case of a linear dependence between variables. Students have the experience with uniform motion from real life and also from physics. The applet available on the address <https://phet.colorado.edu/en/simulation/moving-man> allows simulating the movement of a man. A man can be moved to the house with a mouse or by running simulations of uniform motion. Figure 1 shows a simulation result for the velocity $v = 2 \text{ m/s}$. The simulation of the motion of the man is accompanied by drawing graphs of dependence of the distance moved and the speed over time. The teacher would require students to create a table with the values of the distance moved for the selected time intervals. Student should verbally describe the relationship between distance and time and express it also using symbolic representation in the form $s/t = 2$. Then, using the applet, they could further investigate how the graphs will change for other values of the speed of a man and generalize the symbolic notation of the explored relationship.

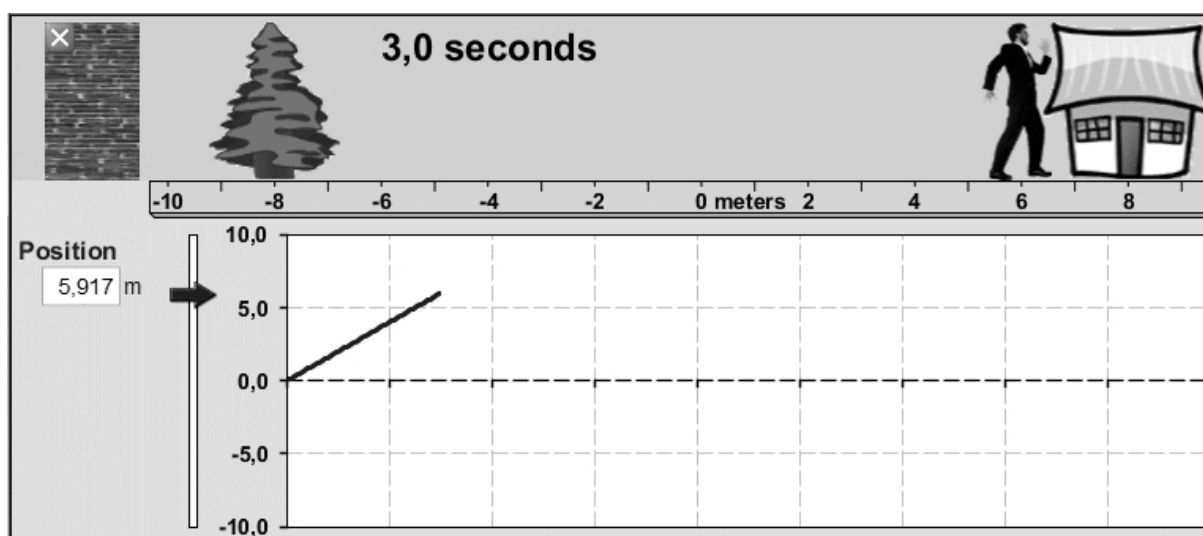


Fig. 1: The simulation of uniform motion

The following interactive activity could enable the students to model a linear relationship between quantities and investigate connections between different representations of data. The basis of the activity is a dynamic construction created using the dynamic geometric system GeoGebra. To explore the linear dependence, we used a theme from real life based on the accumulation of work pieces produced in a workshop during a week. At the beginning of the week 36 work pieces have already been made in the workshop. The initial number of work pieces can be changed using the slider a . Workmen produce some number of work pieces each working day. The numbers of work pieces manufactured in different days of the week determine the values of the sliders b, c, d, e, f, g .

The created graph (see Figure 2) shows a dependence of the total number of work pieces produced in the workshop on time. In order to better understand the graphical representation of the modelled situation, students should create a table with data from the graph and solve two simple tasks displayed above the graph. If students enter correct numbers in the text fields they obtain information about the correctness of their answers. Then students have to set the values of sliders b, c, d, e, f, g , so that the number of work pieces in a workshop at the end of each day grows linearly over time.

Setting the same values for sliders b, c, d, e, f, g causes that the polygonal line straightens out to one straight line. Students can also change the value of the sliders a and observe how it

influences the graph of the linear dependence. After understanding the basic property of the linear dependence students can express the relationship between quantities using the formula $n = a + b \cdot t$, where n is the total number of work pieces produced in the workshop in time t , and the variable b represents the same number of work pieces produced in different days of the week. The linear function can be generally written in the form $y = ax + b$, $a \neq 0$.

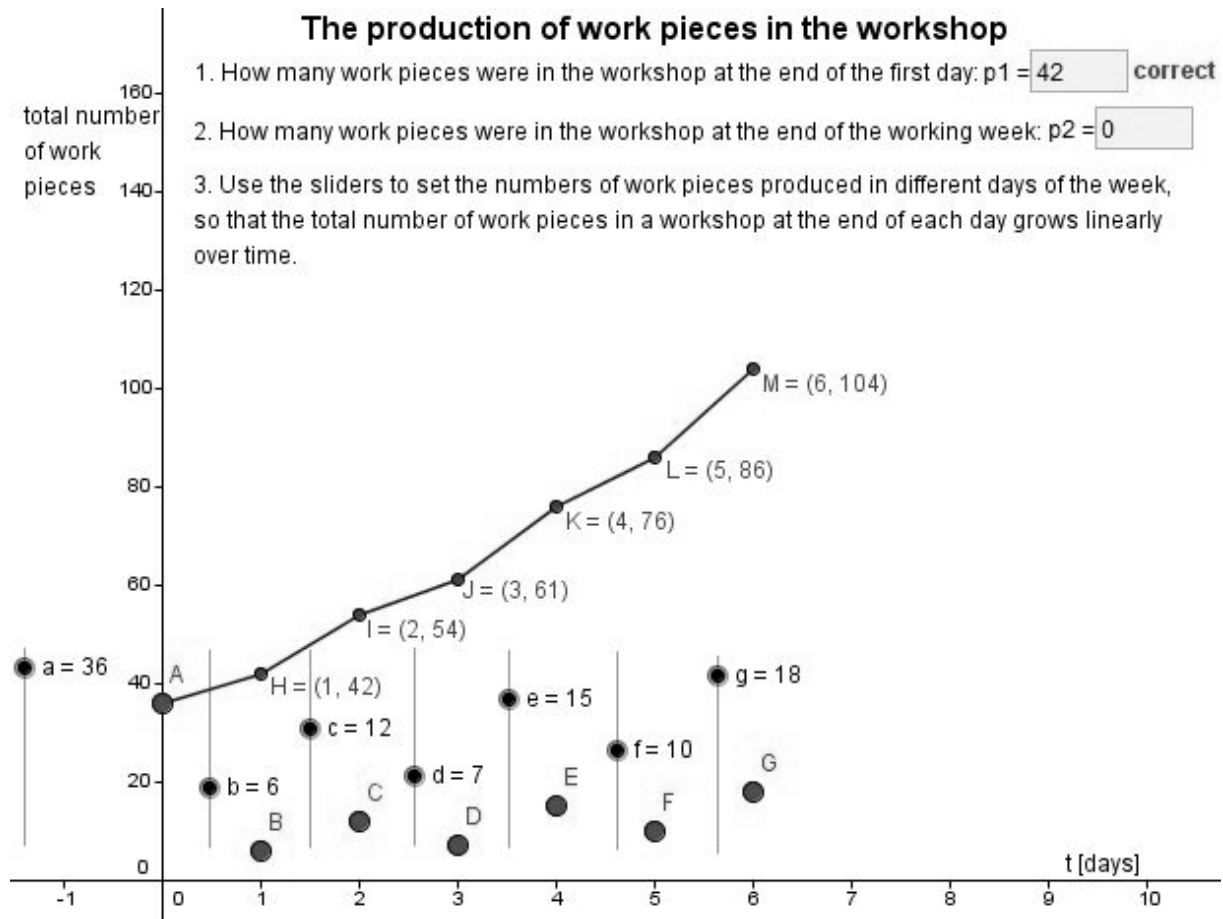


Fig. 2: The modelling of the linear dependence

A teacher can focus students' attention on the growth rate of a linear function. If workmen produce a greater number of work pieces daily, the linear function grows faster and a line will form a larger angle with the x axis.

The proposed lesson plans include also tasks supporting formative assessment, solving of which could also provide students with self-reflection. After using the above mentioned interactive activities, we recommend to give students a task containing parts of a dialog between two boys. One boy is trying to explain to another boy that a linear function expresses direct proportion. Students have to choose one of the options: Always, Sometimes, Never and justify their choice using an example.

A dynamic construction containing a graph of a linear function could be used to improve the understanding of linear functions. Students could change the values of coefficients a , b in the formula of the linear function using sliders. Students could solve the following tasks:

a) How does the graph of a linear function change if we decrease the value of the coefficient a to 0.5; -0.5; -1; ...?

b) What is a relative position of graphs of linear functions $f: y = 2x - 5$ and $g: y = 5x + 3$?

c) Determine the coordinates of the intersection point of graphs of all linear functions given by the formula $y = ax - 2$, where a is any real number different from 0.

d) What is the relative position of graphs of linear functions with the same slope a ?

e) Is there a linear function whose graph is perpendicular to the x axis?

An interactive activity about a black box representing an unknown formula to calculate the function values is included at the end of the part oriented on the work with different representations of linear functions. The black box processes the input number and brings out a function value. This interactive activity contains a sequence of five tasks focused on finding the formula to calculate the output values of a linear function. The formula for the calculation of the function values includes in some tasks the absolute value too. Using the Input button, students enter a value of the variable x to the box input and they receive the output value of the variable y . Students can gradually write the obtained data in the table and use it to create a graph of the explored function. Entering the correct formula and its confirmation provide access to the next sheet with a new task. Figure 3 shows the solution of the second task together with the additional table.

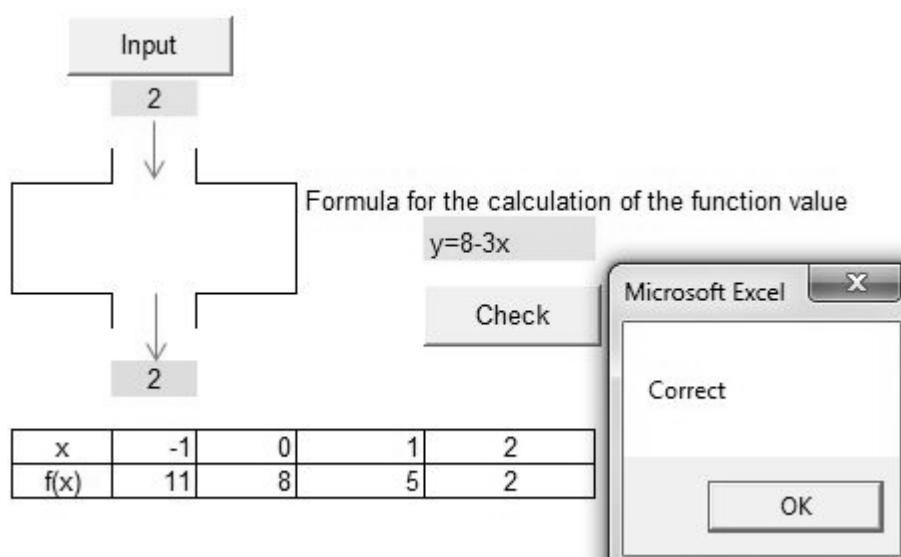


Fig. 3: Black box representing the linear function

Results and Discussion

After the use of the prepared lesson plans, teachers filled the forms in which they expressed their subjective views on the teaching and learning materials, as well as the students' reactions and their learning outcomes. The first experience show that the use of arithmetic and dynamic graphical models helps students to interpret information from graphs correctly and to better understand the symbolic representation of relationships between variables. Most of teachers highlighted the inclusion of tasks for formative assessment at the end of the selected learning activities. These tasks allow early diagnosing student's errors and misconceptions and their correction using the appropriate questions and tasks.

An important research question will focus on the investigation, whether innovative lesson plans based on IBSE contribute to improving conceptual understanding. A post-test for evaluation of the effectiveness of innovative methods will be given in experimental classrooms at the end of the pedagogical experiment. The post-test will be divided into two parts. The first part will contain modifications of selected tasks from the pre-test. We will try

to assess the impact of innovative approaches to teaching of mathematics to develop selected inquiry skills of students. The second part will include conceptual tasks to measure the level of understanding of educational content. These parts of the post-test will be evaluated both quantitatively and qualitatively.

Conclusion

Solving word problems is a convenient resource for developing the ability to apply skills of linear dependence. This kind of dependence can be found in real life problem solving situations that provide opportunities for creating connections between mathematics and other science subjects. Although the linear dependence is a simple type of dependency between quantities, its understanding is necessary for acquiring more complex types of dependencies between quantities. Interactive demonstrations supplemented with asking the appropriate questions and interactive activities for students' individual investigation can assist in the implementation of the inquiry approach to teaching mathematics and science. Their contribution to teaching mathematics can be reflected in an increased student's motivation, in a development of inquiry skills and critical thinking, which is important in finding the right arguments to justify discovered relationships and their generalization.

Acknowledgments

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BUILDING YOUR OWN REAL REMOTE EXPERIMENT CONTROLLED BY A MOBILE OR TOUCH ENABLED DEVICE

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Abstract

We present “iSES Remote Lab SDK”, a new version of software development kit (SDK) devoted for creation of online real remotely controlled experiments. In comparison with the original version based on Java applets, current interface based on JavaScript and HTML5 allows users to access it from smartphones or other touch enabled devices. It offers better graphical and design customization capabilities. While mostly used with ISES hardware, the kit also supports other hardware platforms (COM and USB devices, encapsulated third-party experimental setup, multimeters, stepper motors etc.) When deployed, it also provides basic logging features allowing the creator to observe user interactions with the experimental interface in detail. We also present a unique set of elementary modules of the iSES SDK that may be easily combined and used by beginners to create any parameter value input/output, XY or Y(t) graphs, visualizations including a webcam view etc. Experimental data can be easily exported for further processing. Finally, we present a few sample experimental designs available on our sites <<http://www.eedu.eu>> and <<http://www.ises.info>>.

Keywords

Remote experiments, reseach-based education, Physics, HTML5, JavaScript.

- **Remote experiments based on Java applets**

Since 2002 the remote laboratories have been developed at the Faculty of Mathematics and Physics. The first generation of remote experiments was based on Java applets. However, since 2012 Java applets began to be restricted due to security issues. Users now have to confirm running Java applets with warning about possible security risk. This basically rendered the technology unusable for client-side web user interfaces in all applications. Moreover, support of Java applets in smartphones and similar devices was mostly lacking.

- **Remote experiments based on JavaScript**

Since 2013 we have been moving to JavaScript when creating user interfaces for remote experiments on our faculty. Remote experiments are built with new software kit “**iSES Remote Lab SDK**” (Dvořák, Kuriščák, Lustig 2013). Philosophy of this new kit is the same as in case of Java applet version „ISES WEB Control“ (Dvořák, Lustig, 2003). We want to provide non-programming users a possibility to create custom remote experiments. By using **JavaScript** and **HTML5**, the experiments work also on **mobile and other touch enabled devices**.

Let us summarize how remote experiments work. Remote experiment is a server-client type application. *Server side* of the experiment consists of computer connected to the Internet. A measuring apparatus of real experiment is connected to the computer (e.g. our system ISES

[3], [4], or other measuring systems like LabVIEW, devices with RS 232 or newly USB interface). It can also consist of stepper motors, controllable sources, multimeters etc. Note: If you want to create a remote experiment, where the user is able to control some device, it is not possible to use measuring systems which do not have output channel. Such systems (such as Pasco, Vernier) consist only of input channels and can be used only for experiments of type “sensing”, where quantities are only measured. Systems with analogue or digital control channels, such as ISES, LabVIEW and others, allow building of remote experiments of type “control”.

Server-side computer has to run a *MeasureServer* application that communicates with hardware and provides data to connected users. To serve the actual user interface, a web server has to be also running, usually also on the measuring machine. Our experimental setups are using freely distributable *WebServer Nginx*. To provide webcam-captured live video stream, we developed an *ImageServer* application that can also be running on the measuring computer.

Client device should run an internet browser supporting JavaScript and preferably WebSocket connection (fallback is available). These are considered almost standard features of all modern browsers in most devices.

- **Software kit “iSES Remote Lab SDK” for remote laboratory**

iSES Remote Lab SDK consists of approx. 20 freely distributable (under Creative Commons licence) JavaScript objects in commented source code. Objects/elements with graphical interface are called widgets. The widget source code can be modified by experienced *programmers*. However, widgets are highly configurable and provide many thoroughly documented options, which are available by default and which allow even *non-programmers* to build a complex measuring and controlling interface with data and video transfer. Among built-in features, users have access to real-time spline interpolation, simple processing, export of data in various formats, graphical output and other sophisticated functionality. Direct connection to the remote experiment server is realized through WebSocket protocol, which provides very low-latency.

User interface elements are mostly based on JQuery and few other freely available JavaScript libraries that are distributed together with the SDK. By using these standard elements, the user interface visual design is also highly customisable. Web-page developers are able to alter the default design using standard methods (mostly CSS) to fit the webpage in which the interface is embedded.

3.1. Original on-line pedagogical research based on log system

The MeasureServer records each user’s activity in a log file with time stamps, which provides important information about measurement sessions of all users. Although there is a problem with anonymous IP addresses, we have some means like unique codes for each student that should be used for login before the session starts in order to surely assign a log record to the user. Through the analysis of the log file we can learn how students behave in a virtual learning environment, e.g. how much time they spent on a certain activity, which steps they did or did not perform, and whether the whole procedure was meaningful, or just playing with control elements, perhaps with some kind of confusion. We present an example of a log record in Tab. 1.

81.25.16.87	17.4.2011	18:37:29	1035 s	ID(4)
0:W(1){88}*Sv1{23}*Sv1{10}*Sr(100){71}*S11{1}*S10{4}*S11{7}*Mv(-12.16){0} *Mv(-445.85){0}*Mv(-477.93){0}*Mv(-1000.00){1}*Mv(1000.00){4} *Ma0{160}*Sf(0){1}*Sf(1){3}*Sf(0){10}*Ma1{46}*Pr(1){9}*Ma1{43}*Sf(1){3}*Ma1{43} *Sf(2){3}*Ma1{44}*Sf(3){3}*Ma1{42}*Sf(4){3}*Ma1{43}*Sf(5){8}*S10{5}*Ma1{44} *Ps(1){0}*Pd(1){12}*Pd(1)*D				

Tab. 1: Example of a log record derived from the log file of the remote laboratory on the photoelectric effect.

From the log-record in Tab. 1 we can read that a student selected the measurement of the Volt-Ampere characteristics of a vacuum phototube (mode 0 at the beginning) and had to wait in a queue for 88 seconds till he took control of the experimental setup. He switched the mercury lamp on (Sv1) and after approx. 5 min of playing and getting familiar with the interface he started data recording and systematically measured all the V-A characteristics for six available frequencies of light (Sf0-5). The student always used automatic measurement (Ma1) that takes approx. 40 s. Finally he stopped recording (Ps) and downloaded (Pd) his own data for further processing – determination of the stopping-voltage values and the experimental value of Planck constant. Curly brackets {...} correspond to the time duration since previous action in seconds. Parentheses (...) contain a parameter, e.g. an index of the selected filter.

Furthermore, log records include some basic classification of activities for statistical analysis (S – settings, M – measurement, P – advanced processing of data). We managed to find 4–5 behaviour patterns, e.g. students' decisions to download and process someone else's data records when he/she is completely lost or because of traffic jams just before deadline. We also detected some kind of students' disengagement and perhaps confusion by the user interface, which helps us to develop new and better remote laboratories and to improve user interface as well. Details can be found in (Lustigová, Brom, 2014); (Lustigová et al., 2014).

3.2. Collection of simple remote tasks

For beginners who want to try out custom remote experiments, we prepared the *Collection of simple remote tasks* such as remote analogue record of one quantity (e.g. temperature) in time, remote analogue control of one channel (e.g. switch relay), remote control of digital inputs and outputs, time dependence of two or more quantities, XY dependence of input and output quantities, remote control of linear and stepper motors, remote data transfer from multimeters with COM port, data record, data export, WEB camera stream etc. Examples are written very simply so the source code is clear. These simple tasks can be arbitrarily merged and combined, so even beginners are able to rapidly develop complex interfaces. They can immediately control their own remote experiments via mobile phone or tablet.

3.3. Final notes to “iSES Remote Lab SDK”

Remote experiments built on **iSES Remote Lab SDK** can be used *anywhere, anytime* and *by anyone* and newly we modify them in such way so they are accessible from any *PC platform, tablet or mobile phone*.

Few notes to hardware of measuring apparatus - nowadays we use ISES-PCI and ISES-USB kits. ISES-PCI uses ADDA PCI card installed in desktop PC. The big advantage of solutions based on ADDA card is large number of inputs and outputs (e.g. ISES-PCI with relay card has 8 analogue inputs, 2 analogue outputs, 16 digital inputs/outputs, resp. 16 relay outputs). There is no other kit that would offer such wide possibilities. Moreover, we prepared new simple kit

ISES-USB, which has two analogue inputs, one analogue output and five digital inputs/outputs; also mini kit ISES-link with one analogue input and output and five digital inputs/outputs. Note that all variants provide outputs, because no proper remote experiment can be built without them.

- **Contemporary hardware base for “iSES Remote Lab SDK”**

Software kit “**iSES Remote Lab SDK**” presently supports measuring apparatuses **ISES** (ISES-PCI, ISES-USB, ISES-link), universal measuring apparatuses with **COM** or **USB** communication, especially linear and rotation positioning devices with large XYZ range (10 cm to 1 m). The **commercial equipment “Franck-Hertz experiment”** made by corporation Phywe and few other dedicated devices are supported as well. Support for other equipment is just a matter of new plugins. We are also able to create **plugins for arbitrary equipment on demand**.



Fig. 1: ISES-link kit



Fig. 2: ISES-USB kit



Fig. 3: ISES-PCI kit



Fig. 4: Phy, Che and Bi ISES modules



Fig. 5: Universal measuring device with COM or USB communication port (e.g. multimeter UT-61E, environmental multimeter DT-223, power supply PSP 12010), that are supported by iSES Remote Lab SDK



Fig. 6: Universal rotation and linear stepper motors, which are supported by iSES Remote Lab SDK

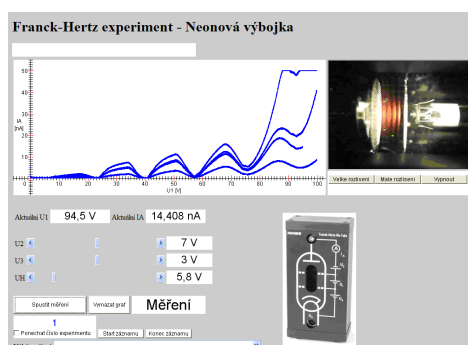


Fig. 7: Commercial laboratory device „Franck-Hertz experiment“ by Phywe (left), which is used in remote experiment developed by iSES Remote Lab SDK (right). http://194.160.213.12/index_js.html on PŘF UKF Nitra, <http://147.251.193.82/index.html> on Ped MUNI in Brno.

• Showcase of remote experiments

On website <http://www.ises.info/index.php/en/laboratory> and <http://www.eedu.eu>, you can find showcase of experiments based on “iSES Remote Lab SDK”, and also videos demonstrating how to work with them. Many experiments also contain an assignment, measuring instructions and examples of processing.

Up to now we have built 18 remote experiments for secondary school and university level, which we freely offer to you for use in your school projects, education and also free time activities.



Fig. 8: Electromagnetic induction
http://kdt-20.karlov.mff.cuni.cz/ovladani_2.html



Fig. 9: Solar energy conversion
<http://kdt-4.karlov.mff.cuni.cz/>

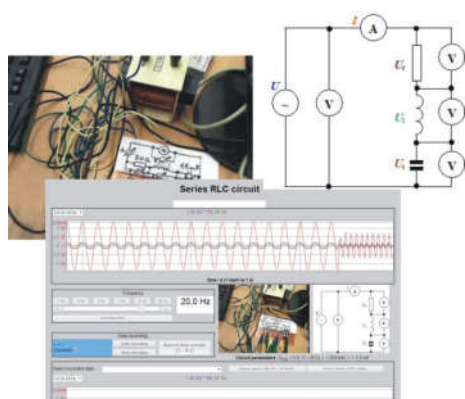


Fig. 10: Series RLC circuit
<http://kdt-30.karlov.mff.cuni.cz>



Fig. 11: Water level control
<http://kdt-34.karlov.mff.cuni.cz/cz/mereni.html>

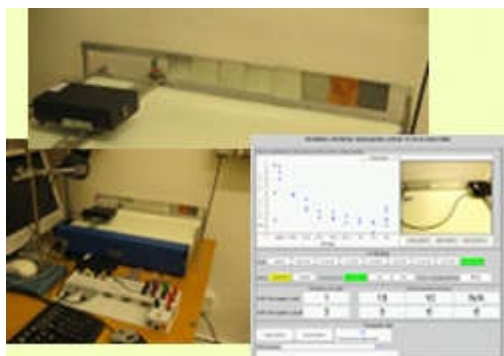


Fig. 12: Study of radioactivity (5 experiments)
http://kdt-38.karlov.mff.cuni.cz/choice_cz.html

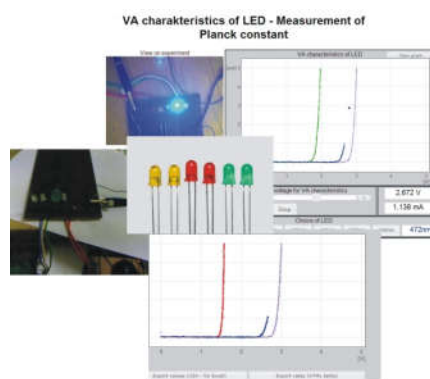


Fig. 13: Measurement of Planck constant
<http://kdt-33.karlov.mff.cuni.cz/>

Other remote experiments:

Rectifier

<http://kdt-19.karlov.mff.cuni.cz>

**Map of stations monitoring
natural background radiation**

<http://kdt-1.karlov.mff.cuni.cz>

Meteorological station in Prague

<http://kdt-16.karlov.mff.cuni.cz/cz/mereni.html>

Heisenberg uncertainty principle

http://kdt-13.karlov.mff.cuni.cz/sterbina_js.html

Natural and driven oscillations

<http://kdt-17.karlov.mff.cuni.cz>

Photoelectric effect

<http://kdt-29.karlov.mff.cuni.cz>

Some remote experiments built with „iSES remote Lab SDK“ are running also on other schools such as:

Mass oscillating on a spring

<http://remote-lab.fyzika.net/experiment/05/experiment-5.php?lng=cs>

at Gymnázium J. Vrchlického, Klatovy

Franck-Hertz experiment (Phywe apparatus) <http://147.251.193.82/index.html>
at Pedagogical faculty MU Brno.

Other remote experiments built with „iSES remote Lab SDK“ are located at Pedagogical faculty in Trnava and Faculty of Natural Sciences UKF in Nitra (SK).

We are going to restore Polarisation of light, Faraday phenomenon, Magnetic field mapping, Magnetic field in coil axis etc. soon.

- **Conclusion – mobile technologies YES or NO?**

On fig. 14 we see the remote experiment Electromagnetic induction, visited by tablet and smartphone.



Fig.14: Remote experiment „Electromagnetic induction“, on iPad and on mobile phone.

We expect that new technologies of remote experiments based on JavaScript, which work on mobile devices, will become attractive for young generation. Mobile phones in school are a controversial topic. Their use is banned during class almost everywhere. However, the smartphones replace calculator, stopwatch, camera, GPS etc. Smart applications make possible to work with sound, light; measure speed, acceleration; record sound and video. They become priceless when one needs connection to the Internet – e-mail, cloud storages etc.

To ban personal mobile devices or to actively use them? The movement to use personal mobile devices is called BYOT/BYOD Bring Your Own Technology/Device.

Passive users of smartphones do not feel the rise of the “cloud computing” (originally based on utility and consumption of computer resources, nowadays providing services, programmes accessible from internet browsers). It is not surprising that the same webpages can be downloaded into PCs and mobile devices. In the past webpages for PCs and mobile phones had to be written separately!

Social media become omnipresent with fast rise of smartphones. We are no more bound to classroom with computers. We are in a “school without walls”.

We are able to download music, videos, and books from the Internet. Now we have proved that you can “download” whole real experiment on physics/nature studies!

Learning can be realised through mobile devices. It can be realised outside school, home, somewhere on the way, in restaurant, on party, while travelling etc. This phenomenon called “downtime learning” and was studied by (Dean Groom, 2011).

Above listed technology and learning visions are suitable for remote experiments on mobile phones. Education, e.g. classic laboratories, which are nowadays inside school walls, become “laboratories without walls”, which are accessible from anywhere, anytime, to anyone and they can be completed from any device (e.g. mobile).

Remote experiments are new objects in e-learning and in m-learning. We do not try to prefer m-learning although it is very tempting. Let us use it spontaneously, on untraditional places, but in such way where we educate, explore and construct with classic or distant form of education; not where we only demonstrate new technologies. Let us work individually or in groups.

In conclusion let us remind Dean Groom, who says that improving in environment of unlimited contact with different people and information means to be fond of exploring – to be anytime ready for an action, until you know everything, you have ever wanted...

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STUDENTS IN ELECTRONIC LEARNING ENVIRONMENT

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Abstract

The study defines the terms electronic learning environment and smart learning environment with their components and contribution to university education. Moreover, it introduces identified trends that are expected to emerge in the next five years. The research on a representative sample of the University of Ostrava students, which was carried out within the scope of the 7th RP IRNet project, was aimed at how the individual components of the electronic learning environment can be used, the reasons for their use and the related needs of students.

Keywords

electronic learning environment, smart learning environment, development trends, research of students' opinions and needs

Introduction

Electronic learning environment at universities provides university teachers and students with technical, information and pedagogical environment for effective study, research, administrative and leisure time activities. It contains several basic components which are being further elaborated in accordance with the development in the ICT field, general teaching theories, university pedagogy and andragogy, pedagogical evaluation in education and other fields. The diversity of this environment with the many naming versions (which sometimes lack clarity and even seem redundant) has led to the formulation of the assessment criteria and their implementation and further development. As far as the development of this environment at universities is concerned, the trend is to ensure its contribution regarding the quality and equality of study. In order to adjust it to the needs of the current “digital students” (Švaříček, Zounek, 2008) and to reach its new development qualities (such as the “smart learning environment” or the “personal learning environment”) a questionnaire research, the results of which are presented in this article (it contains the results of Czech university students), was conducted in each of the nine countries of the research consortium. The questionnaire research was conducted within the scope of the 7th EU framework program called IRNet (*International research network for study and development of new tools and methods for advanced pedagogical science in the field of ICT instruments, e-learning and intercultural competences*).

Generally, three main influences of ICT on education are postulated (Pickett)¹. These have the potential to be enhanced in some way via the use of some technology. Technology can be leveraged to:

1. Present content in a more effective or engaging manner.
2. Facilitate collaboration or interaction with/between students in a more effective or engaging manner.
3. Provide feedback, or to assess/evaluate students in a more effective or engaging manner.

Neumajer (2013) identifies several main trends in the development of ICT in education: cloud computing, a phenomenon when the students bring their own devices (BYOD – Bring Your Own Devices), freely available study materials and DUMs, reverse education, massive open online courses (MOOC), the creation of the personal learning environment (PLE) or electronic textbooks.

Electronic learning environments and their development versions and contributions

There are various designations for electronic learning environment, which can represent its development phases or its potentially or actually used functional possibilities.

eLearning environments (ELE) are most commonly associated with the LMS Moodle, which can save files containing study materials, realize communication between the teacher and the students and between students, plan studies, assign and evaluate tasks, evaluate other students, test, save study results, etc.

Some authors use the term “virtual learning environments” (VLE) or “institutional learning environments” (ILE). However, these are difficult to tell apart; in fact it can be said that the two terms refer to the same environment.

As far as the so-called “smart learning environments” (SLE) are concerned, the term should reflect the interconnection of pedagogy and technologies. In the smart environment, pedagogy is represented by learning and assessment paradigms, social factors and policy. Technology includes emerging technologies, innovative uses of mature technologies, adoption usability and standards, and emerging/new technological paradigms (open educational resources, cloud computing etc). This initiative is supported by the established IASLE (International Association of Smart Learning Environments), which also holds conferences.

Hwang (2014) summarizes the potential contributions of SLE in three points:

(1) A smart learning environment is context-aware; that is, the learner’s situation or the contexts of the real-world environment in which the learner is located are sensed, implying that the system is able to provide learning support based on the learner’s online and real-world status.

(2) A smart learning environment is able to offer instant and adaptive support to learners by immediate analyses of the needs of individual learners from different perspectives (e.g., learning performance, learning behaviors, profiles, personal factors) as well as the online and real-world contexts in which they are situated. Moreover, it can actively provide various personalized support to the learners, including learning guidance, feedback, hints and learning tools, based on their needs.

¹ Alexandra M. Pickett, Associate Director SUNY Learning Network (USA) <http://sln.suny.edu/>

(3) A smart learning environment is able to adapt the user interface (i.e., the ways of presenting information) and the subject contents to meet the personal factors (e.g., learning styles and preferences) and learning status (e.g., learning performance) of individual learners. The user interface is not necessarily a conventional computer. Instead, learners can interact with the learning environment via mobile devices (e.g., smartphones or tablet computers), wearable devices (e.g., Google Glass or a digital wristwatch), or even ubiquitous computing systems embedded in everyday objects. Therefore, it is a challenging issue to adapt the user interface to meet the learners' needs in a smart learning environment.

Another way of approaching the ICT applications in education is the creation and use of the so-called "personal learning environments" (PLE). Schaffert and Hilzensauer (2008) argue that contrary to the traditional learning management systems (LMS), the PLE systems were very well received and have the potential to change the paradigm of education. They identified seven aspects which reflect these changes in the most significant manner. Briefly speaking, studying within the scope of the PLE leads to the following changes: (1) the student has the role of active and self-directing creator of the content, (2) personalization as a result of the information and support of the members of the particular community, (3) the study content as an immense "bazaar", (4) social involvement playing a key role, (5) the ownership of students' data, (6) the significance of self-organized study for the culture of educational institutions and organizations, (7) technological aspects of the use of the social software tools and the collection of various sources. Johnson et al. (2006) summarized some of the critical objections to LMS systems, one of which concerned the inability of many institution-based LMS systems to afford the opportunity of greater peer-based pedagogy.

Milligan et al. (2006) argue that the PLE uses tools that would allow the learner to:

- **Learn with other people:** manage and create relationships, forming connections between contacts that are not part of a formal learning network.
- **Control their learning resources:** allow them to structure, share, and annotate resources they find or have been given.
- **Manage the activities they participate in:** provide opportunities for them to create as well as join activities that bring together people and resources.
- **Integrate their learning:** allow them to integrate learning from different institutions and sources, re-using evidence of competency and making links between formal and informal learning.

According to Malamed (2014), "A personal learning environment (PLE) is a solution for keeping up with the rapid pace of knowledge change. Some say it is a concept, while others say it is a technology". She offers the following definition: a self-directed and evolving environment of tools, services and resources organized by a person seeking a way to accomplish lifetime learning, to create, and to connect with others of similar interests. Because it is personalized, everyone's PLE will be unique. Because it is collaborative, information may be continually created and shared. In the workplace, designing a personal learning environment has the potential to partially replace conventional courses.

According to other sources (IMAILE, 2015), the PLE are "systems that help learners take control of and manage their own learning. This includes providing support for learners to: a) set their own learning goals (with support of their teachers), b) manage their learning, both content and process and c) communicate with others in the process of learning".

The consortium of solvers of the project of the same name considers the following to be its main contributions:

- A personalized learning environment increases the students' motivation and creates a learning situation where they can control their own learning at their own pace.
- It allows students to actively design their own learning strategies
- PLE enables better contact between student/teacher, and the education is less teacher-centered.
- PLE and modern technology together create a customized learning environment that suits the development of the 21st century classroom.
- The technology of today makes it possible to create PLE solutions which are developed to suit the demands from both teachers and students.
- PLE in combination with technical tools increase the students' interest in STEM (Science, Math and Technology) subjects, which is important as there is a growing demand in STEM related professions.
- The young generation of today primarily learns by being interactive. This requires interactive classrooms with personalized ICT solutions.

Taraghi, B.; Ebner, M.; Kroell, C. (2012) describe the development of the PLE and the emergence of the specific solution based on the web 2.0 technology at Graz University of technology in 2010. The main idea in using a Personal Learning Environment is that there are many resources distributed on WWW that are driven in the learning process of the learners directly or indirectly. Nowadays universities and higher educational institutions provide their students with many online services such as LMS to enhance the learning performance and simplify the sophisticated learning process. At TU Graz a PLE has been launched that relies on mashup of widgets. Widgets represent independent resources, services and applications that are all integrated within PLE. Users can select widgets from a pool of widgets (widget store or widget boutique), arrange them as they prefer and configure them to their actual needs and interests. As a result of the implementation of the solution, the number of its users increased by 400% compared to the original version.

In 2004-2008, within the scope of the iCLASS project, which was part of the 6th EU framework program², the so-called intelligent and knowledge-based open educational system and environment adapted to students' individual needs were created.

In 2010-2014, within the scope of the iTEC project³, which was part of the 6th EU framework program⁴, six factors of the successful use of ICT in education were defined: 1) Access to reliable and sufficient infrastructure, 2) Appropriate school ICT policies, 3) Pedagogical and technical support of teachers, 4) Teacher, pedagogical and digital competence, 5) Positive attitudes at all levels toward change, 6) Suitable digital learning resources. The number of factors demonstrates the experience of many schools and countries concerning the necessity to solve a number of related questions (mainly the support and training of teachers) when implementing ICT innovations.

When describing the contribution of the ITEC project, Lewin and McNicols (2014) argue that during its course a number of prototypes of new tools have emerged for the support of education (e.g. TeamUp for dividing students into teams); for learning design (Scenario Development Environment (SDE), which takes into account the user's profile (e.g. the school

² <http://www.scientix.eu/web/guestteacher pedagogical and t/resources/details?resourceId=2918>

³ <http://itec.eun.org/web/guest;jsessionid=AB1CBBA7B95A31E98EF78D7777C133A6>

⁴ <http://www.scientix.eu/web/guestteacher pedagogical and t/resources/details?resourceId=2918>

level and subject) and which can recommend sources such as applications, actions, widgets and lectures); or for cataloging of study resources (The Widget Store).

Lewin et al. (2013) also summarize the influence of the project on the ICT application field: “Detailed meta-analysis of the evaluation data over the first three cycles of iTEC shows that there is a positive impact on students’ knowledge, skills and understanding – in particular 21st century skills, their motivation, engagement and attitudes and their learning practices. iTEC has also had a beneficial effect on teachers, impacting positively on their technology-supported pedagogy, digital competence, and their motivation, engagement and attitudes. Moreover, iTEC is seen as scalable, having the potential to support pedagogical and technological innovation, to increase the effective use of ICT and to encourage experimentation with innovative technologies and tools” (p. 7).

The example of new tools is illustrated by the expected development in the field of “personal” or “smart” learning environments, which will be continually updated with these and other tools in order to become more integral and user friendly toward teachers and students. The annual NMC (New Media Consortium) Horizon Report: 2014 Higher Education Condition formulated six key trends in the field of university education. The first two of the so-called “rapid trends” and the sixth “long-term trend”, which deals with the development of online education, are from our area of research. The trends are as follows:

1. Growing Ubiquity of Social Media
2. Integration of Online, Hybrid, and Collaborative Learning
3. Rise of Data-Driven Learning and Assessment
4. Shift from Students as Consumers to Students as Creators
5. Agile Approaches to Change
6. Evolution of Online Learning

The significance of ICT tools in university education, which brings a certain degree of standardization of resources, is supported by the authors’ critical view of underappreciation of teaching activities at universities. They argue that “*According to the Times Higher Education’s World University Rankings methodology, research and citations account for 60% of a university’s score, while teaching is only half that. There is an overarching sense in the academic world that research credentials are a more valuable asset than talent and skill as an instructor. Because of this way of thinking, efforts to implement effective pedagogies are lacking*” (p. 26).

The great diversity of tools that can enter the electronic learning environment can be seen in the following image “2014 NMC Master List of Tracked Technologies”.

2014 NMC Master List of Tracked Technologies

Consumer Technologies

- > 3D Video
- > Electronic Publishing
- > Mobile Apps
- > Quantified Self
- > Tablet Computing
- > Telepresence
- > Wearable Technology

Digital Strategies

- > BYOD
- > Flipped Classroom
- > Games and Gamification
- > Location Intelligence
- > Makerspaces
- > Preservation/Conservation Technologies

Internet Technologies

- > Cloud Computing
- > The Internet of Things
- > Real-Time Translation
- > Semantic Applications
- > Single Sign-On
- > Syndication Tools

Learning Technologies

- > Badges/Microcredit
- > Learning Analytics
- > Massive Open Online Courses
- > Mobile Learning
- > Online Learning
- > Open Content
- > Open Licensing
- > Personal Learning Environments
- > Virtual and Remote Laboratories

Key Emerging Technologies

Social Media Technologies

- > Collaborative Environments
- > Collective Intelligence
- > Crowdfunding
- > Crowdsourcing
- > Digital Identity
- > Social Networks
- > Tacit Intelligence

Visualization Technologies

- > 3D Printing/Rapid Prototyping
- > Augmented Reality
- > Information Visualization
- > Visual Data Analysis
- > Volumetric and Holographic Displays

Enabling Technologies

- > Affective Computing
- > Cellular Networks
- > Electro vibration
- > Flexible Displays
- > Geolocation
- > Location-Based Services
- > Machine Learning
- > Mobile Broadband
- > Natural User Interfaces
- > Near Field Communication
- > Next-Generation Batteries
- > Open Hardware
- > Speech-to-Speech Translation
- > Statistical Machine Translation
- > Virtual Assistants
- > Wireless Power

Fig. 1: 2014 NMC Master List of Tracked Technologies (Source: NMC Horizon Report: 2014 Higher Education Edition)

As far as the area of educational technologies is concerned, the following changes will be taking place in the next five years: flipped classroom, learning analytics, 3D printing, games a gamification, quantified self and virtual assistants.

Hénard and Roseveare (2012, p. 9) argue that significant changes concerning the concept of education are taking place at universities. The new teaching and learning paradigms in higher education actually imply:

- New relationships regarding access to teachers, and a wider range of communication and collaborative working through learning platforms
- Re-designing of curricula
- Bridging teaching and research more intensively
- Re-thinking of student workload and teaching load
- Continuous upgrading in pedagogy, use of technologies, assessment models aligned with student-centered learning
- Creating of innovative learning platforms
- Providing guidance and tutoring to students with new means and methods
- Assessing impacts and documenting effectiveness of the teaching delivered.

They add that learning environments (libraries, computing facilities...) and the organization and management of teaching and learning are partial initiatives as far as the improvement of university education is concerned (p. 7). They also formulate a set of procedures which should provide quality education and highlight two specific parts. In the first part dedicated to the “coordination of the quality of education and technology policies” they recommend the following (p. 30): 1. Explore the impacts of the introduction of technology into teaching and

learning practices (e.g., on management process, learning outcomes, assessment, interactivity, etc.), 2. Assess the added-value of the use of technology in teaching on learning outcomes and ensure this information is provided to the institution's ICT decision-makers. In the second part dedicated to the "coordination of education and the learning environment policy" they require the following: 1. Make sure the learning environments reflect a range of teaching modes (e.g., interactive learning) and ensure that they allow for experimentation and easy adaptation to changes in teaching and learning processes, 2. Explore how learning environments can be made more conducive to exchange of knowledge, information and ideas on and out of campus, and encourage staff and students to interact within and across disciplines.

The LMS Moodle has been used at the University of Ostrava for almost 10 years. Therefore, it is logical that the respondents were evaluating this environment and working in it. The LMS Moodle is a system for the management of education, which – despite its relatively short existence – is unrivaled as it is the world's leading system of its kind in the field of school and business education. Therefore, we can argue that Moodle is the most widespread LMS system both worldwide and in the Czech Republic. Through this system the standard procedures, which occur in common education, are being continually electrified – these are mainly students' educational processes managed by textbooks and study texts.

Moodle enables the creation of simple courses, which consist of a collection of study texts, as well as the most elaborate interactive courses, which use all the available technologies that today's computers and eLearning offer. The creation of courses has six levels:

0. The course contains only the basic information about the subject, it contains no study materials, such a course is sometimes called an "empty" course
1. The teacher posts study materials (mainly texts and presentations) which the students can browse or download
2. The course contains communication instruments (discussion forums, chat, e-mail, blogs, etc.), which enable students to communicate with the teacher or with their fellow students and thus present their opinions
3. The teacher can manage the education process, assign tasks, test students' knowledge and evaluate them
4. The course contains interactive, multimedia and dynamic aspects such as animations, video sequences or computer simulations of the discussed phenomena
5. The teacher can manage the activity of individual students and individualize it; on the basis of the student's previous results, the teacher can, for instance, influence which tasks they should solve.
6. The students can actively add their own notes or resources to the study materials and thus modify the entire course.

Nowadays, the Pedagogical Faculty of the University of Ostrava mainly offers the level 4 courses and some level 5 courses.

Research on use of electronic learning environment by University of Ostrava students

Research objectives

The subject of the research was the use of the electronic information environment (EIE) by the university students. The goal of the research was to collect and analyze data about the current situation concerning the use of individual components of the electronic information environment and learn whether it varies in various forms of study.

Research problem and research questions

The authors of the study formulated the basic research problem as follows: There are no relevant data concerning the University of Ostrava students' use of electronic information environment instruments, which kinds and why the students of the particular university use them and what their needs and expectations are as far as this area is concerned. The formulated research problem was further specified by the following research questions:

1. Which components of the electronic information environment do students use?
2. What are the reasons for students' use of the electronic information environment?
3. What could have a positive impact on students' activity concerning the use of electronic information environment and which parameters of the environment could influence this activity?
4. Should be students' personal needs taken into account when developing the sources of the electronic information environment? If so, which are they?
5. Which components of the electronic information environment can influence a student's choice of university the most?
6. In students' opinion, in which way could some of the instruments of the electronic information environment influence the planning of their study activities?

Research hypotheses

Corresponding research hypotheses were formulated on the basis of preliminary findings regarding university students' learning habits and their orientation in corresponding studies:

H1: The daily attendance (DA) students prefer to use different components of the electronic information environment than the combined study (CS) students.

H2: The DA students have different reasons for using the electronic information environment than the CS students.

H3: As far as the reasons for the increase in activity concerning the use of the electronic information environment are concerned, the opinions of the DA and CS students will vary.

H4: The needs of the DA and CS students concerning the expansion of the electronic information environment will be different.

H5: As far as the choice of university is concerned, the DA students prefer different components of the electronic information environment than the CS students.

H6: The opinions of the DA and CS students on the possibilities of the use of the electronic information environment will vary.

Research file and data collecting

The students of the Pedagogical Faculty of the University of Ostrava, which is participating in the international research IRNet (*International research network for study and development of new tools and methods for advanced pedagogical science in the field of ICT instruments, e-learning and intercultural competences*), which is being conducted within the scope of the 7th framework program in 2014-2017, were the research file of this research. All of the Faculty's students were asked through a bulk email to fill out a questionnaire, which was compiled by a consortium of project solvers. 171 (5.4%) out of the total number of 3161 students who studied at the Faculty in the 2014/15 academic year filled out the questionnaire in the Google electronic environment. Considering that students' participation in the questionnaire research was voluntary, the selection of respondents was random. Furthermore, considering the portion of the total number of students and the approximately same number of DA and CS students (1761 (55.7%) DA students and 1405 (44.3%) CS students are studying at the Faculty), the sample can be considered representative. More detailed characteristics of the research file can be found in Chart 1.

Category	Count	%
Daily attendance students	100	58,5 %
Combined study students	71	41,5 %
Women	141	82,5 %
Men	30	17,5 %
BA students	99	57,9 %
Follow-up MA students	60	35,1 %
MA students	8	4,7 %
Ph.D. students	4	2,3 %
Students of teaching study programs	143	83,6 %
Students of non-teaching study programs	28	16,4 %
Students – advanced users	77	45 %
Students – intermediate users	89	52 %
Students – beginners	5	2,9 %
Total	171	100 %

Chart 1: Respondents of the questionnaire research

A larger portion of women and students of teaching study programs in the research sample is determined by women's naturally greater interest in (the mostly feminized) teaching professions and the prevailing portion of teaching study programs at the Faculty. Moreover, in the sample the portions of students of all three levels of study correspond to the real portion as represented at the Faculty. More than half of the students consider themselves intermediate ICT users and only a small number consider themselves beginners.

The data collecting took place in April 2015. The students answered the questionnaire questions through the electronic system Google Questionnaire.

Results and their interpretation

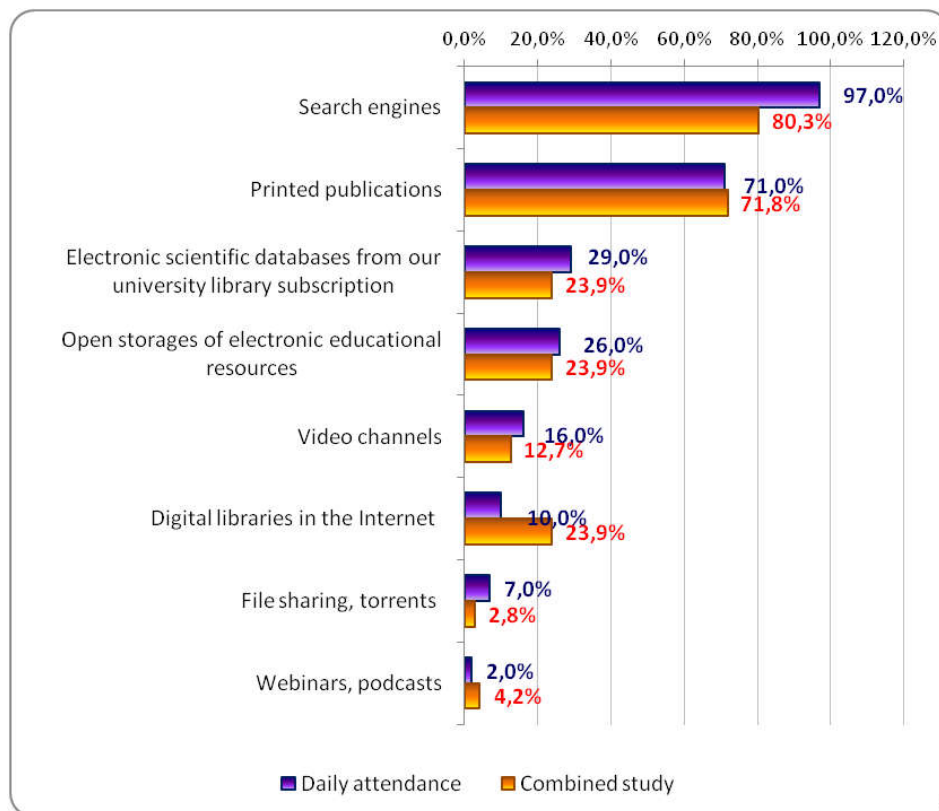
The research results were processed using the statistical program and are being presented in the order of the sequence of the research questions.

Research question 1 results: Used components of the electronic information environment

The students answered the question “Which information resources do you use most often when solving assignments, conducting a research, writing papers?” Yes or No in all of the 8 variants: 1) search engines (Google, Yandex, etc.) – a keyword search, 2) printed publications (books, journals, guidelines, etc.), 3) electronic scientific databases of the university library (the database of electronic journals, full-text electronic resources, etc.), 4) digital libraries on the Internet, 5) Open storages of electronic educational resources (repository, WIKI), 6) video channels (YouTube), 7) file sharing, torrent, 8) webinars, podcasts. The data presented in Chart 2 and Graph 1, respectively show the following:

Quest. No.	Informational resources I use most often when solving assignments	Daily attendance	Combined study	Chi-square sig.
10.1	Search engines	97,0 %	80,3 %	,000
10.2	Printed publications	71,0 %	71,8 %	,906
10.3	Electronic scientific databases of the university library	29,0 %	23,9 %	,463
10.5	Open storages of electronic educational resources	26,0 %	23,9 %	,760
10.6	Video channels	16,0 %	12,7 %	,544
10.4	Digital libraries on the Internet	10,0 %	23,9 %	,014
10.7	File sharing, torrents	7,0 %	2,8 %	,308
10.8	Webinars, podcasts	2,0 %	4,2 %	,650

Chart 2: EIE components used by students



Graph 1: EIE components used by students

- Students largely use search engines in their work (90% of students).
- They still work with printed publications (71%).
- However, they use electronic scientific databases (26.9%) and digital books (15.8%) to a small extent. Every fourth student (25.1%) uses stored data or saves their own data in open storages of electronic study materials. Every eighth student (14.6%) uses video channels. Students hardly ever make use of webinars or file sharing.
- The DA students use the mentioned resources to the same extent as the CS students. The CS students work more with digital libraries and less with search engines. It can be said that the CS students have a more targeted approach to searching and using of study materials.

The H1 hypothesis was confirmed only for search engines (0.000 significance) and digital libraries (0.014 significance). As far as other variants are concerned, the H1 hypothesis cannot be accepted. Due to a large number of the low expected frequencies, Fisher's exact test for a 2 x 2 contingency table was used in two cases (variants 10.7 and 10.8).

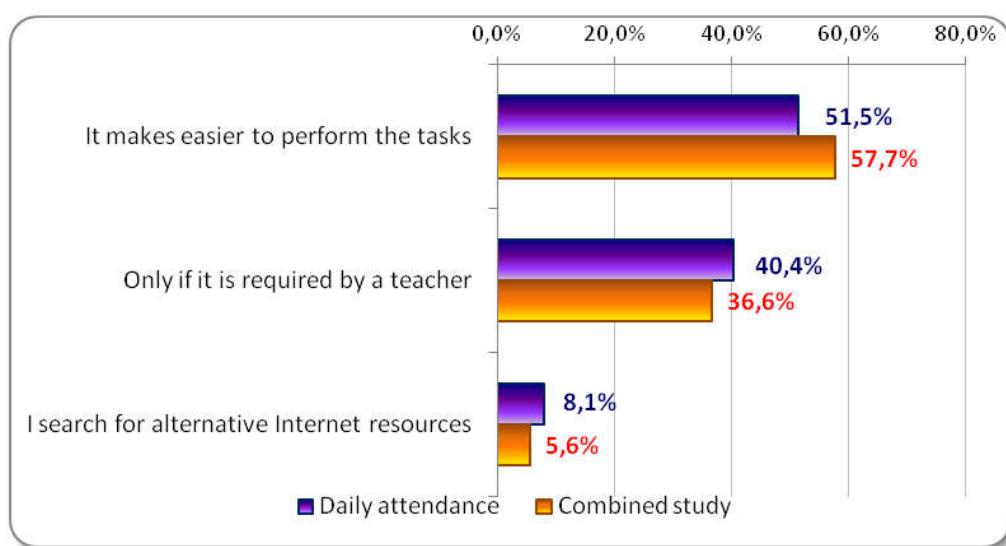
Research question 2 results: Reasons why students use the electronic information environment

Students answered to the question "Why do you (not) use those resources?" in order to learn the reasons for their (non)use of EIE instruments. The question could be answered by selecting one of the four offered answers: 1) I use them only if it is required by the teacher, 2) I use them because they make it easier to perform the tasks, 3) I do not use them because I don't know how they could help me, 4) I do not use them and rather search for the alternatives on the Internet (e.g. massive open online courses, etc.). The data presented in Graph 2 (the results are classified according to the respondents' form of study) show the following:

1. For both forms of study, the EIE is used because it is required by the teacher (40.0% and 36.6% of students).
2. The CS students use the resources more of their own will because they help them meet the requirements. Only one DA student stated that he/she did not use the resources and 5.6% of the CS students search for the alternatives on the Internet.
3. The similar number of both the DA and CS students states the reasons for their (non)use of the EIE instruments. Therefore, the H2 hypothesis was not confirmed (0.670 significance). The chi-squared test could not be used for this question because the conditions for its use were not fulfilled (37.5% of the expected frequencies was less than 5). As a result, it was necessary to remove the least represented variant "I do not use them because I don't know how they could help me".

Purpose of the use of the University electronic environment		Daily attendance	Combined study	Total
It makes it easier to perform the tasks	Count	51	41	92
	%	51,5 %	57,7 %	54,1 %
Only if it is required by a teacher	Count	40	26	66
	%	40,4 %	36,6 %	38,8 %
I search for alternative Internet resources	Count	8	4	12
	%	8,1 %	5,6 %	7,1 %
Total	Count	99	71	170
	%	100,0 %	100,0 %	100,0 %

Chart 3: Reasons for students' use of the EIE instruments



Graph 2: Reasons for students' use of the EIE instruments

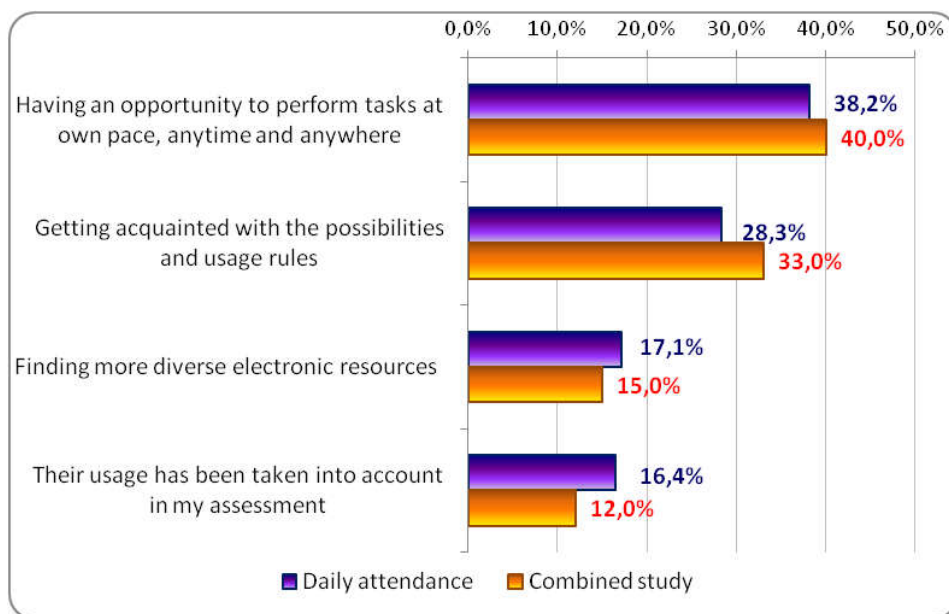
Research question 3 results: Factors potentially influencing students' activity concerning the use of the electronic information environment

The factors were being determined from the students' answers to the following question: "Which would be the two main reasons that would increase your interest in the active use of the university EIE resources?" The students were asked to choose two of the four following answers: 1) It would make you acquainted with the possibilities of their use, 2) Your using them would be reflected in your evaluation and grades, 3) It would enable you to perform assigned tasks at your own pace, anytime and anywhere, 4) It would help you find more diverse electronic resources. The data presented in Chart 4 and Graph 3, respectively show the following:

Main reasons that increase the students' interest in the active use of the university EIE resources		Daily attendance	Combined study	Total
Having an opportunity to perform tasks at my own pace, anytime and anywhere	Count	58	40	98
	%	38,2 %	40,0 %	38,9 %
Becoming acquainted with the possibilities and usage rules	Count	43	33	76
	%	28,3 %	33,0 %	30,2 %
Finding more diverse electronic resources	Count	26	15	41
	%	17,1 %	15,0 %	16,3 %
Their usage would be taken into account in my evaluation	Count	25	12	37
	%	16,4 %	12,0 %	14,7 %
Total	Count	152	100	252
	%	100,0 %	100,0 %	100,0 %

Note: The chart does not include the number of students, but the number of answers (as the students could choose as many as two reasons).

Chart 4: Factors potentially influencing students' use of the EIE



Graph 3: Factors potentially influencing students' use of the EIE

1. Nearly 39% of the 252 reasons stated by the students was the possibility to perform the assigned tasks at their own pace. Next in line (30% of answers) was the opportunity to become acquainted with the possibilities and advantages of their use. The remaining two reasons accounted for 15% and 16%, respectively of the answers. Therefore, one of the main advantages of the EIE was confirmed: a student's time flexibility when using it.

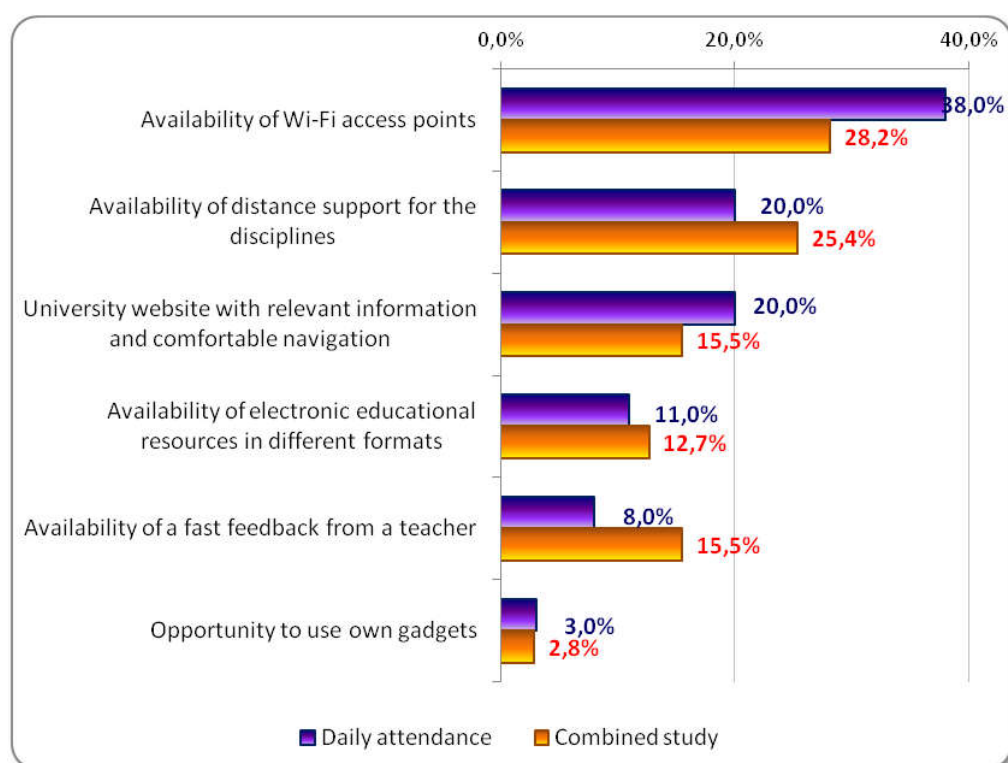
Deciding about the more active use of the EIE resources is connected to students' opinions on the functionality or availability of its instruments and components. The respondents could choose one of the six provided answers which would signal their preferred indicator for assessing the EIE: a) availability of Wi-Fi access points, b) opportunity to use their own gadgets, c) availability of electronic educational resources in different formats (video, audio, hypertext, etc.), d) university website with relevant information and easy navigation, e) availability of distance support for individual subjects (tasks in electronic form, electronic journals, course website or Moodle), f) immediate feedback from the teacher. The data presented in Chart 5 and Graph 4, respectively provide specific results:

1. Students mostly prefer the availability of Wi-Fi access points (38%), then the availability of distance support, e.g. in the form of Moodle (22.2%), and a quality university website.
2. The DA students, who spend more time at school than the CS students, find the availability of Wi-Fi access points more important than the CS students.
3. The CS students, on the other hand, prefer the availability of distance support and immediate feedback from the teacher. It can be said that the CS students are more interested in the specialized EIE instruments than the DA students.
4. Male students find the availability of Wi-Fi access points more important than female students and at the same time find the availability of distance support and immediate feedback far less important.

The H3 hypothesis could not be confirmed as there was no statistically significant difference between the preferences of the DA and CS students (0.495 significance).

The most important indicators of comfort of the university electronic environment		Daily attendance	Combined study	Total
Availability of Wi-Fi access points	Count	38	20	58
	%	38,0 %	28,2 %	33,9 %
Availability of distance support for individual subjects	Count	20	18	38
	%	20,0 %	25,4 %	22,2 %
University website with relevant information and comfortable navigation	Count	20	11	31
	%	20,0 %	15,5 %	18,1 %
Availability of electronic educational resources in different formats	Count	11	9	20
	%	11,0 %	12,7 %	11,7 %
Immediate feedback from the teacher	Count	8	11	19
	%	8,0 %	15,5 %	11,1 %
Opportunity to use their own gadgets	Count	3	2	5
	%	3,0 %	2,8 %	2,9 %
Total	Count	100	71	171
	%	100,0 %	100,0 %	100,0 %

Chart 5: University students' EIE evaluation criteria



Graph 4: University students' EIE evaluation criteria

Research question 4 results: Students' personal needs concerning the EIE

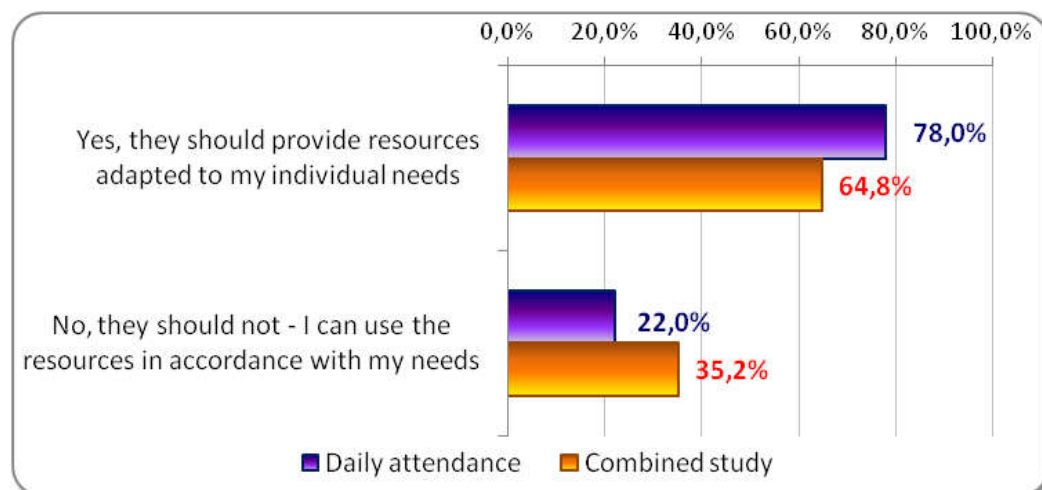
Through the Yes/No question it was being determined whether or not “Should teachers take into account students’ needs and interests while creating resources in the electronic environment (presentations, websites, tests, video lectures, etc.)? The question focused on learning the students’ possible expectations concerning the creation and use of personalized/adjusted resources created by their teachers – the “No” part of the answer had a postscript which read “I can use the resources myself according to my needs” and the “Yes” part had a postscript that read “They should provide me with the resources adapted to my needs”. Which resources adapted to their current needs the students would welcome in the

EIE was learned from the additional question with 4 possible answers: a) foreign language study, b) acquiring another profession, c) information about start-up companies and the students' own business options, d) other. The data presented in Graph 5 show the following:

1. Nearly two thirds of students (72%) would welcome if the educational resources were adapted to their own needs. Male students would welcome this option even more (77%).
2. 78% of the DA students answered this question in the affirmative. On the other hand, only 65% of the CS students answered this question in the affirmative. The difference can be interpreted as follows: the CS students choose their own study resources, they are used to them and do not expect their teachers to create resources adapted to their needs.
3. At the 5% significance level the H4 hypothesis could not be confirmed (0.057 significance). However, the result is so close to being statistically important that the hypothesis should be tested on a larger sample.

Should teachers consider students' educational needs and interests while creating el. resources in the educ. environment?		Daily attendance	Combined study	Total
Yes, they should provide resources adapted to my needs	Count	78	46	124
	%	78,0 %	64,8 %	72,5 %
No, they should not - I can use the resources myself according to my needs	Count	22	25	47
	%	22,0 %	35,2 %	27,5 %
Total	Count	100	71	171
	%	100,0 %	100,0 %	100,0 %

Chart 6: Students' personal needs concerning the EIE

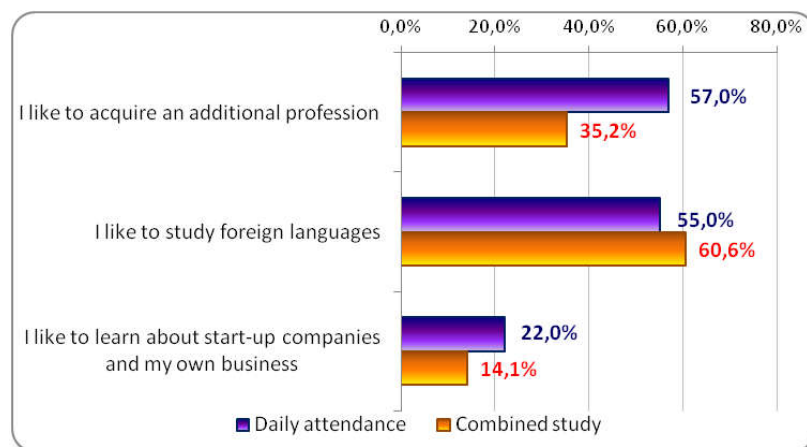


Graph 5: Students' personal needs concerning the EIE

As far as the choice of possible additional study resources is concerned, 57% of all respondents would welcome resources for the study of foreign languages, 48% for the acquisition of another profession, and 18.7% for the information about start-up companies and their own business options. Due to their job responsibilities, the CS students are less interested in the information resources about other job possibilities and their own business options than the DA students.

Quest. No.	Informational resources I use most often when solving assignments	Daily attendance	Combined study	Chi-square sig.
5.2	I would like to acquire an additional profession	57,0 %	35,2 %	,005
5.1	I would like to study foreign languages	55,0 %	60,6 %	,469
5.3	I would like to learn about start-up companies and my own business options	22,0 %	14,1 %	,191

Chart 7: Other resources required by the students



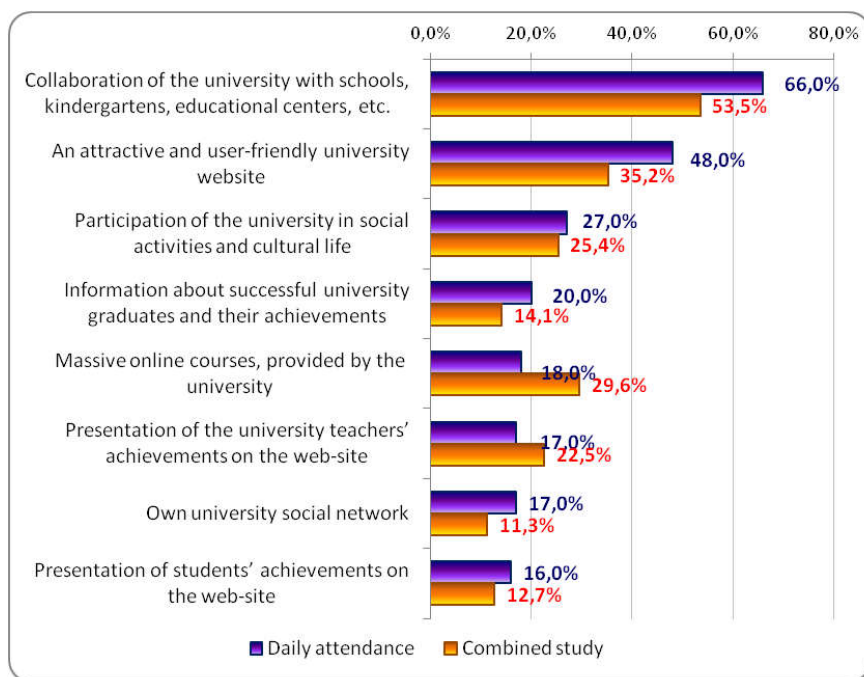
Graph 6: Other resources required by the students

Research question 5 results: The EIE components potentially influencing the students' choice of university

The main point of determining which EIE components of a particular university the students find the most important when choosing a university was to learn the students' specific expectations concerning study conditions and the quality of the educational environment. The respondents were instructed to choose the most important of the following answers: a) university massive online courses, b) an attractive and user-friendly university website, c) university social network, d) transparent presentation of the university teachers' achievement on the university website (awards, publications, etc.), e) transparent presentation of the university students' achievements on the university website (awards, publications, etc.), f) information about successful university graduates and their achievements, g) collaboration of the university with schools, kindergartens, educational centers, firms, etc., h) participation of the university in social activities and cultural life (volunteering, charity concerts, exhibitions, etc.).

Quest. No.	The EIE components potentially influencing the students' choice of university	Daily attendance	Combined study	Chi-square sig.
11.7	Collaboration of the university with schools, kindergartens, educational centers, firms, etc.	66,0 %	53,5 %	,100
11.2	An attractive and user-friendly university website	48,0 %	35,2 %	,096
11.8	Participation of the university in social activities and cultural life	27,0 %	25,4 %	,809
11.6	Information about successful university graduates and their achievements	20,0 %	14,1 %	,316
11.1	University massive online courses	18,0 %	29,6 %	,075
11.4	Presentation of the university teachers' achievements on the university website	17,0 %	22,5 %	,366
11.3	University social network	17,0 %	11,3 %	,296
11.5	Presentation of the university students' achievements on the university website	16,0 %	12,7 %	,544

Chart 8: The potential of the components to influence the choice of university



Graph 7: The potential of the components to influence the choice of university

1. It is surprising that the largest portion – 27.8% - of the entire number of respondents' answers (374) representing their opinion on the influence of the factors on the choice of university was represented by the information about cooperation of the university with lower level schools. As far as the number of students who stated this factor is concerned, the portion is 60.8%. It can be the result of 83.6% of the research sample students studying in the teacher study program. 62.2% of the teacher study program and 53% of the specialized program students considered this factor to be the most important.
2. An attractive university website is the second most important factor (19.5% of all answers) followed by the participation of the university in social and cultural activities.
3. As far as the DA students are concerned, the portion of answers preferring the influence of information about the cooperation of the university with lower level schools is higher (32.7% of all answers) than the CS students' (29.9% of all answers). Moreover, the DA students also appreciate the significance of an attractive university website more than the CS students.
4. On the other hand, the CS students – as expected – stress the importance of the university massive online courses, the presentation of the university teachers' achievements and the participation of the university in social and cultural activities.

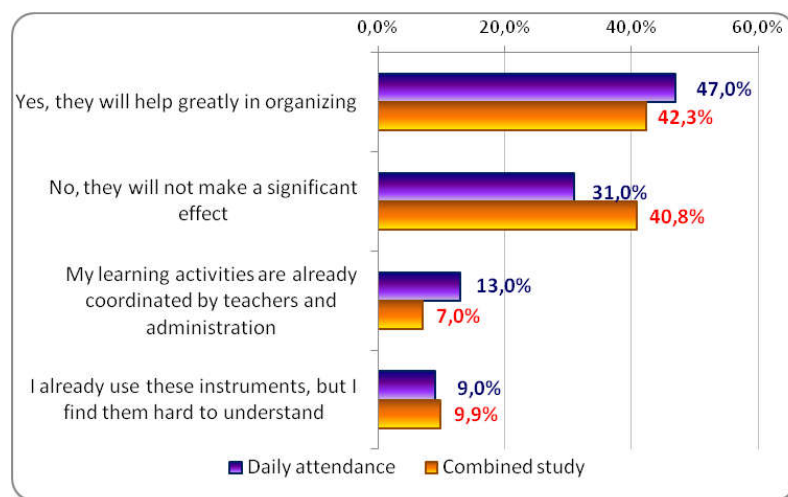
The results do not make it possible to confirm the H5 hypothesis for any of the 8 answers (see Chart 8).

Research question 6 results: Students' opinions on the influence of the EIE on the planning of their study activities

Determining these opinions can be interesting from the point of view of time management, which is – with regard to the preparation of the majority of students for the teaching profession, which requires not only management of one's own time, but also of their students' time – a significantly important skill. The answer to the research question was obtained through the processing of four proposed answers to the questionnaire question "Would the information technology instruments (electronic diaries, planners, calendars, reminders, etc.) help plan students' educational and extracurricular activities?". These are the four possible answers: a) no, they would not have a significant influence, b) yes, they would help me significantly with organization, c) my study activities are adequately coordinated by teachers and administration, d) I already use the tools, but I do not find them helpful.

Would the information technology instruments help me in the planning of my educational activities?		Daily attendance	Combined study	Total
Yes, they would help me significantly with organization	Count	47	30	77
	%	47,0 %	42,3 %	45,0 %
No, they would not have a significant influence	Count	31	29	60
	%	31,0 %	40,8 %	35,1 %
My study activities are adequately coordinated by teachers and administration	Count	13	5	18
	%	13,0 %	7,0 %	10,5 %
I already use these instruments, but I do not find them helpful	Count	9	7	16
	%	9,0 %	9,9 %	9,4 %
Total	Count	100	71	171
	%	100,0 %	100,0 %	100,0 %

Chart 9: Students' opinions on the possibilities of the use of the EIE for time management



Graph 8: Students' opinions on the possibilities of the use of the EIE for time management

1. Nearly half of the students (45%) think that the EIE instruments will help them in the planning of their educational and extracurricular activities.
2. The CS students are more skeptical – every fourth CS student believes that the EIE instruments will not help them with time management. The fact that they have already chosen other possibilities such as classic recorders, diaries, etc. and do not intend to change their habits may be one of the reasons.

3. Every tenth female student is not using the instruments yet, but 46.8% of them are contemplating using them (more than male students).

The acquired data do not make it possible to confirm the H6 hypothesis stating that there will be differences in the opinions of the DA and CS students on the use of the EIE instruments (0.426 significance).

Conclusion

In the presented research of the developing university electronic information environment, which was realized within the scope of an international project, the most observed factor (among many others) was the influence of the form of study on the use of individual components of this environment and the students' needs that could be initiated by this environment. Six operational hypotheses were being verified that – based on the long-time experience of the solvers – expected both agreements and differences in the students' applying of the EIE instruments and in their opinions on the reasons for their application. Particular findings in the form of answers to individual questions enable the pedagogical staff at universities to consider further development of the “smart learning environment” and the students to consider more active and perspective involvement in it. As far as the next part of the project is concerned, the representativeness of the research file allows for the comparison of the results acquired in the Czech Republic with the results acquired in the eight remaining countries participating in the project and to evaluate both our advantages and shortcomings as compared to other countries.

Acknowledgments

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PYTHON AND TEACHING PROGRAMMING AT UPPER SECONDARY SCHOOLS

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Abstract

Teaching programming fundamentals in the Python language is becoming increasingly popular at the upper secondary schools abroad. However, in Slovakia no official textbooks devoted to this programming language exist yet. In this paper, we review textbooks for the Logo and Pascal programming languages used at upper secondary schools in Slovakia. We focus mainly on commands and constructions discussed by these textbooks. Based on this survey, we compare the syntactical differences in writing programs in the Logo, Pascal and Python languages. We are also interested in various types of exercises that students are able to solve after graduating from upper secondary school. We solve the same or analogous exercises in all three languages. Furthermore, we examine the similarities of solutions in Python compared to the Logo or Pascal, and conclude whether it is necessary to choose a completely different programming approach for exercises.

Keywords

teaching programming, upper secondary schools, textbooks, comparison, Pascal, Logo, Python

Introduction

Teaching programming fundamentals at upper secondary schools (students aged 15 to 18) and grammar schools is focused on teaching algorithms, development of algorithmic thinking and problem solving skills, see (ŠPÚ, 2008). In the past, students at upper secondary schools were learning programming in the Logo language and later in Pascal. Several textbooks were created for teaching programming in these languages: Algorithms with Logo, see (Varga et al., 1999) and Programming in Delphi and Lazarus, see (Blaho, 2012). Currently, at the majority of upper secondary schools, students study programming in Pascal using the Delphi or Lazarus programming environments.

The Python language is currently gaining ground as more and more universities and upper secondary schools choose this language for teaching introductory programming courses. There are textbooks for teaching programming in Python, but they often concentrate mostly on the language syntax, respectively highlight the differences in writing certain commands used by the Python language compared to other programming languages. Most of the teachers need such programming materials for teaching that would teach the students the language while doing exercises in it. Therefore, many teachers create their own materials for teaching programming. These materials are designed for a narrow circle of students, customized for the needs of the school and the characteristics of the teachers' teaching style.

In our research we focus on the general-academic subject Informatics and the place of the programming in it. A part of our research will be devoted to the creation of a methodology for

programming in the Python language for students at upper secondary schools as well. We have therefore decided to review the existing textbooks of programming for Pascal and Logo used at upper secondary schools in Slovakia. These textbooks partly fit with our target group, which consists of the first two grades of grammar and upper secondary schools.

Textbooks for programming

In our previous article, see (Mészárosová and Tomcsányiová, 2015), we described four programming courses and their teaching materials. We compared the sequence of topics in these materials among each other and with the sequence of topics in the textbook *Programming in Delphi and Lazarus* used by most of the teachers to teach programming fundamentals at upper secondary schools. For our further research we made the first important decision: to design a methodology for teaching programming in Python at upper secondary schools in a way, so that one of the first topics the students encounter, will be the graphical interface and the options of drawing in it. Both aforementioned textbooks are based on works dealing with graphics.

Salanci states, see (Salanci et al., 2011), that proper textbooks place emphasis on gathering experience by the students:

- They are not encyclopaedic in nature. They contain only an inevitably small amount of theory. They offer a sufficient amount of graded exercises to practice.
- The sequence of topics starts with acquainting the children with the programming environment. The basics of programming (algorithmic) concepts are gradually explained, the students learn to solve (elementary) algorithmic problems, but in addition to this they are also practicing their newly gained knowledge.
- The authors do not rush with the explanation and leave enough time for students to get familiar with the concepts. The emphasis is on fun and motivating examples, illustrations, tracing and gradual discovery of the laws.

Textbook Informatics for grammar schools: Algorithms with Logo (*Informatika pre gymnáziá: Algoritmy s Logom*)

This thematic workbook was published in 1999, see (Varga et al., 1999). It was approved by the Ministry of Education and was included in the list of recommended textbooks for grammar schools. From the content perspective it covers all the requirements from the national education curriculum. From the didactic perspective the textbook is prepared analogically with examples. It contains relatively many examples and exercises to practice the new knowledge. The authors put the emphasis on motivation. After the explanatory texts, there are examples with solutions, followed by definitions for the generalization of the new knowledge and exercises to practice the covered topics using new and existing knowledge.

The textbook elaborates on the following topics:

- introduction to the Logo language and the Comenius Logo environment
- loop, procedure, parameter, variable, conditions, simple recursion
- keyboard input processing and working with the mouse
- working with multiple turtles

Textbook Informatics for upper secondary schools: Programming in Delphi and Lazarus (*Informatika pre stredné školy: Programovanie v Delphi a Lazaruse*)

The textbook was published in 2012, see (Blaho, 2012), and it is the second modified edition, which is approved by the Ministry of Education as an official textbook for upper secondary schools. From the content perspective it covers all the important topics, notions and concepts

from the national education curriculum. Moreover it includes topics that are not included in the subject Informatics, but are among the target requirements for the final exams at upper secondary schools. From a didactic perspective the textbook is detailed. Explanations are complemented with examples and illustrations. It contains exercises to practice the new knowledge after each comprehensive section. New terms are highlighted, explained and described in detail.

The textbook elaborates on the following topics:

- introduction to the Pascal language and the Lazarus, respectively Delphi programming environment
- graphics
- variables and assignments, `for` and `while` loops, procedures and functions, `if` conditional command
- timer, working with the mouse
- algorithms with strings, arrays and text files

An important finding for our research is that the order of the first few topics matches in both textbooks. Based on this we can partially conclude that the authors sought a way in both programming languages to utilize graphics and drawing to familiarize students with the basics of programming. Since this approach is used in teaching programming in Slovakia for a while, it would be good if our research and methodology for programming in Python language could pick up on this.

The syntax of commands and structures in Pascal, Logo and Python language

In this part we focus on the commands and language constructions, which are used in textbooks and show the differences in their syntax in all three programming languages. In Logo we use basic commands from the Imagine Logo environment, in Pascal we use the notation from the Lazarus environment and in Python we use the syntax of the version 3.4.

The Logo language was designed as a tool for learning and teaching programming and despite its age it still belongs among the strongest tools of constructivism and constructionism. The most important features of the language and its implementation by the Imagine Logo environment are, from the didactic point of view, its simplicity and interactivity. One of its valuable features is, for example, that after entering a command to the command prompt, this command is immediately executed so the user has immediate feedback whether it was executed properly. Currently the programming in Imagine Logo was transferred to the lower secondary school (students aged 10-15), and is no longer used at upper secondary schools (students aged 15-18).

Pascal was designed primarily as a programming language for teaching programming, to get good programming habits and experience in working with data structures. In upper secondary schools it has gradually been used in the Borland Pascal and Turbo Pascal environments. Currently, most of the schools use the programming environment Delphi or a free alternative called Lazarus.

The Python programming language was created in 1989. Python supports object-oriented programming, procedural and also functional programming. Attractive features of the language Python are the easy readability of the code, its clean syntax and also it is more intuitive than the other languages. One of the benefits of the Python language is also the number of existing libraries available for free, but their use is not mandatory. The most important libraries for teachers could be the `Tkinter` graphical library and the `turtle` graphics

library called **Turtle**, which allows the students to create attractive and interesting programs. These two libraries also let the teacher choose a way to teach the curriculum either by standard graphical interface or by turtle graphics. Nowadays this programming language is gaining ground. Lot of the secondary schools in England run introductory courses for programming, also some of the schools abroad and in the Czech Republic and Slovakia have already switched to teaching programming in Python.

In Tab.1 we list the commands and structures that are common to all three languages, and which are discussed in both of the aforementioned textbooks of programming. We can see the differences in the syntax of the commands in different languages and compare, for example, the complexity of the syntax of the commands **for** or **if**.

Note a few differences in the use of the conditional command **if**: in Pascal we distinguish whether there is only one command or more – if we write more commands into a block, we have to add the beginning and ending commands **begin** and **end** that surround the block. In Python a block of commands is indicated by equal whitespace indentation. In Logo a group of commands is enclosed in square brackets. In Pascal and Python we can, but need not to write the **else** part of the condition. In Logo we distinguish two types of conditional commands: **if** and **ifElse**.

When defining procedures and functions in the Pascal language we distinguish procedures and functions with a return value (**result**). In Python, we use only functions where we can but do not have to specify a return value (**return**). It is up to the programmer whether he/she determines the return value in Logo procedures (**op**).

	Pascal (Lazarus)	Python	Logo (Imagine)
assignment	<code>x := 150;</code>	<code>x = 150</code>	<code>make "x 150</code>
conditional command	<code>if condition then begin</code> <code>command</code> <code>end;</code> <code>if condition then begin</code> <code>commands</code> <code>end</code> <code>else begin</code> <code>commands</code> <code>end;</code>	<code>if condition:</code> <code>commands</code> <code>if condition:</code> <code>commands</code> <code>else:</code> <code>commands</code>	<code>if condition [</code> <code>commands</code> <code>]</code> <code>ifElse condition</code> <code>[commands]</code> <code>[commands]</code>
for loop	<code>for i:=1 to 10 do begin</code> <code>commands</code> <code>end</code>	<code>for i in range(1,11):</code> <code>commands</code>	<code>repeat 10 [</code> <code>commands</code> <code>]</code>
procedures and functions	<code>procedure name(x,y:integer);</code> <code>begin</code> <code>commands</code> <code>end;</code> <code>function name(x,y:integer):integer;</code> <code>begin</code> <code>commands</code> <code>result := value;</code> <code>end;</code>	<code>def name(x,y):</code> <code>commands</code> <code>def name(x,y):</code> <code>commands</code> <code>return value</code>	<code>to name :x :y</code> <code>commands</code> <code>end</code> <code>to name :x :y</code> <code>commands</code> <code>op value</code> <code>end</code>
random numbers	<code>x := random(5);</code>	<code>x = random.randrange(5)</code>	<code>make "x random 5</code>

Tab. 1: The commands and structures that are common to languages Pascal, Python and Logo

This comparison of how the commands and structures are written in different programming languages is interesting for our research while working with graphics. While in the textbook Programming in Delphi and Lazarus the authors prefer drawing lines, rectangles and ellipses using basic procedures of the default graphical interface, in the textbook Algorithms with

Logo relative turtle graphics is used. If we look at these two approaches from the perspective of the Python language, which includes both approaches already in its standard library (modules `Tkinter` and `turtle`), we find out that it can just as effectively work with the graphical interface as with the turtle graphics.

Pascal (Delphi / Lazarus)	Python
<pre> procedure TForm1.FormCreate(Sender:TObject); begin Image1.Canvas.Brush.Color := clRed; Image1.Canvas.Rectangle(10, 10, 40, 40); end;</pre>	<pre> import tkinter g = tkinter.Canvas() g.pack() g.create_rectangle(10, 10, 40, 40, fill='red')</pre>
Logo (Imagine Logo)	Python
<pre> repeat 4 [fd 30 rt 90]</pre>	<pre> import turtle t = turtle.Turtle() for i in range(1,5): t.fd(30) t.rt(90)</pre>

Tab. 2: Solutions of a task to practise work with graphics in Pascal, Python and Logo language

From Tab. 2, we see that for some exercises there **is no difference** between the solutions in Pascal and Python, resp. Logo and Python, except the differences in the commands' notation and the access to the graphical interface (in Pascal students are required to add the **Image** to the **Form** and are usually taught to do this using the designer).

Exercises for practising the curriculum in textbooks

We are interested in what types of exercises are the students able to solve in the context of the discussed topics.

For loop

After studying the textbooks we chose this topic to show what types of tasks the textbooks mostly contain. For example there is an exercise in the textbook Programming in Delphi and Lazarus on p. 37 for practising loops (**for**):

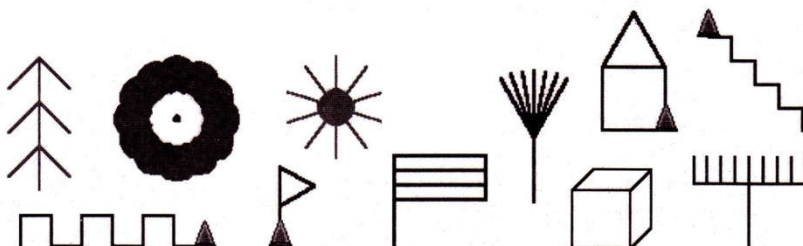
*Write a program that progressively draws these 31 line segments **using for loop**:*

```

Line(0,0,0,300);
Line(10,0,0,290);
Line(20,0,0,280);
Line(30,0,0,270);
...
Line(300,0,0,0);
```

In the textbook Algorithms with Logo (p.11) there is the following exercise to practice the basic command **repeat**. This textbook contains similar tasks for all discussed topic.

*Draw these pictures using the **repeat** command:*



Conditional command if

Since both books contain chapters covering conditions and the `if` command, we were looking for exercises that students can solve by using them. We chose two tasks from textbooks which are the most similar and investigated whether the solution in Python requires changes in these exercises due to the new language in which they will be solved.

According to our solutions in Pascal and Python, see Tab. 3, we see that the solutions are very similar, except for differences in the definition of the graphical interface and the syntax of the commands.

Textbook Programming in Delphi and Lazarus includes on p. 67 task:

Write a program that will simulate throwing three dices: firstly generate and write 3 random numbers from the interval $<1,6>$. If all three are the same, then display the message BINGO, if only two numbers are the same, display the message SUPER. If all the numbers are different, display the message PITY.

The solution of this task in Pascal (Lazarus) and Python language can be for example:

<pre> procedure TForm1.FormCreate(Sender: TObject); var X, Y, Z: Integer; begin X := Random(6)+1; Y := Random(6)+1; Z := Random(6)+1; Image1.Canvas.TextOut(20,20, 'X: ' + IntToStr(X)); Image1.Canvas.TextOut(20,35, 'Y: '+IntToStr(Y)); Image1.Canvas.TextOut(20,50, 'Z: '+IntToStr(Z)); if (X = Y) or (Y = Z) or (X = Z) then begin if (X = Y) and (Y = Z) then Image1.Canvas.TextOut(20,65, 'BINGO') else Image1.Canvas.TextOut(20,65, 'SUPER'); end else Image1.Canvas.TextOut(20,65, 'PITY'); end; </pre>	<pre> import tkinter, random g = tkinter.Canvas() g.pack() x = random.randint(1,6) y = random.randint(1,6) z = random.randint(1,6) g.create_text(20,20, text='x: '+str(x)) g.create_text(20,35, text='y: '+str(y)) g.create_text(20,50, text='z: '+str(z)) if (x==y) or (y==z) or (x==z): if (x == y) and (y == z): g.create_text(20,65, text="BINGO") else: g.create_text(20,65, text="SUPER") else: g.create_text(20,65, text="PITY") </pre>
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Tab. 3: The solution of a task in Pascal (Lazarus) and Python language

Similarly we searched for an exercise in the textbook Algorithms with Logo using which students can practice the `if` command and recursion. There is a partly solved task on page 28, which continues in the exercises. In the table Tab. 4 we can see that the solutions in both languages are very similar.

Write a program in which the computer selects a random number from the interval $<1,10>$ and lets us guess what number it is. Modify the program so that it outputs whether our number is larger or smaller than the number which we have to guess.

<pre> to guess_number sh [I have a number, guess it!] guess 1 + random 10 end to guess :number let "nap readWord if :tip = :cislo [sh [Got it!] stop] ifElse :nap < :number [sh [My number is larger, try again.]] [sh [My number is smaller, try again.]] </pre>	<pre> import random def guess_number(): print("I have a number, guess it!") guess(random.randint(1,10)) def guess(number): nap = int(input("Give your nap:")) if nap == number: print("Got it!") return if nap < number: print("My number is larger, try again.") else: </pre>
--	--

<pre>guess :number end ? guess number</pre>	<pre>print("My number is smaller, try again.") guess(number) guess number()</pre>
---	---

Tab. 4: The solution of a task in Logo (Imagine) and Python language

Exercises from the end of the textbooks

We are also interested in what type of exercises the students are able to solve after graduating from upper secondary school. The last topic in the textbook Algorithms with Logo is working with the mouse. It contains tasks such as (from the p. 47):

Write a memory game Pexeso.

Write a game Tic Tac Toe (3x3). Each game field is represented by an animation turtle with the shape of the symbol variable. By clicking on an unmarked field the phase of the corresponding turtle changes according to which player's turn it is.

This topic can be found in the middle section of the textbook Programming in Delphi and Lazarus. An example of exercises from the textbook that is on page 75:

Write a simple Paint – program for drawing pictures. Make a few buttons for deleting the selected areas, varying the thickness of the pen and the colour of the pen as well.

As we mentioned above, the textbook includes topics that are also included in the target requirements for final exams at upper secondary schools in the subject Informatics. For example working with arrays and with text files. An example exercise from the textbook Programming in Delphi and Lazarus to work with arrays is (on p. 119):

Define three arrays of strings in the program: an array of a few names (e.g., Eva, Michal, Zuzka, Paľo), array of a few words (e.g., loves, knows, combs, breeds) and a few objects (e.g., an elephant, a dog, a snake). The program assembles random sentences using these sets of words and writes them to a text area.

A very similar exercise is in the textbook Algorithms with Logo on the page 43:

Let's write a procedure, which will generate random sentences.

There is a solution for this exercise in the textbook that we adjusted to the Imagine environment and solved in Python as well. From the table Tab. 5 we can see that the solutions are almost identical. The exercise from the textbook Programming in Delphi and Lazarus mentioned above has a very similar solution too.

<pre>to sentences let "name [Anicka ZuZka Ferko Julia Terezka Jozko] let "verb [love like hate eat] let "foor [cake. milk. cheese. pie. apple. spinach.] repeat 5 [let "text [] let "text fput pick :verb :text let "text fput pick :name :text let "text lput pick :food :text sh :text] end ? sentences</pre>	<pre>import random def sentences(): name = ["Anicka", "ZuZka", "Feko", "Julia", "Terezka", "Jozko"] verb = ["love", "like", "hate", "eat"] food = ["cake.", "milk.", "cheese.", "pie.", "apple.", "spinach."] for i in range(1,5): text = "" text += random.choice(name) text += " " + random.choice(verb) text += " " + random.choice(food) print(text) sentences()</pre>
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Tab. 5: The solution of a task in Logo (Imagine) and Python language

An example of exercises to practice working with text files from the textbook Programming in Delphi and Lazarus on p. 130 is the following:

Write a program that produces the following text file: the first line contains 26 A letters, the second 25 of B, etc. Up to the 26th line which contains a single Z letter.

Conclusion

In our previous research we decided that we would teach the basics of programming at upper secondary schools in the Python language using graphics. We are still considering whether to use more conventional, basic commands for drawing geometric figures or to dedicate ourselves to turtle graphics from the beginning.

In this paper we examined the currently used textbooks of programming. In both textbooks the basic topic is graphics and the other terms and concepts are explained by means of it, so the students can visually check if the exercise was solved correctly. We found out that the order of the first few topics in both of the textbooks coincides with each other, which means that loops, conditions and procedures can be taught using classic graphics and turtle graphics as well.

We also investigated the exercises for practicing the curriculum in the textbooks and found that the solutions of the selected exercises were similar in all three programming languages and we used the same programming approach – sequence to solve them. As a part of our research we will solve other exercises from the examined textbooks in the Python language and check if they need some major changes in their sequence of solution or structure of the code in Python. In the design of our future methodology for teaching programming fundamentals in Python for upper secondary schools we will build on these textbooks and use the exercises designed by experienced and respected authorities of programming textbooks for upper secondary schools.

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TEACHERS' VIEWS ABOUT THE POSSIBILITY OF USING DYNAMIC GEOMETRY SYSTEMS IN MATHEMATICS EDUCATION

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Abstract

Innovative trends in education are now often associated with the integration of ICT into the teaching process. Several software systems are available for mathematics teachers, among which have dynamic geometry systems a significant presence. Although various forms of education for teachers are currently organized and teachers have at their disposal a variety of learning materials and ideas for teaching, it is questionable to what extent these factors are reflected in school practice. The article describes a survey which was aimed to assess the state of the use of dynamic geometry systems in mathematics teaching at elementary and secondary schools and to find out teachers' views about suitability and possibilities of using it to improve mathematics education.

Keywords

Questionnaire, dynamic geometry system, GeoGebra, mathematics teaching, modelling

Introduction

Present time is characterized by rapid development of ICT that permeate all areas of social life. In today's information age, the information can be relatively easy to obtain, share and exchange. Some visionaries began to think about the use of ICT in education shortly after completion of the construction of the first computers. This idea is not to appear unrealistic given the possibilities and versatility of ICT. Seymour Papert is one of the main representatives of those policies. He is the founder of constructivism theory that characterizes the use of ICT for the formation of the internal system of knowledge the students.

ICT make its way into schools for more than 40 years. The first efforts to use ICT in education were associated mainly with testing students and with solving routine exercises focused on the training of the calculation operations. Over time have been improved a graphic and computational potential of ICT and the programmers developed a variety of software applications. A revolutionary leap in the exchange of the information meant connecting computers into the networks that allow easy acquiring and sharing information. Currently, the Internet provides a range of educational portals and interactive applications to support active learning.

In this paper, we focus on dynamic geometric systems (DGS) which provide various tools for mathematics education. The first DGS were developed early 80s of last century. One of the first applications of this type has been Geometric Supposer. On the present, GeoGebra is the most widespread DGS in the mathematics education. GeoGebra is created in the Java programming language and it is independent of the software platform. The created dynamic constructions can be easily published on the Internet in the form of applets. The name GeoGebra indicates that this program is a complex system integrating tools of geometry and

algebra. This dualism can be seen mainly in the equivalence of two basic ways of defining geometric objects: geometric construction in a graphical window and insertion of an analytical representation of the object in the input line.

Studies to determine the status of the use of ICT in mathematics education

Application of innovative trends in mathematics education is often associated with the integration of ICT in the learning process. National Council of Teachers of Mathematics (NCTM) in the United States published the basic principles and standards for modern teaching mathematics in 2000 [6]. This document identifies six basic pillars of modern mathematics education. The integration of ICT in teaching mathematics to encourage active work with information and facilitate the learning was included among the basic pillars. Efforts to integrate ICT in education clearly show also in the United Kingdom. The UK Government's Department for Education and Skills (DFES) was established in this country. The important aim of DFES is to characterize the potential for integration of ICT into the school curriculum subjects. The set of documents named ICT across the curriculum was created, at which the document ICT in mathematics was prepared for mathematics teaching.

Many studies and reports focused on the characterization of the potential of ICT in mathematics education were developed for DFES. Report for the project ImpaCT2 [3] states that 67% of primary school students never or rarely used ICT in mathematics. For secondary school it was more than 80% of students. The description of the situation in the USA in 2000 was one of the conclusions of the survey [3]. One conclusion is that students used the computer in mathematics teaching occasionally, and only a small section of work with ICT was used productively. Goos mentioned in the document [2] about the results of a three year project in Australia. Research team came to the conclusion that ICT is most frequently used to enhance traditional approaches to teaching.

The situation did not change significantly over the next few years. The report of agency OfSTED (The Office for Standards in Education) [5] states that the majority of students have only a little opportunities to use ICT for active work with the information in mathematics. The same document shows a graph (see Fig. 1), which characterizes the rate of the use of ICT in mathematics teaching at primary and secondary schools in the UK. The survey covered 1,990 primary schools and 2,061 secondary schools. The sum of percent in the chart does not 100 due to missing answers in some questionnaires and rounding numbers.

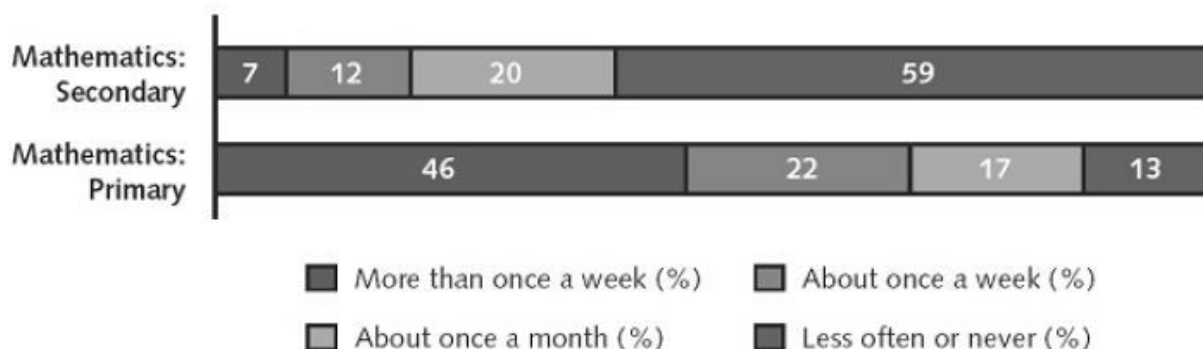


Fig. 1: The use of ICT in mathematics education (Keating, 2009)

Let us look at utilization rate of ICT in the teaching to our neighbours. In 2008 and 2010 Stehlíková and Špačková conducted surveys in the Czech Republic, which were focused on the utilization rate of e-learning at Czech secondary schools. The authors present that 48% of secondary schools not used e-learning in 2008, when as the percentage decreased to 37% of

secondary schools in 2010. In 2008, e-learning was not used at secondary schools mainly because of lack of money to buy the needed software technologies. In 2010, inadequate technology equipment of schools was the main reason for non-use e-learning. To compare other factors affecting the non-use of e-learning at Czech secondary schools, we present a graph (see Fig. 2) from the paper [7].

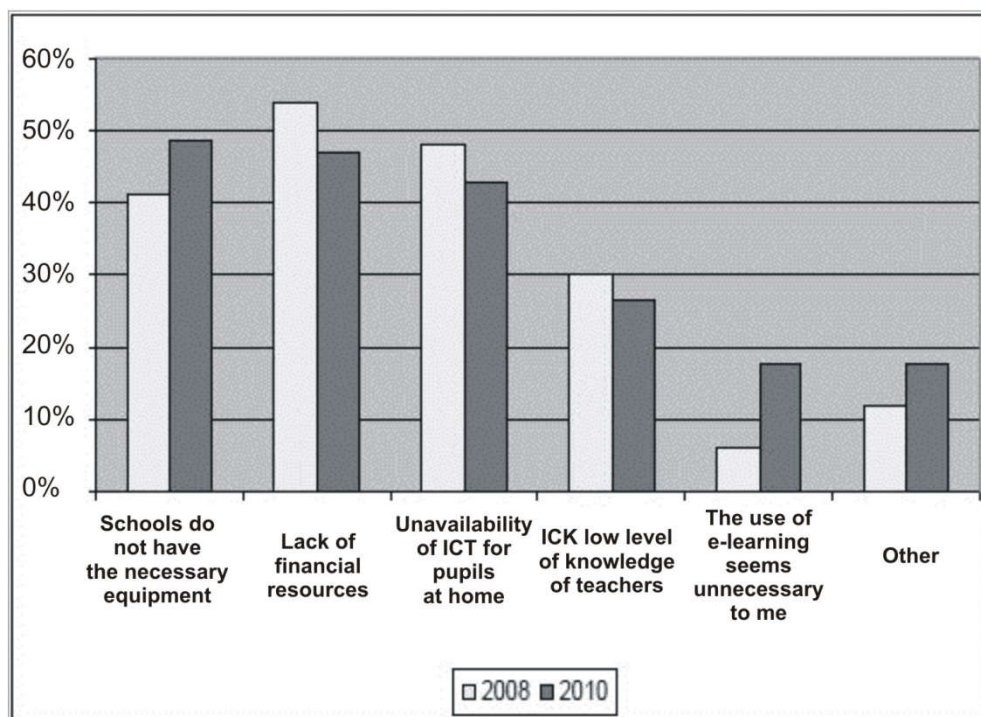


Fig. 2: The reasons for non-use of e-learning in secondary schools in ČR (Stehlíková, Špačková, 2011)

The efforts for innovation of the mathematics education with the support of ICT have been reflected in a variety of national and international projects. ICT can be used in the educational process in different ways. Teachers can include a presentation into teaching to supplement their explanation. However ICT provide a great potential to create the stimulating learning environment in which students can experiment, model, and discover new relationships.

International Project SITES (Second International Technology in Education Study) [1] tried to bring more information for analyzing impact of ICT on teaching and learning and to create the more detailed view of the use of ICT in mathematics. The comparative research program SITES was launched in 2006 in 22 countries, among which was included also Slovakia. Great attention was paid to teaching mathematics and science in the 8th grade of primary schools. Norway was ranked in the first place of the participating countries who have declared the use of ICT in mathematics teaching in the 8th grade of primary school (80.29%). Slovakia took the 11th place (51.17%) in the list of participating countries.

Teachers should comment in the questionnaires also to the purpose and ways of the use of ICT. If we focus only on the use of ICT in teaching and learning, then teachers most used ICT to find information, to use of the educational resources available on the Internet (57.1%) and to present information (51%). Most mathematics teachers in Slovakia have claimed the use of additional devices such as projector and different types of calculators (48%). Only 2% of math teachers declared the use of modelling software.

Stols G. and J. Kriek in their survey [4] devoted on analysis of the reasons why mathematics teachers do not use DGS. The survey was realized through questionnaires for mathematics

teachers in South Africa in 2011. The positive, statistically significant correlation (0,754) was found between perceived confidence in their abilities and the digital literacy of teachers. The highly significant correlation (0,902) was observed between the teacher's perceived usefulness of DGS and the rate of the use of DGS in mathematics teaching. The important conclusion of the survey pointed to the finding that teacher will use DGS in the teaching process regularly only if he is satisfied with it and it will be useful for him and for students.

Modelling activities using the DGS

The application of innovative trends in mathematics teaching may also include modelling activities to stimulate active learning based on the investigation and discovery of mathematical relationships. We present two proposals of modelling activities from different areas of mathematics that could be used in mathematics teaching already at primary school. The main focus is on visualizing mathematical objects and relationships which could contribute significantly to the development of students' mathematical knowledge and improve understanding of mathematical concepts.

The first activity can be used to investigate symmetry of geometric shapes. It enables students to explore the images of the right triangle in axial and central symmetry for different position of an axis of symmetry or a centre of symmetry. Students should focus not only on observing relative positions of the right triangle and its image, but also on the possibility of creating a variety of specific types of quadrilaterals. The deltoid and parallelogram are formed in Figure 3.

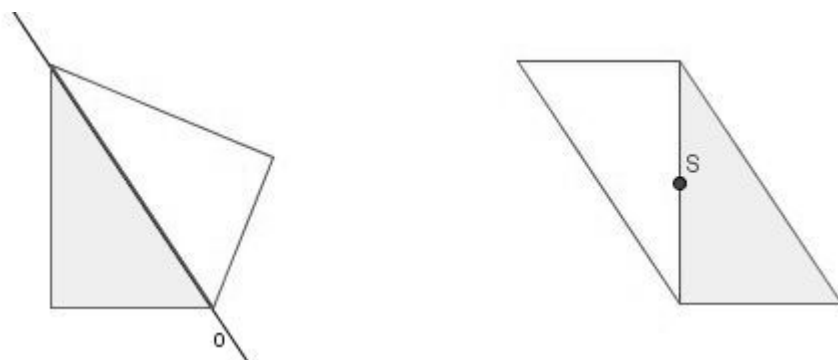


Fig. 3: Reflection of the right triangle in the axial and central symmetry

The left side of Fig. 3 shows the position of the axis of symmetry determined by the hypotenuse of the right triangle in which the right triangle and its image form the deltoid. The right side of Fig. 3 shows the location of centre of symmetry in the middle of the leg. The right triangle and its image form a parallelogram. Changing the position of the line of symmetry and the centre of symmetry enables students also get isosceles triangles and a rectangle. Students could write results of the investigation into a table with the position of the axis or centre of symmetry and the type of the quadrilateral. This activity could be the introduction to the investigation of specific types of symmetrical quadrilaterals.

The second activity can be used for modelling of the linear dependence. We have chosen an example to exploring the relation between the height of water column and time for the uniform filling of the cylinder with water (see Fig. 4). Students can use the first slider to simulate the flow of water into the cylinder. The height of water column in relation of the water volume in the cylinder is displayed in the coordinate system at the same time. Students should predict the type of dependence before the simulation.

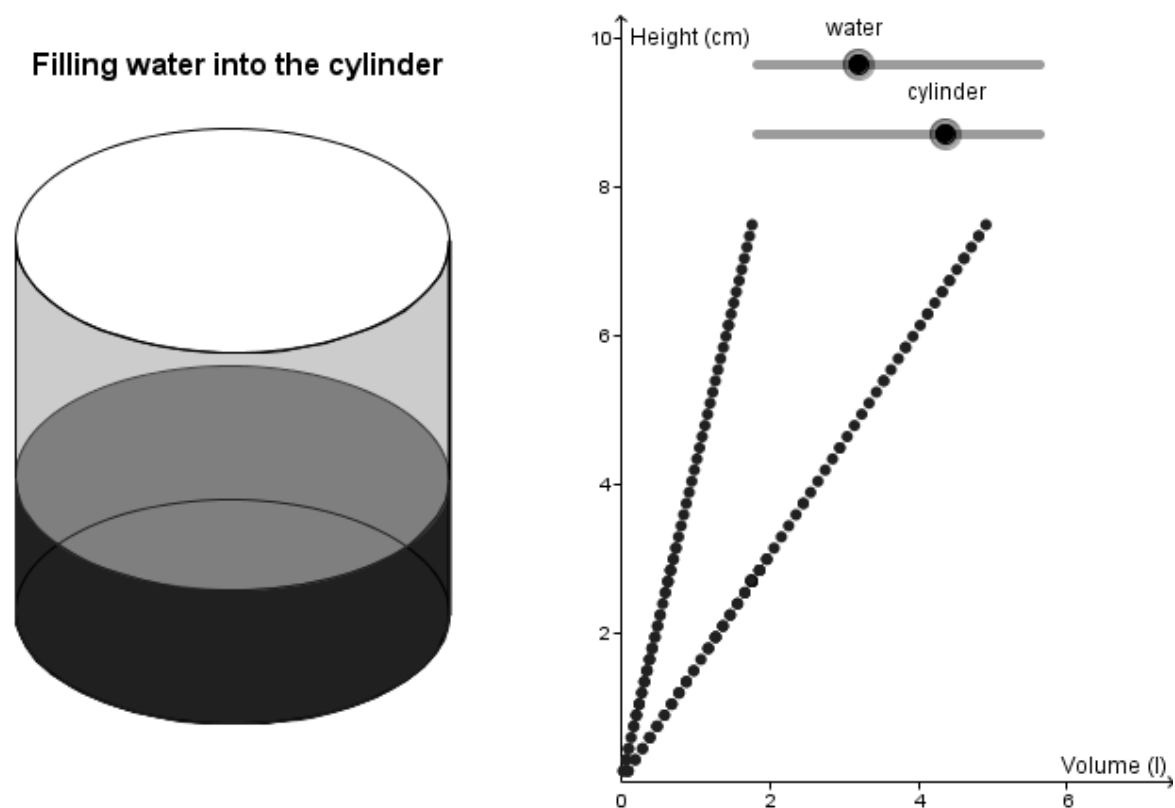


Fig. 4: Simulation of filling the cylinder with water

Then students may change the diameter of the base of the cylinder using the second slider. Students can thus observe how change of the diameter of the base will affect the graphic representation of this dependence.

The survey to the use of DGS in mathematics teaching

The aim of the survey was to determine the status of the use of DGS in mathematics teaching at secondary and elementary schools. We are also interested in the evaluation of the teachers' opinions about the possibilities of the use of DGS to support the learning and in teachers' views on the benefits and effects of DGS for improving the teaching and learning. When we planned a survey, we focused on the following research questions:

- What is the rate of the use of DGS in mathematics teaching at elementary and secondary schools?
- Where teachers have acquired the skills of using DGS?
- How do teachers perceive and assess the benefits of DGS for teaching purposes and enhancing the quality of teaching?
- At what stage of the learning process do teachers use most frequently DGS and how do they organize learning?

The survey was conducted through distribution of the electronic questionnaire in December 2014. After the closure of the questionnaire, 48 completed questionnaires were recorded. One questionnaire was filled by the university teacher and therefore we did not include it in the final evaluation. The summary of responses to the questionnaire items is available at: <https://docs.google.com/forms/d/1RkQTGeTCmpWweiPkjDFTQ5i1Hc-c9Xb4znJ2sxNuR3c/viewanalytics>.

In January 2015, we distributed to teachers in the course of innovative education the same questionnaire in printed form. We have included in the final assessment 60 from the 61 questionnaires. The questionnaire was completed by 24 elementary school mathematics teachers (second stage) and by 36 secondary school mathematics teachers (grammar school, vocational schools). The questionnaires showed that 12 primary school teachers (50%) and 23 secondary school teachers (63.9%) use DGS in mathematics teaching of 60 participating teachers.

The information about other approbation subject that teachers have studied may be interesting for the evaluation of utilization rate of the DGS by teachers. Graph in Figure 5 shows this information about teachers using DGS in the classroom that are divided by length of their teaching praxis.

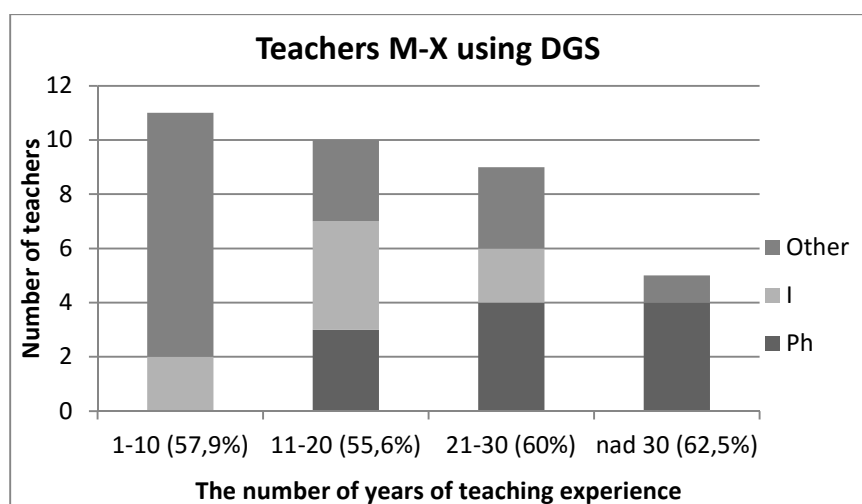


Fig. 5: The rate of the use of DGS by mathematics teachers

Between teachers with teaching experience more than 10 years the significant group consists of teachers that have studied physics or informatics with mathematics. Teachers with teaching experience over 30 years could not study informatics as a second subject of approbation. Teachers with teaching experience less than 10 years had a richer offer to select another subject. The graph in Figure 5 shows that the most teachers using DGS has teaching experience less than 10 years. However, the situation is different considering the number of teachers in each category. The percentage of teachers using DGS is shown in the graph in Figure 5 in brackets after the number of years of teaching experience. The survey sample of teachers shows that the length of teaching experience has not significant impact on the use of DGS in mathematics teaching.

The vast majority of teachers using DGS (77%) indicated that they use the system GeoGebra. Since the item of acquiring the basics of working with DGS had the open form, not all teachers using DGS wrote down the answer. The most teachers reported various forms of further education (16) and self-study (8).

The views of teachers on the benefits of DGS for facilitating learning and increase the quality of teaching were divided into five-point scales. The most positive views were assigned to the value 1. The graph in Figure 6 shows the positive views of teachers divided into two groups by the use of the DGS in mathematics education. Opinions of teachers that do not use DGS are not based on their own experience, but they are derived from their knowledge about the tools and functionality of DGS.

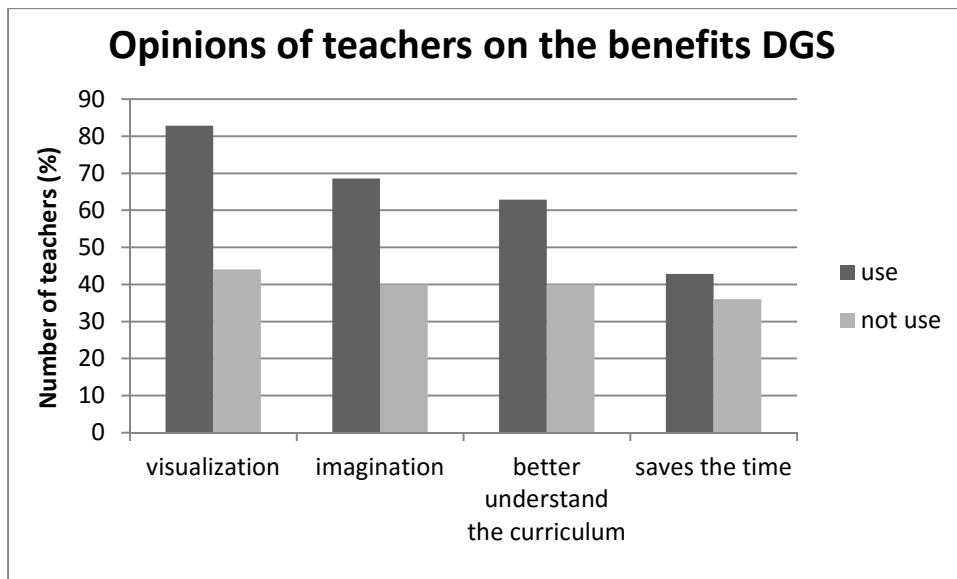


Fig. 6: The teachers' opinions on the effects of DGS in mathematics teaching

The evaluation of respondents sample showed that teachers using DGS in education have greater conviction about the correctness and benefits of the use of DGS for teaching purposes. The most teachers (34) reported that they use DGS in the teaching of geometry. Then follow: functions (24), equations, inequalities and their systems (8).

The graph in Figure 7 shows stages of the learning process in which teachers most frequently use DGS and how they organize learning. We evaluated 34 responses because one of the teachers using DGS did not answer. Teachers use the most frequently DGS in the explaining the new curriculum. In terms of organizing learning is represented demonstration, individual and group work nearly as well.

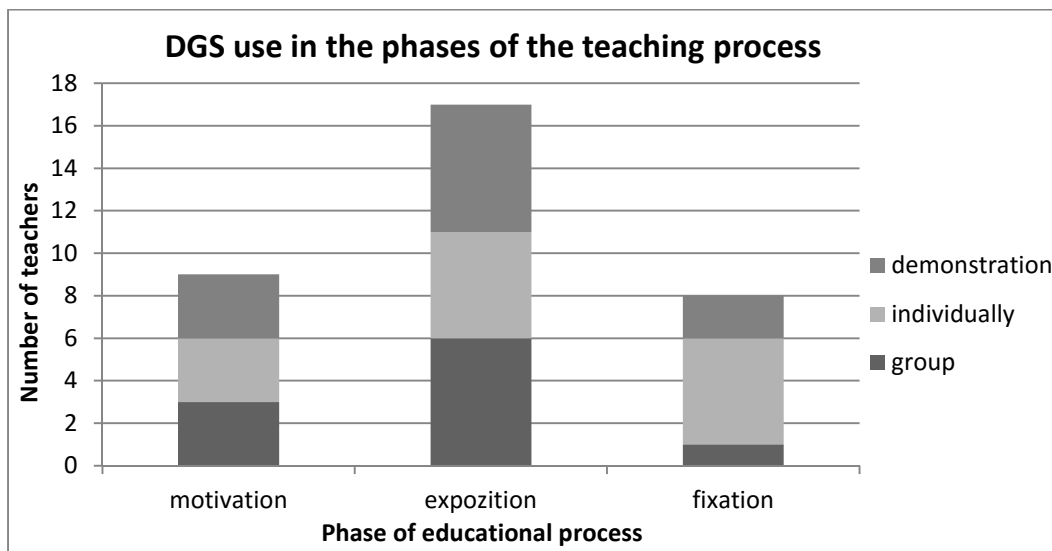


Fig. 7: The teachers' opinions on the use of DGS in the teaching process

The most teachers (12) mentioned as a reason for non-use DGS a lot of the time needed to learn the program by the students. Seven teachers reported about their insufficient working skills of the use of DGS. Teachers reported the following additional weaknesses of the use of DGS in the mathematics teaching:

- the time required for preparation of teaching plan and teaching materials,
- a large number of students in the classroom,
- concerns about the weakening of traditional skills of students,
- the benefit from the use of DGS is not adequate to time spent in teaching process.

Conclusion

In respect of small sample of mathematics teachers at the elementary and secondary schools we cannot make general conclusions about the use of DGS in the mathematics teaching. We were unable to obtain information from the teachers, whether they use DGS also for create a stimulating learning environment which could enable students to experiment, explore and discover the properties of objects and mathematical patterns. Similarly to other studies [e.g. 4] our survey showed that enthusiasm and internal conviction of teachers are crucial to integrate DGS into the mathematics teaching.

Acknowledgement

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PUBLIC INFORMATION AND EDUCATIONAL ENVIRONMENT AS ONE OF THE WAYS TO IMPROVE THE ICT COMPETENCE OF FUTURE SPECIALISTS

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Abstract

The article describes one of the ways to improve the quality of higher education in Ukraine in the context of European quality standards in the educational space of the university. There is designed model of public information and educational environment of the university, the ways of its use and development. The interdependence quality is shown between the educational environment of modern higher education institution and the level of ICT competence of their teachers and students. The model of corporate standards of ICT competence of participants of the educational process was described, developed and approved by Borys Grinchenko Kyiv University. The monitoring tools of ICT competence formation of students and the ways of its improvement were also analyzed.

Keywords

information and educational environment of the university, standard, ICT competence Model, monitoring

Introduction

The modern labor market demands cause changes in the higher education system, including the transfer of emphasis from the educational process to its ultimate quality results. To solve complex problems, current student must learn the fundamentals and special knowledge, the methodology of scientific research, information and communication technology, be able to use all the new that appearing in the science and practice, adapt to market changes and improve their skills, be ICT competent. UNESCO recommendations emphasize that for the modern professional is not enough to be technologically literate and be able to shape the technological skills. Modern teachers should be able to help students use ICT to successfully cooperate, to solve arising problems, develop 21st century skills. One solution of this objective is the creation and development of public information and educational environment.

1. Designing information and educational environment of the University

Studying the experience of world universities we have developed the model of information and educational environment, the use and development of which will help improve the quality of university education. An obligatory condition of its creation is the availability of e-content, technology of e-interaction and e-collaboration. (Fig. 1).

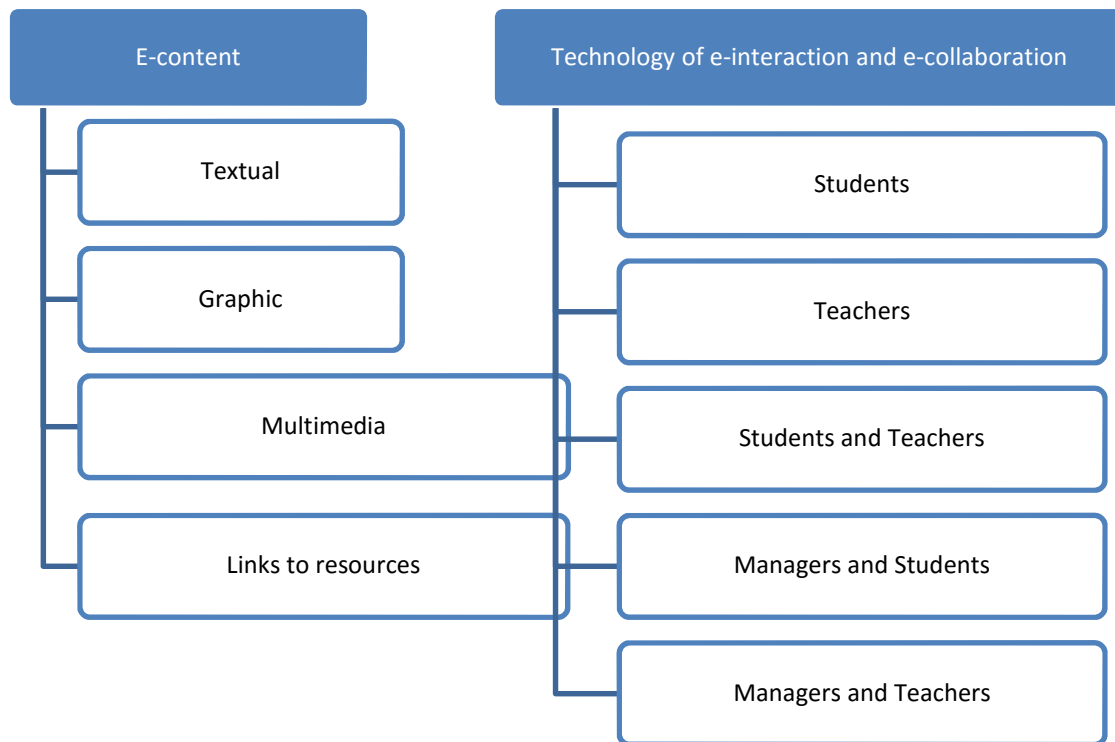


Fig. 1: E-environment of the University

Among the e-content we highlight textual, graphic, multimedia, links to resources. Technologies of e-interaction and e-collaboration differentiate among students, teachers, students and teachers, managers and students, managers and teachers. The content of electronic information and educational environment of the University is shown on Fig. 2.

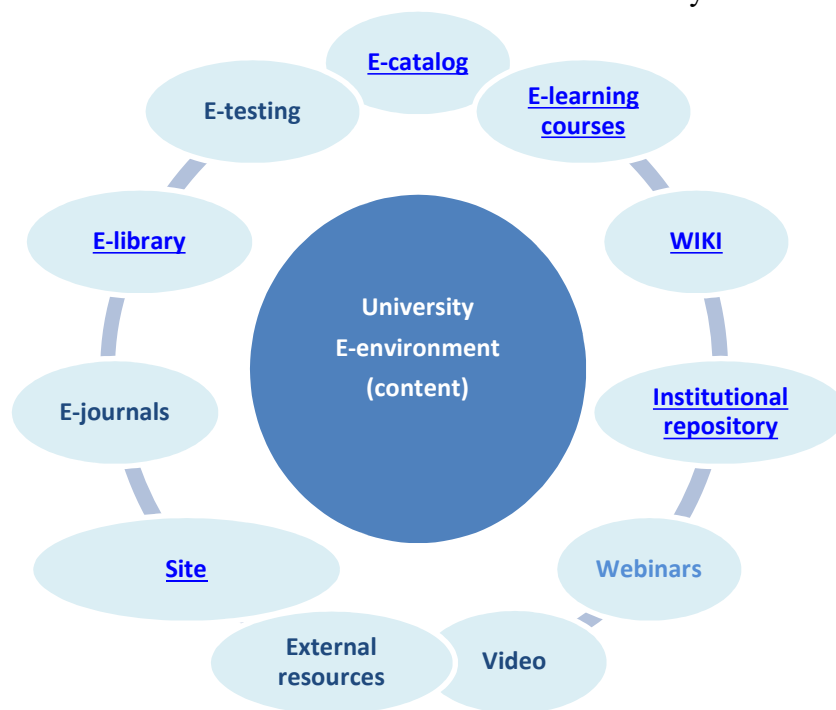


Fig. 2: E-content of e-environment of the University

Details of the e-content of e-environment in Borys Grinchenko Kyiv University can be found on the official portal <http://kubg.edu.ua/>, selecting main page menu «E-environment» (Fig.3), or use the links:

- E-catalog - <http://lib.kubg.edu.ua/cgi-bin/koha/opac-main.pl>
- Learning management system - <http://moodle.kubg.edu.ua/>
- WIKI - <http://wiki.kubg.edu.ua>
- VULYK - <http://vulyk.kubg.edu.ua/>
- Institutional Repository - <http://elibrary.kubg.edu.ua/>
- Webinars - <http://kubg.edu.ua/servisi/2012-11-12-08-34-21.html>
- E-publishing - <http://library.kubg.edu.ua/resursi/fakhovi-elektronni-vydannia-universytetu.html>
- Scientific masterworks - <http://masters.kubg.edu.ua/>
- Astudia - <http://astudia.kubg.edu.ua/>
- E-Library - <http://elib.kubg.edu.ua/>
- E-testing- <http://testing.kubg.edu.ua/>
- E-portfolio - <http://e-portfolio.kubg.edu.ua/>

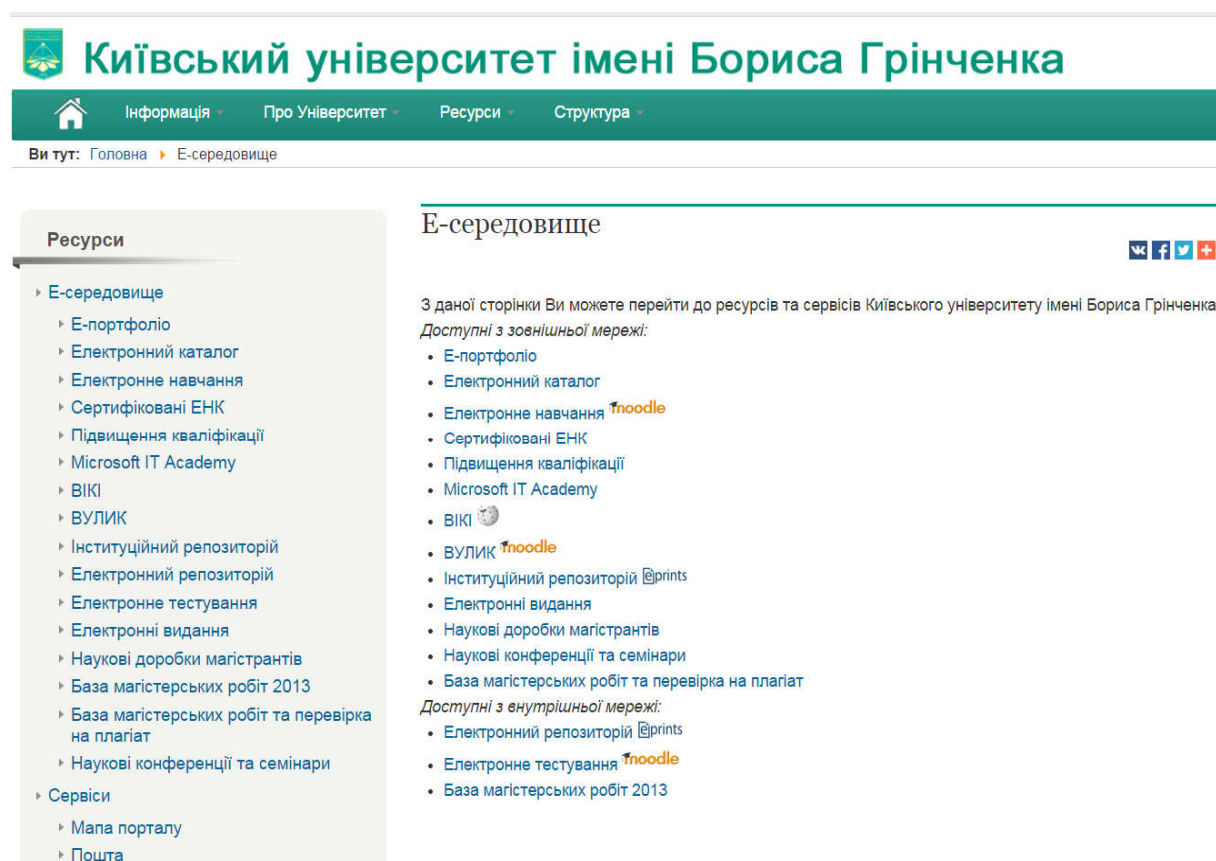


Fig. 3: E-environment of BGKU

Conventionally e-content can be divided into four main components: educational information portal, electronic library, institutional repository and anthology of pedagogical direction. Given this distribution model obtain electronic information and educational environment of the University (Fig.4).

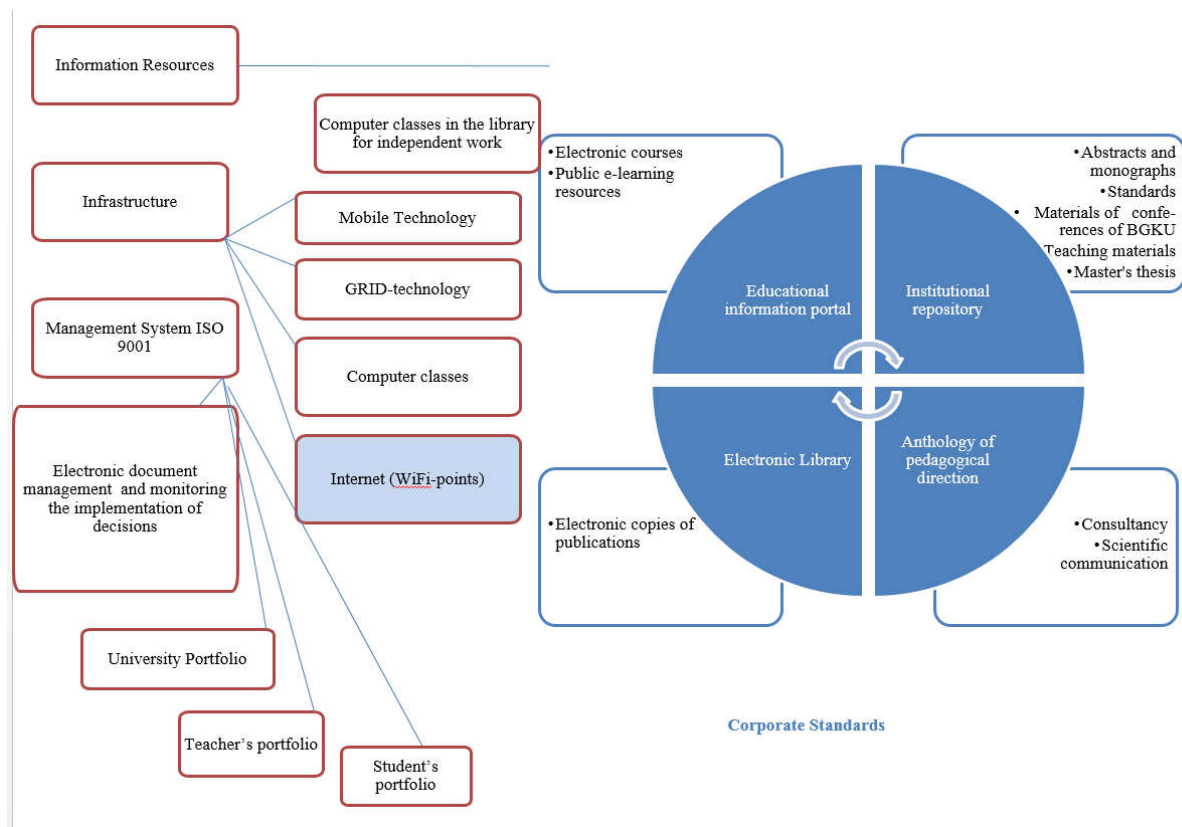


Fig. 4: The model of information and educational environment of the University

Constructing an electronic information and educational environment of the University, structure-functional model which is based on competence and personality-oriented approach learning, Borys Grinchenko Kyiv University will provide a modern information society demands on preparing competitive professionals.

Schematically, the process of creating and using information and educational environment of the University is shown on Fig. 5.

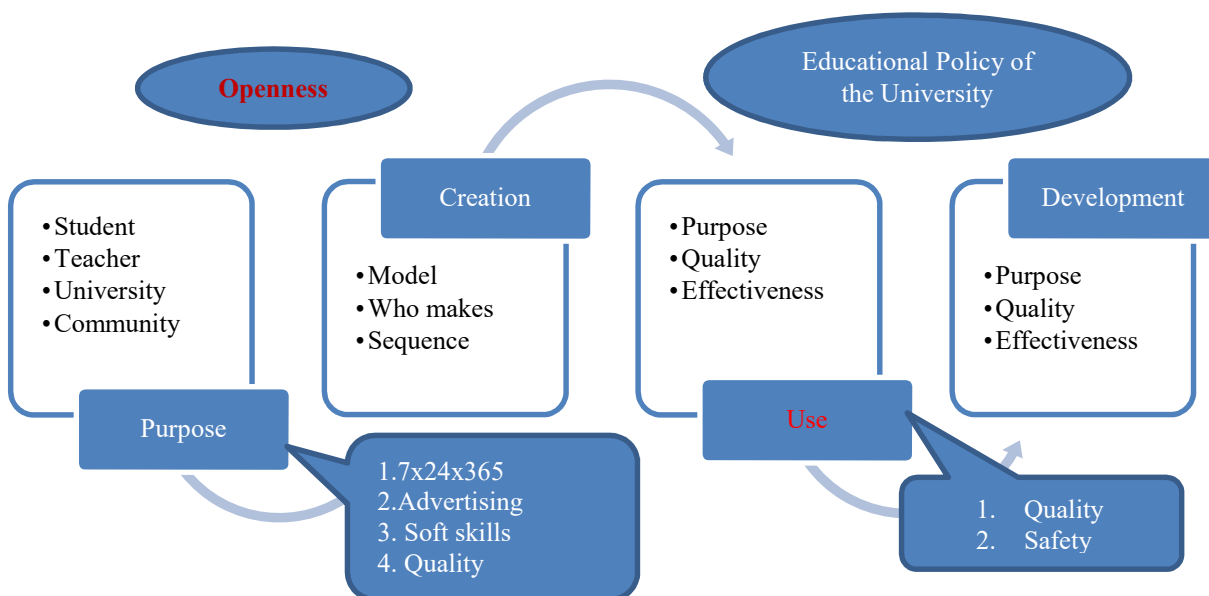


Fig. 5: The process of creating and using information and educational environment of the University

Modern specialists should have ICT competence, which should become part of the professional competence of specialists of any profile. To implement this task universities have to develop and approve their own corporate standards which will ensure the appropriate competence of students and teachers of Modern Universities.

Among the corporate university standards we highlight:

- Standards for Quality Management System
- Standards for IT and information environment
- Standards of training documentation in electronic form – Electronic Document Management
- Standards to provide additional education on the basis of DL
- Standards on scientific and methodological materials and tests
- Standards for the training
- Standards for organization of scientific activity
- ICT competency standards of teacher and student
- Standards for e-content and e-learning environment
- Standards for educational technology

As to form ICT competence is the development of standards in the ICT expertise of all participants of the educational process of the University to ensure quality of education and the creation and subsequent implementation of educational policy of the University, these corporate standards for ICT competencies of student and teaching fellow developed and approved in Borys Grinchenko Kyiv University. The main tasks here is to create the model, determining the levels of development and monitoring tools.

Key information and communication competence - the ability to effectively use ICT in teaching, research and daily activities, to address information and professional tasks [1].

In developing ICT competency standards we followed the standards of ICT competencies of UNESCO (Figure 6) which defined the international program UNESCO (ICT Competency Framework for Teachers) [2].



Fig. 6: UNESCO: ICT competence Standard

UNESCO recommendations emphasize that for the modern professional is not enough to be technologically literate and be able to shape technological skills. Modern teachers should be able to help students use ICT to successfully cooperate to solve arising problems, develop 21st century skills. When building a model ICT competencies of scientific and pedagogical staff member identified three main approaches to teacher activities. The first approach - «Technological literacy» - the ability to require the teacher to help students use ICT to improve teaching and research. The second - «Enhancing Knowledge» - requires the ability of teachers to help students learn the content in deep subjects, applying the acquired knowledge to solve complex problems that occur in the world. Third - «Creating Knowledge» - requires the ability of teachers to help students produce new knowledge and skills that employers need today.

Let us consider the standard model of corporate ICT teacher competency Borys Grinchenko Kyiv University in terms of its main aspects: understanding the role of ICT and their applications in education, research activities, training. Each of specified levels of ICT expertise of the teacher inherent specific knowledge and skills [3].

Activity	Technological literacy	Enhancing knowledge	Creating knowledge
Understanding the role of ICT in education and their use	Familiarity with education policy	Understanding educational policy	Innovation in education
ICT	Basic tools	Advanced tools	New technologies
Educational work	Basic knowledge: fragmented ICT use in education	Application of knowledge: systematic use of ICT in education	Skills knowledge of society
Scientific activities	Basic knowledge of scientific communication	The use of scientific knowledge (incl. virtual) electronic communications and scientific cooperation	Skills implementing research projects
Advanced training	ICT literacy: formal training in ICT	Management and direction: informal ICT learning	The teacher as an exemplary student: study on public courses (eg, MOOC)

Tab. 1: Model of corporate standard of ICT competence of teaching staff

For the measurement of formation of knowledge and skills of each of the levels required specialized tools. Such monitoring tools forming ICT teacher's competence is presented in Table 2.

Corporate ICT competency standards developed and approved for students Borys Grinchenko Kyiv University. With the formation of student ICT competencies conditionally distinguish three main levels:

- base (1st level, corresponding 1st bachelor year);
- advanced (2nd level, corresponding 4th bachelor year, or early education in magistracy);
- professional (3rd level, 2nd master year).

Activity	Technological literacy	Enhancing knowledge	Creating knowledge
Measurement tools: <i>Understanding the role of ICT in education and their use</i>	1. Online survey to determine the level of awareness of teachers about the availability of documents on education policy at the University or the State and their role in the activities of the university. 2. Participation in seminars (full-time or remote) on educational policy of the University.	1. Survey of students for use in the profession of innovative educational policy. 2. The survey of teachers in understanding ways to use innovation in the profession of education policy. 3. Survey of students to determine the role of ICT in education and identify requests students to enrich the e-university environment. 4. Teacher's e-portfolio: availability of data on participation in some group of educational initiatives.	1. E-portfolio: availability of information on participation in the group to create new educational development, a strategy for ICT and their use.
Measurement tools: <i>ICT</i>	1. Tests for independent verification of levels of basic tools (created by the University, IT-Academy). 2. Some components of e-learning courses (electronic educational course)	1. Certified electronic educational course, which is a necessary condition for the use of complex ICT tools. 2. Teaching materials are based on the use of e-tools	1. Usage of Wiki portal. 2. Own blog of the teacher. 3. Usage of social networks for education. 4. Teacher's e-portfolio.
Measurement tools: <i>Educational Activities</i>	1. Survey of students about the quality of fragmented use of ICT. 2. E-testing students' educational achievements. 3. Availability of electronic course in LMS Moodle. 4. Questioning teachers in understanding the effectiveness the use of ICT in practice.	1. Statistics of usage by students of electronic course, placed on LMS Moodle. 2. Links in electronic course on Institutional repository resources. 3. Links on open e-resources. 4. Links on open learning courses (MOOC). 5. E-science publications. 6. Survey of students on teacher satisfaction with the proposed e-resources. 7. Evaluation of training programs: a list of recommended resources. 8. Availability of certified electronic courses on each disciplines that teacher teaches. 9. Assessment of systematic use of electronic course resources: reports on e-dean and electronic gradebook of specific electronic course. 10. Availability on the Wiki portal annotations to certified electronic course. 11. Assessment of systematic use of resources in the university environment	1. Creation an open electronic courses (MOOC) and statistics of their members. 2. Organization of email communication and collaboration (including educational projects) in soc. networks and on the basis of virtual communication (skype, video conferences, webinars, etc.). 3. Joint projects on the Wiki portal. 4. Teacher's e-portfolio. 5. The use of ICT for administration of the educational process

Measurement tools: <i>Scientific activities</i>	1. Survey for teachers awareness on the use of scientific communication: repositories, scientometric databases, e-libraries, e-journals, as well as opportunities and participate in online conferences. 2. Number of publication in Institutional repository. 3. Citations index in Google Scholar.	1. Number of international publications. 2. Number of appearances at international conferences	1. Participation in Intercollegiate and international research projects. 2. Teacher's e-portfolio. 3. Number of joint international publications with scientists from other universities. 4. Citations index in international scientometric databases. 5. Organization and conduct online conferences, seminars.
Measurement tools: <i>Advanced teachers training</i>	The certificate of training for ICT	1. E-portfolio. 2. Participation in distance training courses in Ukraine. 3. List of graduated non-formal learning.	1. E-portfolio. 2. The list of graduated open professional online learning courses (MOOC). 3. Training for colleagues on the use of ICT. 4. Online consultations, conducting webinars out of the experience.

Tab. 2: Monitoring Tools of formation ICT teacher's competency

In accordance with the defined levels developed model of ICT competency of the student, which is based on standards laid by UNESCO [4].

Levels Aspects of Masters	Basic (basic knowledge and skills to meet the needs of their own cognitive)	Advanced (to meet the challenges of educational, scientific, social, cultural and practical nature)	Professional (component of professional competence to solve professional tasks)
Exploring ICT	Basic knowledge and skills Basic tools	Advanced Knowledge and skills Complex tools	Ability to self-education in ICT
Educational Activities	Application of knowledge and skills	Solving Competence Tasks of educational nature	The solution of the tasks of the competent professional designation
Research activities	The use of scientific communication	Scientific cooperation The ability of application of e-Science	Presentation of research results in the form of research project
Social and cultural activities	Knowledge and skills of citizen knowledge society	Solving Competence general tasks	Submission of Portfolios

Tab. 3: ICT competence Model of student

Formation of basic and advanced levels assigned to the department of computer science and information technology department and mathematical disciplines. With the formation of the professional level of ICT competence the responsibility of graduating university departments. Each level of ICT competence formation of the student has its own monitoring tools. It may

be, TEST software, sets competency tasks, master work, complying with the requirements, developed a personal portfolio and the student's educational environment, etc.

Division of monitoring tools of formation of the ICT competencies presented on Fig.7.

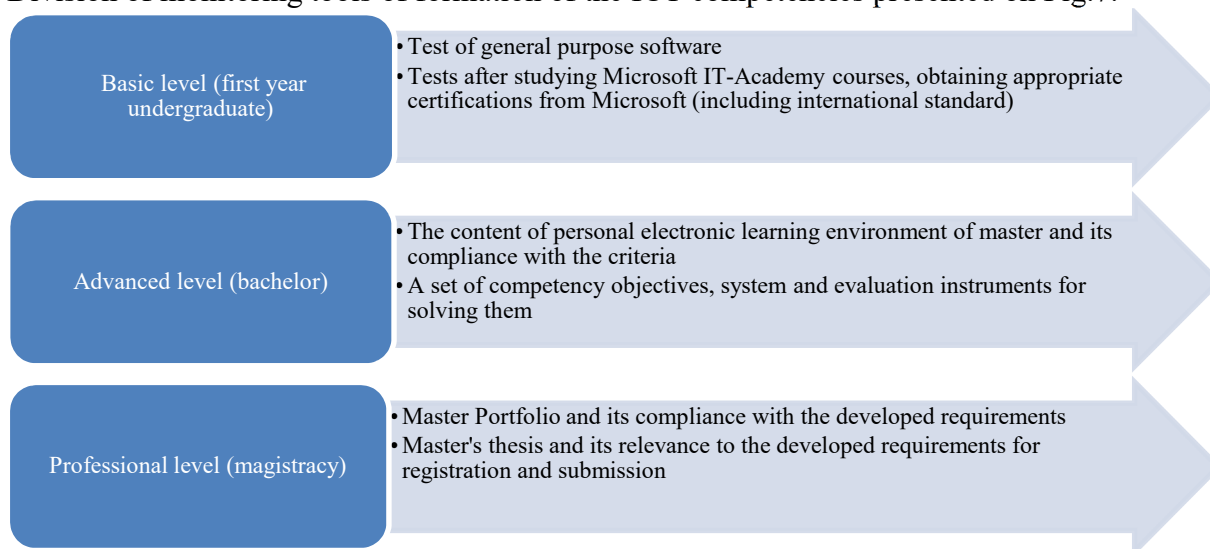


Fig. 7: Monitoring Tools of formation of ICT competence of student

In order to test the developed tools were tested the basic level of ICT competencies of students in Borys Grinchenko Kyiv University.

During checking baseline formation of ICT competencies tested: knowledge and ability to use personal computers and computer networks; knowledge, understanding and ability to use computer programs (different OS (operating system), work with files, start the program, use the help system OS and other programs to work with files, word processor, image editor, means preparing presentations, tools preparation of publications, spreadsheet, antivirus programs, archiving and other programs); knowledge and ability to use basic services for the Internet (e-mail, information retrieval systems, teleconferencing); knowledge and ability to use technology Web services and Web 2.0 - 3.0 for solving educational problems; the ability to use electronic information and educational environment of the University; use of teaching tools created through ICT.

The test consisted of 100 questions, divided into four main sections: the study of ICT; ICT training activities; ICT research activities; ICT in social and humanitarian activities. Students had to answer 50 questions that were selected randomly automated (20 questions - studying ICT, 10 questions - ICT in the educational activity, 10 questions - ICT research activities, 10 questions - ICT in social and humanitarian activities). The computer questionnaire was attended by 885 students of 1 year (from 1360, enrolled at the University), representing 65% and 253 students of 5th year (of 475 people), which is 53%. Average score for the monitored University Bachelor's Degree students of 1 year of training is 31,4. Average score test results for the 5th year students of the University is 33,6. Due to the test results we can see that students like 1 and 5 study years should seriously increase the level of formation of ICT competence. To recommend this undergraduate students: seriously treat the study course "I'm in the information environment of the University", fulfill all the tasks placed in an open course on wiki portal of the University; be trained in IT Academy; seize all opportunities and related corporate mail free services and more. For the 5th year students recommend: receive training in IT Academy; seize all opportunities corporate e-mail and related services free of charge; open master course "Presenting research masters using ICT", which is hosted on the environment on wiki portal of the University; master the use of e-learning university. These recommendations are nothing like the necessary conditions for the formation of the ICT

competencies for students who participated in the monitoring. In general, the necessary conditions for the formation of ICT competencies include: the use of certified teacher's courses and social networks and Web 2.0 services; electronic course monitor the quality and effectiveness of their use; creation of personal electronic learning environment of the student; creation of e-Portfolios of student and its analysis; requirements for professional competence of masters, which includes ICT competence. This in turn is qualitatively created an public information and educational environment of the university.

Conclusion

One way to create an electronic information and educational environment of the University is to develop corporate standards, create a personal learning environment for students and teachers. An important condition for the effective functioning of electronic information and educational environment is to transform it into a public system by the interaction with the labor market, providing students with more control over the educational process by participating in its planning and evaluation of quality, implementation of self-control and self-esteem. Privacy is a public environment in this case will be a means of strengthening the subjective position of students in teaching, increase the level of formation ICT competence as a teacher and student. The presence of public information and educational environment of the university is a necessary condition of formation the ICT competencies of students, which improves the efficiency and quality of the learning process.

Acknowledgments

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DISTANCE LEARNING TECHNOLOGY AS TOOL FOR MONITORING AND IMPROVEMENT OF ICT-COMPETENCE OF TEACHERS OF COMPUTER SCIENCE

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Abstract

In the article considered components of the information and communication competency computer science teachers, the proposed criteria for evaluation of formation of the information and communication competency computer science teachers, tools and results of the leading monitoring of the level of formation of the information and communication competence among computer science teachers Mykolaiv region, lysed due to insufficient training of science teachers and the ways to overcome this problem.

Keywords

information and communication competence, digital competence, professional development, professional competence of teachers of computer science, teachers' advanced training

Introduction

Today's society is at the stage of formation of a global knowledge community. In the foreground there is a human factor, because people are both owners, creators and consumers of knowledge, and informatization of all spheres of human activity is a key factor of structural social change. To solve socio-economic problems successfully we need to provide high quality education at all levels without exception. The task of modern teacher – is not only to give knowledge according to the curriculum, but to form in pupils the vital skills to work with information: searching, collecting and processing the necessary data and knowledge, the ability to interact effectively, preserve and present the results of their work. The growing need for information, technology and visual literacy of school leavers, understanding that students have changed and educational practices have not changed, it requires a significant number of teachers who have practical skills in using information and communication technologies, that are defined by international academic communities and organizations. (Badarch Dendev, 2013)

The high level of information and communication competence of teachers of computer science is the key to effective use of information and communication technologies in the institution, is one of the most important indicators of the success of its activity and also a prerequisite to further improve of the professional competence.

Distribution of digital technologies contributes to the transformation of learning to continuous one, individually-oriented, flexible and dynamic process. UNESCO pays special attention to the development of high-tech educational competencies and skills of the XXI century by the means of modern information and communication technologies.

Theoretical basis

Over the past few years there is carried out a study that examines how technology really affect the educational standards and processes, for education in general, how to use modern information technologies to create competencies that are required for modern life and future. (Mishra & Kereluik, 2011; Voogt & Pareja Roblin, 2012).

Analysis of national research that are concerning the determining of list and content of professional competence of teachers, particularly teachers of computer science(V.U. Bykov, L.I. Bilousova, M.I. Zhaldak, N.V. Morze, S.A. Rakov, O. M. Spirin, M.P. Lapchyk, G.V. Lunyova, Rams'kyj U.S., T.V. Tikhonova et al.) makes it possible to conclude that the formation of professional competence of the teacher envisages the earning fundamental knowledge on learning subject, technique of training, didactics, psychology, education, development of teaching skills related to the actions of teachers in various educational situations, formation of necessary personal qualities, communication skills, presence of need to self-improvement and self-development (Galdak M.I., Ramskyj J. S., Rafalska M. V, 2009).

Despite the considerable number of works devoted to the preparation of future teachers of computer science and the formation of professional competencies, there are many questions remain unresolved, including the need to study such issues as methodical preparation of teachers of information science, and improvement of their professional and information and communication competence.

Problem statement and research questions

Actuality of the study caused by the following factors:

- constant development of information and communication technologies, increasing of their educational potential and accordingly increasing of the requirements of professional competence of teachers of information science;
- constant updating of the structure and content of the subject "Information science" requires from teachers independent acquisition of new factual material and leaves aside the question of methods of teaching the subject;
- need for the formation and development of self-learning skills, self-organization and personally professional development of teachers;
- absence of a system of objective criteria and methods for monitoring and assessing the quality of training of teachers of information science.

The aim of the study is to establish the actual level of information and communication competence of the teachers of computer science in secondary schools of Mykolaiv region, determination of the capacity's level of teachers to solve everyday practical problems associated with the use of integrated information and communication technologies, issues in professional activities of teachers of computer science and their solutions.

Introduction the computer science to the 2nd and 5th form has increased the number of teachers who teach information science, but do not have the appropriate special education and sometimes have only the user's skills. The teacher's activity is the main determinant of student achievement in the particular subject area. Due to the effective use of technologies in the learning process, students can acquire a range of competences, including informational. Firstly teachers must help to develop these competencies, who are themselves possess these competencies and be willing and able to perform activities associated with their formation (ISTE Standards Computer Science Educators, 2011).

Thus, the proportion of teachers who do not have special education in computer science in the past academic year in secondary schools of Mykolaiv region has increased to 56%. Therefore, in Mykolaiv region in November 2013 on the basis of Mykolaiv Regional In-Service Teacher Training Institute was launched the regional experiment "Improving ICT-competence of the teachers of computer science in conditions of constant education".

In 2014 and 2015 were carried out monitoring research of the level of information and communication competence of the teachers of computer science in secondary schools of Mykolaiv region in 2014. The participants of monitoring were 493 teachers of computer science of secondary schools in Mykolaiv region, representing 85.7% of all teachers of computer science in the Mykolaiv region.

The study was based on the structure of information and communication competence of teachers of computer science (table 1), which was developed on the basis of recommendations of UNESCO "UNESCO ICT Competency Framework for Teachers"[4] and "Guidelines on Adaptation of the UNESCO ICT Competency Framework for Teachers"[5]. ICT-CFT project is aimed at teachers of primary and secondary schools, but the approach can be applied to all levels of education. It is obvious that for different categories of pedagogical staff competence in the field of information and communication technologies can and should vary in content. In particular, information and communication competence of teachers of computer science should differ significantly from the information and communications expertise to other teachers in volume, depth and systematic knowledge in the field of information technology. After all, information and communication technologies, the hardware and software of the teachers of computer science are the part of the curriculum content and the use of ICT in the educational process, a combination of traditional forms of learning activities of students – is a necessary condition for teaching computer science in school.

Leaving the UNESCO proposed approaches to teachers of information science, it is possible to combine activity modules of the proposed structure of ICT competence and present it as follows (table 1):

- Ideological component (module "Understanding ICT in Education")
- Technological component (modules association "Curriculum and assessment" and "Information and communication technologies")
- Organizational and methodological component (modules association "Pedagogy" and "Organization and administration")
- Self-educational component (module "Teacher professional learning")

	TECHNOLOGY LITERACY	KNOWLEDGE DEEPENING	KNOWLEDGE CREATION
Ideological component	<ul style="list-style-type: none"> • Understanding the basic principles of using ICTs in teaching; • Understanding the information and ICT in education, science and society 	<ul style="list-style-type: none"> • Understanding the essence of "information culture" • Knowledge state documents about ICT in education • Ability to prove expediency of using ICT 	<ul style="list-style-type: none"> • Knowledge of patterns and problems of development and the information society • Initiation of innovation on the use of ICT in school
Technological component	<ul style="list-style-type: none"> • Basic knowledge of 	<ul style="list-style-type: none"> • Knowledge that go 	<ul style="list-style-type: none"> • Consultation on

	<p>computer science (knowledge of digital devices, systems, and networks, modern knowledge high-level programming language, principle of constructing correctly functioning programs involving simple and structured data types; compound boolean expressions; and sequential, conditional, and iterative control structures)</p> <ul style="list-style-type: none"> •using digital devices; •basic ICT skills; •Knowledge of educational standards and curriculum; •knowledge of the curriculum standards for their subject, •knowledge of standard assessment strategies. 	<p>beyond the limit of basic knowledge on the subject)</p> <ul style="list-style-type: none"> •Effectively use network resources •Effectively use, manipulate, and explain various external data stores: various types (text, images, sound, etc.), various locations (local, server, cloud); •Effectively use a development environment •Ability to create complex real-world problems; •using elements collaborative problem- and project-based learning knowledge of formative assessment tools; •using formative assessment tools 	<p>the optimal choice of ICT and network services to solve educational problems</p> <ul style="list-style-type: none"> •Ability to create complex practical problems aimed at self obtaining knowledge and acquire new skills and competencies •plan and implement educational projects with their students •Describe the assessment criteria in accordance with the goals and objectives of educational projects, practical problems
Organizational and methodological component	<ul style="list-style-type: none"> •knowledge that ICT can be used and how •using ICT in the classroom •using of ICT in different stages of lesson 	<ul style="list-style-type: none"> •Plan and teach computer science lessons/units using effective and engaging practices and methodologies (Knowledge of the main provisions of collaborative problem- and project-based learning, student-centered learning) •Design and implement developmentally appropriate learning opportunities supporting the diverse needs of all learners 	<ul style="list-style-type: none"> •A variety of networked devices, digital resources, and electronic environments are used to create and support this community in its production of knowledge and its collaborative learning •ability to choose optimal methods for studying •correction of deviations students from their educational path; •teacher is a learning facilitator

Self-educational component	<ul style="list-style-type: none"> •Ability to use web-resources for the selection of educational information, problems • using network educational resources to search for information 	<ul style="list-style-type: none"> •using digital educational resources for ownself •Ability to create educational network resources •Consult colleagues about the use of ICT •regularly shows other teachers how the uses ICTs to enable students to generate knowledge 	<ul style="list-style-type: none"> •yourself study using open educational resources, •Identify and participate in professional computer science and computer science education societies, organizations, and groups that provide professional growth opportunities and resources •use ICTs to consult with experts, and collaborate with other teachers to support their own professional learning
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Tab 1: The structure of ICT-competence of computer science teachers

According to the developed structure for determining the level of information and communication competence of teachers of information science, it was formed four groups of criteria which provided evaluation:

- understanding of the essence of the concept "information culture" and knowledge of the key public documents related to implementation of ICT in education (ideological component);
- basic knowledge of computer science and skills of work with systems, software and digital devices (technological component);
- knowledge of methods of teaching information science, the main provisions of pedagogy and skills of using of ICT at different stages of the lesson (organizational and methodological component);
- skills to use and create digital educational resources for their own education, dissemination of experience in applying of ICT, communication with colleagues (self-educational component).

Methods of research

It was used the method of questioning and testing to collect the necessary information. The maximum number of points that can be obtained during the monitoring period is 195 points and is represented in qualimetric model (table 2).

Testing was conducted on a platform of distance learning «Moodle» <http://monitortest.moippo.org.ua/>, for each participant of the test were prepared the personal login and password and set a schedule of participation in the research process.

Components	Assessment Tools	The maximum
Ideological component	The survey	10 (5 %)
Technological component	The survey, testing, practical problem solving	93 (48 %)
Organizational and methodological component	The survey, practical problem solving	81 (42 %)
Self-educational component	The survey	11 (5 %)

Tab. 2: Qualimetric model Components of the structure of ICT competence of computer science teachers

Implementation of combined practical task to determine the professional competences testified of the level of teachers' practical skills to use the information technologies. In addition, the proposed tasks allowed to assess methodological preparation of teachers.

The survey was carried out by the using of questionnaires based on the service Google Drive with a tool Google. The survey was anonymous, that allows asserting about the objectivity and honesty of the received responses. It was received the data set by questioning and testing, which allows to compare the results of self-assessment and actual results. It revealed that the most teachers of computer science estimate biased their own level of informational competence. The results of self-assessment are much higher than the test results (mean value of difference is the 30%).

Data analysis and results

Monitoring Results 2014

In Mykolaiv region at the beginning of the 2013/14 school year, from the 575 teachers who taught computer science in educational establishments of the region, the 56% did not have adequate special education, 36% of respondents had experience in teaching computer science less than 5 years, 39% were raised their qualification in computer science for past 5 years, 38% had no certificate in teaching modern ICT and using of ICT in the educational process.

Only 6% of surveyed teachers were able to give correct answers to 80% and more of the test, and about 50% of teachers were not able to give the correct answers more than for half of the questions. The average result for the test is 51.1 points out of 100 maximum possible. Average of test results looks as follows (fig. 1) and indicates a lack of certain theoretical knowledge on the subject in a significant number of teachers.

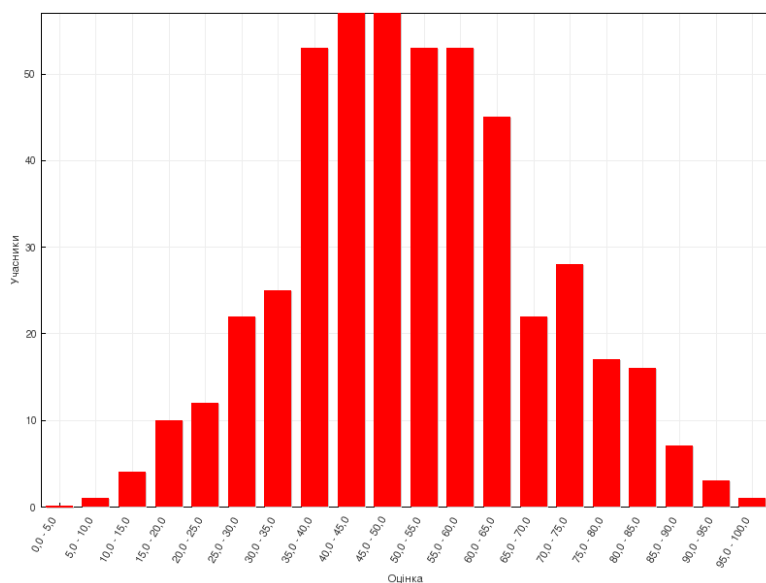


Fig. 1: Test results of the teachers of information science (2014)

The most difficult were questions about the theoretical basic knowledge of information science, such as information, informational processes, algorithms, objects, and questions regarding the operating system, spreadsheets and databases. As it turned out, the problem of determining the manifestation of information human culture offered in specific circumstances was also difficult. A significant number of teachers of computer science are not have basic knowledge of algorithms and programming.

Some teachers reported that they did not have time to answer all questions because of the low-speed of Internet in the facility. According to the survey, 26% of schools have high-speed Internet access from multiple computers, 39% have access to low-speed Internet from multiple computers, and 28% have access to the Internet from only one computer.

Low sped of Internet, overloading teachers prevent 21% of interrogated teachers that use a variety of online resources in the educational process, and 35% do not use online resources in their work about.

The following situation is also causing the anxiety, 35% of the teachers of computer science do not communicate with colleagues at professional forums and communities due to lack of time and lack of connection to the Internet. The vast number of teachers use the Internet to search the material for their lessons and to communicate in social networks, only 13% of respondents placed teaching materials on Web-resources, 21% have their own training/methodical website or blog, but the frequency of records is low.

Lack of constant communication with colleagues, exchange by ideas and best practices hinders professional development of teachers, especially in the modern world.

The most difficult for teachers was practical work, which was composed of professional competency tasks. Poor knowledge and lack of technological skills in working with electronic presentations and environment for processing tabular values are clearly evidenced in the performance of these tasks. Fully or partially were completed the tasks of practical work by 84% of the teachers. Text document could create 81.6% of the teachers, 79% passed the monitoring, presentation to the desired stage of the lesson and spreadsheet - 73.7% of the teachers.

During the fulfillment of the task to create a text document it was about 20% of the teachers who couldn't decide the key concepts of the lesson, choose the form of organization of students in class. 7% of teachers instead of the proposed tasks (answers to certain questions) submitted abstracts of the lesson on the subject of other teachers that are on the Internet. We can also note the difficulty in processing text document (diverse nature and many-coloring font, "not readability" of the created document). It were presented links to Internet resources in some papers, but the information on Web pages had no relation to the training topics and did not meet the requirements of the job.

While performing the task to build charts and graphics with given tabular data that was revealed that some teachers do not understand the purpose of diagrams of different types, can not present the data in graphic form, apply statistical functions for data analysis.

While performing tasks for creating computer presentations the teachers often do not adhere to the requirements of the pedagogical design. For about 40% of teachers it was difficult to isolate a part of the curriculum slide.

Simultaneously with testing, it was proposed for teachers to rate their own knowledge of the specific topics of the course. After analyzing respondents' answers should be noted that self-esteem of teachers coincides with the results of testing only for specific topics. For all other themes observed overestimation of their own self-teacher (figure 2).

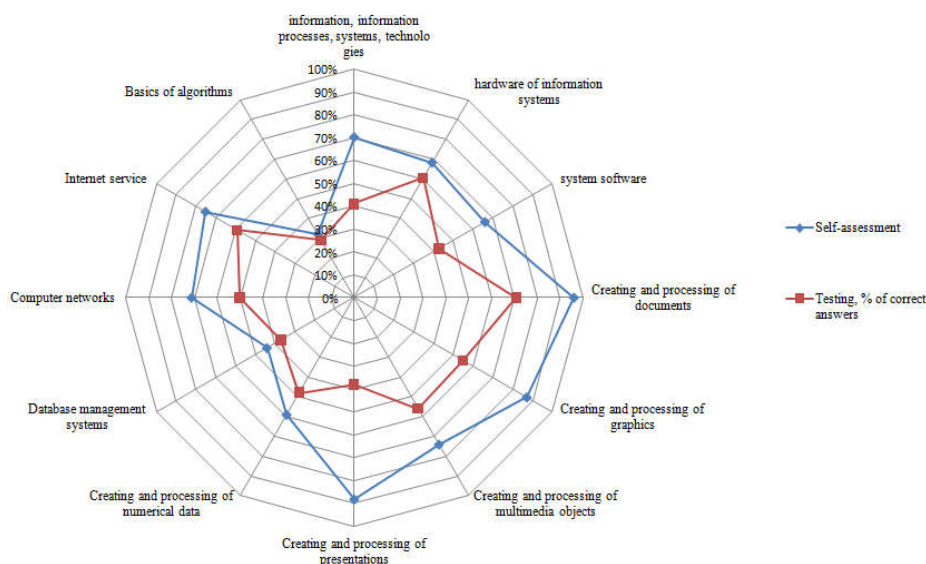


Fig. 2: The comparison of test results from self-evaluation of the teachers

As for the question about the frequency of teachers' advanced training in information science, the 38% of respondents indicated that it's enough to take courses 1 time in every 5 years. The remaining teachers wishing to pursue advanced training in computer science more than 1 time in 5 years due to the rapid development of information technology and changes in training programs in information science, but consider that it is necessary to reduce the duration of such courses. The most convenient for teachers of computer science was manifested the training on short-term eye or distance courses and annual participation in seminars, trainings, workshops and more.

Ways of formation of Of ICT competency science teachers based on data start monitoring research

During the years 2014-2015 methodical work with teachers was oriented to personal professional needs of teachers, establishment of new forms of lifelong education for teachers.

In order to support the blended form of teacher training at the portal of the Mykolayiv Regional Institute established distance learning platform Moodle. Teachers and teacher's trainers of Institute developed and placed distance courses on the platform Moodle (do.moippo.org.ua) for listeners of extension courses of blended learning and mini distance learning courses for teachers to study different themes from school course of computer science.

In Mykolayiv Regional Institute courses computer science teacher training and between the treatment courses period was conducted familiarization of teachers with species didactic possibilities and ways of using modern Web 2.0 services in the educational process, introduced elements of training in cooperation, interaction in a team with colleagues through online means organizations interactive cooperation (websites, blogs, services Google, Wiki environment and community, map knowledge, etc.) created professional teacher community. During the training sessions and master classes on the use of Web 2.0 service science teachers not only improve their information and communication competence and skills and develop the collaboration skills, communicability and self education, the ability to identify problems and (ways of their solution) and solutions, responsibility. Because teachers from their own experience master methods and ways of formation of competencies that are necessary in modern society.

Monitoring Results 2015

In 2015 was held the next monitoring. The main purpose of monitoring research in 2015 - enable the teacher to independently check their knowledge and skills and compare their professional level with modern requirements for teaching computer science.

There are 497 teachers of computer science of secondary schools of Mykolaiv region that was involved in research. Test results demonstrate improving knowledge teachers of subjects, especially on the topics "Creating and processing of multimedia objects", "Basics of algorithms", "Information. Information processes, systems and technologies." The average result for the test was 64.1 score out of 100 possible maximum. Distribution of teachers by amount of points are presented in Figure 3.

Among the reasons for the rapid increase in the number of answers 85-100 points are the following:

- self-treatment of materials by teachers for a thematic evaluation of students, their use in the educational process;
- cooperation and collaboration of teachers in some areas during the passage of the monitoring study.

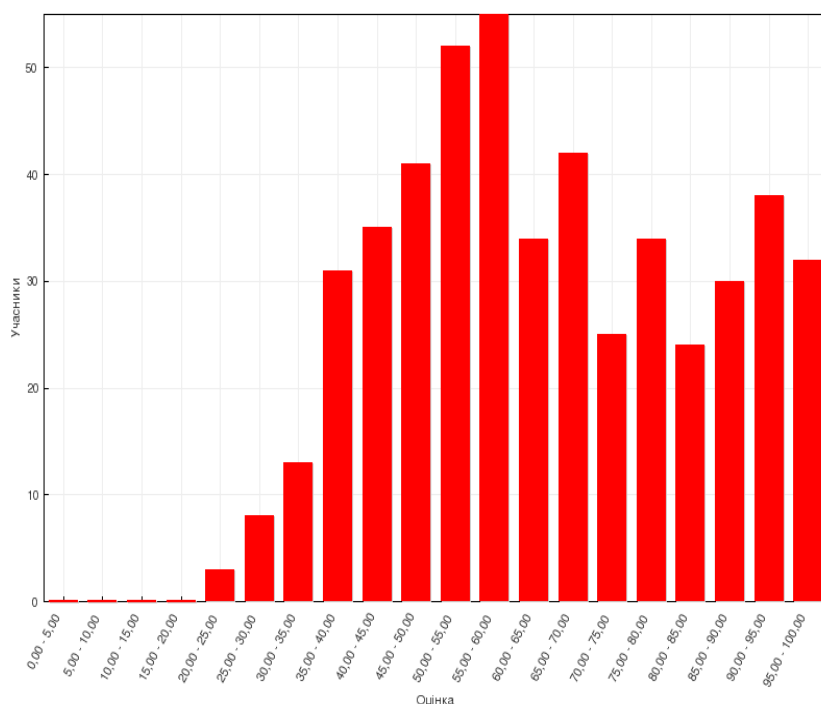


Fig. 3: Test results of the teachers of information science (2015)

Like in the previous year, for teachers was the most difficult practical work, which consisted of professional competence problems. Fully or partially completed the task of practical work 74% of teachers. The mind map or text document created 57% of the teachers that were monitoring, the lesson presentation - 53%, student publication - 51%, and the requirements and criteria for evaluating student work pass of only 38%.

Should be noted that more than a third of teachers who perform practical work, presented a mind map, through its various construction services.

Many science teachers said that thanks to the monitoring task they met with tools such as mind maps and mastered services of their construction.

Compared to the previous year the positive aspect was that almost all the presentations have been decorated with themes of presentations and compliance with the same style. More difficult was the situation with the creation of comments to slides (teacher's explanation of new material) and formulation of a problem for students at the beginning of the lesson. About 20% of teachers have made comments to a presentation slide, about 15% of teachers use educational material to explain the elements of problem-based learning.

Almost all participants of monitoring study correctly identified the information technology student to perform tasks more difficult was the definition of information products - publication(electronic version of the wall newspaper, electronic newspaper, a computer publishing, text document). But there were also quite unclear definition of information product that offers to create disciples, such as "Information products have the data necessary for the student explanation, comprehension, understanding, is the result of its information activities" "information products - vital importance of water", "information products in this work is water, which is important for the human body." The most difficult task turned up was in which teachers needed to determine the information product, add a formal requirements for it, to make the criteria for evaluating the work of students and determine the time it takes a student to complete the task. Only 17% of teachers could correctly define what is information

product, put demands on him and offer evaluation criteria. The problem for some teachers turned up was determine the time for students to complete the task. It is not clear what criteria guided the teachers for themselves that determined the time on the job less than 12 minutes. Because disciples needed during this time - to read and analyze 2/3 printed page of text, select necessary information and spread it in the appropriate columns, issue a text document, adding images and headlines. Exactly this task highlighted the lack of readiness of teachers to self-assembly competence tasks for students, which is one of the consequences of permanent use of the vast majority of teachers prepared methodical manuals printed with standard tasks for pupils and criteria proposed to them. There needs to study reasons for the refusal of some teachers to perform practical tasks of monitoring, although at this year's tasks was given much more time than compared to the past. In our opinion, the main factors reluctance of teachers to perform tasks is the inability to take account of the results of monitoring of teachers during the regular certification and skills not formed self education. The survey results highlighted the lack of willingness of teachers to self- assembly of competency assignments for students and develop criteria for their evaluation and insufficient formation of self education skills. This can be explained by the constant use of ready tasks and criteria, lack of experience combined self-assembly tasks and development criteria.

Conclusions

The main reason for biased assessment of the teachers own level of competence in the information area is the low level is professional training of teachers and lack of knowledge on assessment of student achievements in information science. That is a significant part of teachers of computer science who participated in the study did not examine students work on specific criteria, based on a subjective assessment.

After analyzing the responses to the question "What are the factors that impede the development of your ICT competence" can identify other factors:

- lack of basic professional education;
- overloading of teachers of computer science by additional responsibilities as a result of lack of time for self-education;
- small number of hours to study the subject information science;
- lack of facility to connect to high-speed Internet;
- linear coursework model of teachers' advanced training (1 time in every 5 years) does not match the current pace of development of ICT and changes in the curriculum of computer science.

It should be noted that the low level of theoretical and practical knowledge in computer science affects the quality of teaching the subject and the formation of information culture of pupils not only in high school, but in elementary, and middle tier. Analyzing the results of the study, we can conclude that the problem of raising the level of information and communication competence of teachers of computer science is relevant. Information and communication competence of teachers of computer science is a determining factor of formation ICT-competencies of pupils and a prerequisite for further professional development. This requires changes in the content and in traditional forms, in the methods of current system of teachers' advanced training, focus on personal professional needs of teachers. The results of the study are the starting point for the formation of educational goals of the system for teachers of informatics field. The need for a systematic updating of knowledge and skills of teachers, the formation of necessary professional competence require reforming of the system of teacher training, particularly teachers of information science.

The introduction of distance learning technologies in service teacher training has great prospects, encourages teachers to search for and analysis of information in the context of the subject area of informatics, creates favorable conditions for the professional development of science teachers, the implementation of the principle of "lifelong learning".

Research results underlie the educational goals of the Region system service teacher training of computer science. To ensure high quality education at all levels, without exception, perhaps only in the presence of stable quality system of continuous professional development of teachers compulsory introduction of distance learning technologies.

Acknowledgement

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ICT IN NORTHERN MORAVIA ELEMENTARY SCHOOLS

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Abstract

Over past two decades, the process of integration of information and communication technologies into education at all school levels has been the subject of many discussions and projects. This project requires schools to be equipped with the necessary devices (computers, interactive whiteboards, mobile devices, etc.) on which large amounts of financial resources are being spent. Moreover, effective incorporation of ICT into the education process requires corresponding software and also the training of teachers to work with the new technology. Teachers also need to be supported and motivated. The paper summarizes the results of a questionnaire research in Northern Moravia elementary schools. It is particularly aimed at the current situation regarding the school equipment, i.e. if the schools have interactive whiteboards, computers and computer rooms, but also if the Internet is available in schools. The actual usability of technology in the teaching of particular courses is also part of the research.

Keywords

Elementary school, education, technical equipment, presentation technology, global Internet environment.

Introduction

The changes caused by information and communication technologies are rapid and all-embracing. Technologies influence all fields of human activity. The newly emerging global Internet environment is – thanks to the tools of the so-called second (today, we are talking about the third) generation of the Web – becoming available to every user (even to those with minimal computer literacy) (O'Reilly, 2005). The OECD research results show that the new generation of children starts to use the Internet earlier than ever (OECD, 2014) (ČSÚ, 2014).

A number of theoreticians focus their research activity on the characteristic features of the new generation of children growing up in the environment of modern network technologies. Brdlička summarizes the qualities of the new “Net” generation: Technologies and working with them clearly influence thinking and form problem solving approaches. The current computer technologies require performing of multiple tasks concurrently – multitasking. Non-linear and often interrupted procedure of information processing is determined by the nature of the Web, which is based on hyperlinks. The amount of available information and the way of its presentation leads to a simplified perception of information, often without understanding it within its context. Compared with earlier generations, the new generation displays a selfless willingness to cooperate and share the results of their work with strangers who can improve it, use it to create something new and then offer it for others to use through network technologies.

These changes, which modern information and communication technologies entail, influence the area of education, particularly the education of pupils from early age (Kalaš, 2002).

Increasing computer literacy is also reflected in the knowledge of university students (Nagyova, 2013).

The paper analyses the results of a questionnaire research in selected elementary schools in the Moravian-Silesian region, which was aimed at the technical equipment of schools and whether or not they are prepared for education in the environment of modern technologies.

Object of Analysis

The “Smart Helpers in Education or The Simple and Creative Use of ICT” project (Chytráci, 2015) consists of 43 partner elementary schools in the Moravian-Silesian region, 24 of which are nine-year schools and 19 of which are lower primary schools. 25 of the schools are coupled with a kindergarten.

Moravian-Silesian region has almost 500 primary schools (seznamskol.cz, 2015); the project partner schools represent less than 10% of all schools. The questionnaire was filled by the headmasters in coordination with the engineer of the project, which information is continuously checked and complemented. The aim was to obtain the most relevant information on use of ICT in primary schools.

The questionnaire research (in the electronic form) in the project partner schools took place in September 2014. It was aimed at the current situation regarding the use of ICT in schools. It was particularly aimed at the Internet access options and the equipment of the computer rooms and their organization (user accounts, passwords, administration). The research also covered information about the presence and use of further technical (data projectors, interactive whiteboards, headphones, photographic technologies) and software (digital study materials, the LMS educational environment, etc.) equipment in schools and in the teaching of particular subjects.

Internet Connection and User Accounts

Nowadays, Internet connection is common in elementary schools. Computers used for school administration, teachers’ computers and computers in the computer rooms are connected to the Internet.

However, Wi-Fi, the wireless connection, which would be available in individual classrooms and would enable work with mobile devices (tablets) in individual subjects, is not common. The results concerning the capacity of the Internet connection line and the number of the local wireless network access points show that only 7 of the monitored schools have the technical equipment required for the use of global Internet environment. At the beginning of 2015, the remaining schools – within the scope of the follow-up project – started to develop local wireless networks.

It is necessary to have user accounts in order to be able to use modern network technologies. 20 (47%) of the schools stated that they do not have user accounts (not even for teachers) protected by a username and a password. Mostly they use 2-3 accounts; one joint account for teachers and one for pupils. Only 11 (26%) schools have individual accounts for every teacher and student. The schools are yet to adopt this basic precondition for working with the Internet. This situation is related to the technical equipment of schools and to the administration of user accounts (more precisely to the lack of qualified people).

The majority of schools use the Windows operating system. Besides three schools, which use Linux for the administration of accounts, the schools also use the Microsoft software tools for the administration of user accounts. One school stated that it uses the Mac OS X operating system. This school, however, does not administer teacher or pupil accounts.

Presentation Technologies in Schools

In the previous years, the equipment of schools consisted mainly of presentation technologies – interactive whiteboards and data projectors (see Fig. 1).

Schools usually own several interactive whiteboards and data projectors. On average, the monitored schools own 2-5 interactive whiteboards, which are used in the education process particularly at the lower primary education level (6 schools stated that all the classrooms at the lower primary education level are equipped with interactive whiteboards). As far as the type of interactive whiteboards is concerned, SmartBoard is the most frequently used type (24 schools) while 19 schools use the ActivBoard type. The remaining types of interactive whiteboards are rarely used.

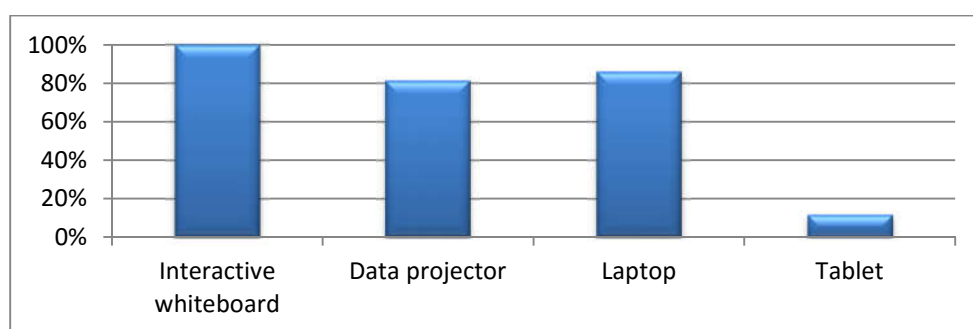


Fig. 1: Schools equipped with notebooks, tablets, interactive whiteboards and data projectors

Teachers evaluate interactive whiteboards positively. All the schools stated that they use interactive whiteboards frequently and consider them to be a valuable tool in the teaching of every subject. However, it is inconvenient that pupils need to move to the classrooms equipped with an interactive whiteboard as they are not in every classroom. As has already been mentioned, and as the comment of one of the schools proves, the schools are satisfied with interactive boards and are willing to use them:

“Interactive boards can be used in many ways: presentation classes (preparation, writing notes); individual work with pupils when introducing them to the curriculum; operational work in classes (sample, information search, playing music, etc.), teaching programs...”

Data projectors and computers are used for presenting the curriculum at the upper primary school level. Average schools own 6-7 data projectors; it is now common that all the classrooms are equipped with the presentation technology.

Besides the presentation technology, the schools are equipped with laptops (which are used particularly by teachers). However, the computer rooms equipped with laptops are still unique. At the time of the questionnaire research, almost no schools had tablets as only 5 schools stated that they own a tablet, only one of which stated that it uses the tablet for group work in all the subjects.

Other Technical Devices in Schools

Schools are often equipped with other technical devices such as a scanner, headphones and microphones, cameras and camcorders, the GPS, electronic and robotic kits, etc.

The majority of schools (17) stated that they do not own a scanner, or that they own 1-2 scanners (22 schools). The scanners, however, are used by the school administration and are

not intended for the purposes of education. Only one school, which owns as much as 10 scanners, uses them in the education process.

Headphones and microphones are used particularly in the teaching of foreign languages. 25 of the monitored schools (58%) have at least one language classroom equipped with headphones (and microphones).

75% of the schools own a camera; only 9 of them stated that they do not own one. Usually, the schools have 1-2 cameras (27 schools), which they use to document school-related events. The cameras are of a different quality – there are schools that have a compact camera, but there are also schools that own electronic or SLR cameras. Two schools, which own more than 10 cameras, stated that those are compact cameras used when working with pupils. Camcorders are unique as only 11 schools stated that they own a digital camcorder.

As far as other technical devices are concerned, elementary schools own visualizers (7 schools), weather stations (1) and voting machines.

Only 7 schools own electronic measuring devices that can be connected to a computer and electronic kits. Usually, these are measuring devices and sets of sensors intended for measuring in physics and chemistry classes. Only one school owns a robotic kit – 12 sets of the Lego Mindstorms kits.

Generally, the schools are satisfied with technical devices and use them frequently. Moreover, the schools train their employees to work with the devices and technologies.

Computer Rooms in Schools

All the schools now have computer rooms. 28 (58%) of the schools have only one computer room. Elementary schools usually do not have more than one computer room; and only one school stated that it has as many as 4 computer rooms.

There are 15-20 computers on average in the computer rooms – 18 schools. 10 schools have not more than 10 computers in the computer room. These are smaller schools with a fewer number of students in the classrooms. 15 schools have more than 20 computers in the computer room.

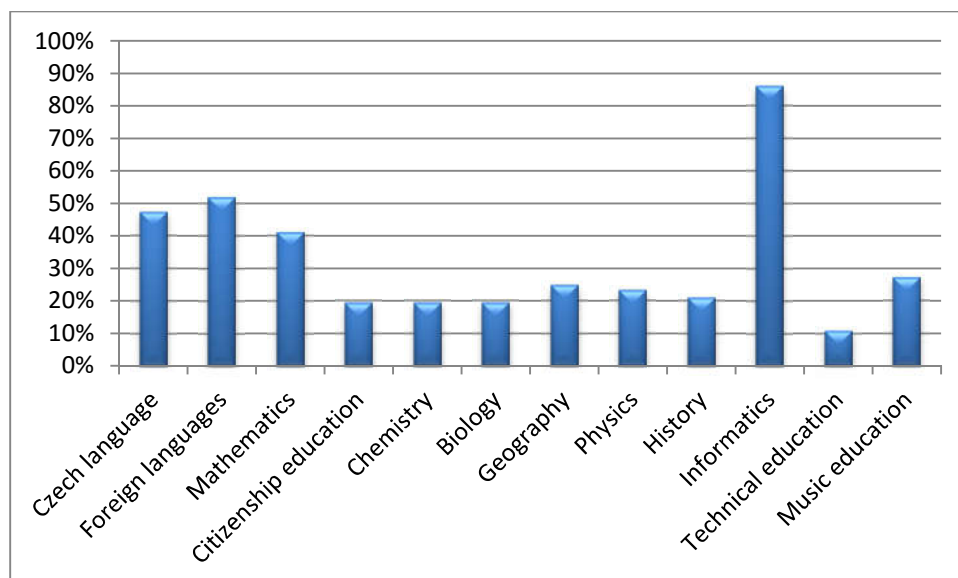


Fig. 2: Use of the computer rooms for the teaching of individual subjects

As far as the monitored schools are concerned, the computer rooms are used to the maximum extent. Informatics, which is regularly taught in the computer room, is the subject in which the computers are used the most. Moreover, the computer rooms are often used for the teaching of foreign languages and the teaching of the Czech language and mathematics. As far as other subjects (including the natural history subjects) are concerned, the computer rooms are used less frequently (see Fig. 2). Note the frequent use of the computer rooms in music education classes.

Software Equipment of Schools

As has already been mentioned, the majority of schools use different versions of the Windows operating system. All the monitored schools also have the Microsoft Office software. 8 of the schools also use the Open Office software.

Elementary schools use all kinds of pedagogical software. The most used are the ones by Terasoft and Silcom (Alík – for children, Didakta – for older pupils) – see Fig. 3. Other paid educational programs are rarely used. The graph does not include special educational programs, which are used by individual schools, such as touch typewriting education programs, encyclopaedias for individual subjects, traffic education programs, etc. 9 of the schools stated that they do not use educational programs at all.

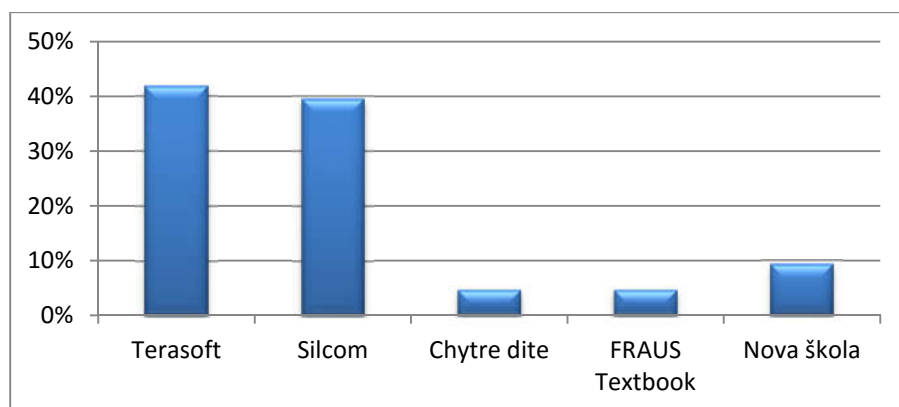


Fig. 3: Use of programs of individual companies in elementary schools

As far as the use of other educational programs (particularly presentation programs) in individual subjects is concerned, foreign languages, the Czech language and mathematics are the subjects in which these are used the most (see Fig. 4). It is partly because of the availability of the programs and partly because the teachers of these subjects are willing to use them. The questionnaire research results showed that the teachers of these subjects (the Czech language, a foreign language and mathematics) were the ones who created digital study materials (within the scope of various projects) and used the eLearning environment most often.

The use of the pedagogical software in natural history subjects is not as frequent (approximately half as frequent). It is interesting that in the teaching of informatics the pedagogical software is used less. It is to be assumed that the teachers did not understand the question, which is also reflected in their answers concerning other subjects – the teachers find the terms pedagogical software and educational program, if they do not include the name of the companies that manufacture them, confusing.

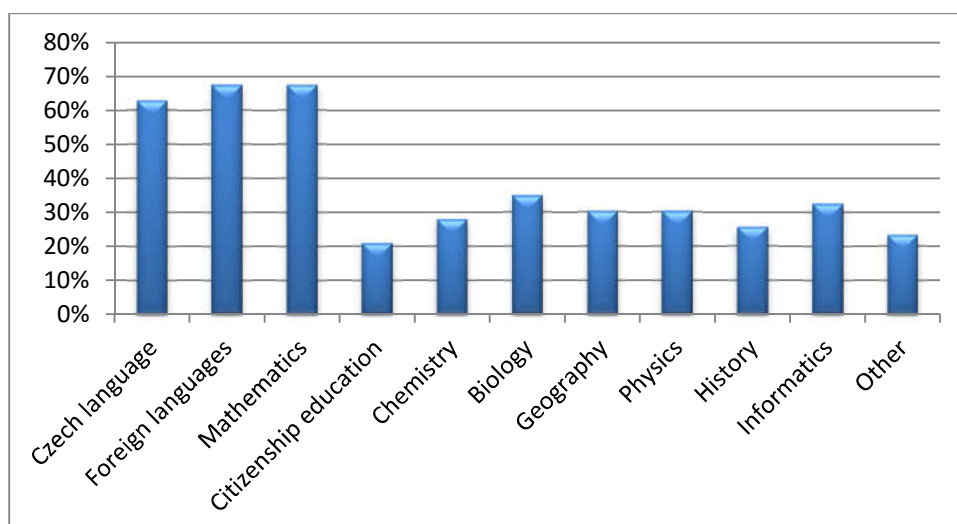


Fig. 4: Use of individual programs in individual subjects

As far as the specialized software for working with multimedia in the teaching of informatics is concerned, the situation in schools is even more alarming. The elementary schools use only the Zoner programs (9 schools). The remaining schools do not use such programs at all and, as can be concluded from their responses, cannot even place them in the relevant category. It is evident that the teachers do not understand the term software for working with multimedia properly.

In the future, the schools would like to extend the process of integration of ICT into education to the following subjects: chemistry, physics and citizenship education. As far as informatics is concerned, the schools would like to improve the technical equipment of the computer rooms. As far as other subjects are concerned, the teachers do not expect a significant increase of integration of ICT into education.

Conclusion

The long-term plan of the development of the education system in the Czech Republic stresses that it is necessary to integrate modern technologies into the education process, to develop pupils' competences in the area of working with information and digital technologies, and to develop pupils' informatics thinking so they could be of use in the information society throughout their lives. As far as the realization of the long-term plan is concerned, the data of the Czech Statistical Office show that the availability of the Internet and the technical equipment in the Czech households is sufficient. The questionnaire research and further information provided by elementary schools confirm that the schools are trying to create the technical infrastructure and to effectively integrate ICT into the education process. Moreover, teachers express interest in the entire process and in improving their information and computer literacy.

However, it needs to be said that, as far as modern network technologies are concerned, the technological equipment of schools and the availability of the Internet is insufficient (as far as education in today's information society is concerned). The schools are now in the phase of developing the global Internet environment, the integral part of which is the availability of Wi-Fi. Schools also need to be equipped with mobile devices with suitable software. Projects such as "Smart Helpers in Education or The Simple and Creative Use of ICT" can help schools meet this requirement (Chytráci, 2015).

The questionnaire research showed the problematic part of the entire process – the adequate software equipment that would correspond with the individual subjects educational programs and that could be used for pupils' work in the classroom. The problem is not only the insufficient equipment, but also teacher's lack of knowledge in this area.

Acknowledgments

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ASPECTS OF USE OF ELECTRONIC EDUCATIONAL RESOURCES BY UNIVERSITY PROFESSORS

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Abstract

This article represents some results of a survey for academic teachers and educational management, developed by the international research team within the European IRNet Project: International Research Network for study and development of new tools and methods for advanced pedagogical science in the field of ICT instruments, e-learning and intercultural competences. The study targets professors from the Dniprodzerzhinsk State Technical University – official partner of the project. The article reveals professors' beliefs and preferences about ICT-aided learning, supported by digital data. The article analyzes the importance of the goals that the teacher of higher educational establishment sets in his teaching activities when working with electronic educational resources and also the need to attract a variety of information and communication technologies in the framework of higher educational institutions. At a later stage recommendations for university educational management might be formulated in order to take into account the revealed professors' attitudes and current trends in higher education.

Keywords

ICTs, e-learning, university teachers, International Research Network, questionnaire

Introduction

At present stage of development of the world community the use of ICT becomes increasingly topical in all spheres of social life in general, in science and education in particular. In the majority of countries the scientific and educational environment is not only one of the major developers, but also a consumer of electronic resources which meets basic goals of "knowledge society". The analysis of worldwide experience of creation, implementation and use of e-learning proves its effectiveness and potential (Harry, Magnus, 1993; Trentin, Benigno, 2000; Merrill, 2001; Lin, Hsieh, 2001).

Prerequisite of quality modern education today is a harmonious combination of traditional teaching with advanced technologies. The purpose of modern education in Ukraine is the development of active, conscious, responsible, constructive personality, which is spurred greatly by ICT-aided educational process. Its basis is a deliberate and controlled intensive self-study of students who can learn at a convenient time, under the individual schedule, having the complete set of special tools and opportunity for personal contact with the teacher or in the on-line mode using modern technology. Recently, work to diversify modes of distance learning has intensified in Ukraine, but there are many problems that need immediate solutions.

The introduction of information technologies in educational process dramatically changed attitude to learning materials. Normative legal acts of Ukraine and specific educational activities in modern conditions implicitly point to the possibility, or rather, the need for the use of electronic educational resources in the educational process next to the printed ones or instead of them (Sorokina et al., 2014). In our view, the use by teachers and students of ICT in the educational process is really necessary, because such training improves the training of qualified professionals capable of self-learning and self-development; provides differentiation and individualization of learning; creates conditions for improving the quality of higher education etc.. The use of new information technologies allows to diversify classes, to make them more interesting, informative and useful for learners. Among the advantages of electronic educational resources we should also mention the popularity, multimedia modes, interactivity, accessibility. However, there are a number of problems associated with the use of ICT in teaching practice, the main of which is probably the complexity of choosing electronic educational resources that can be used to teach students.

In these circumstances one of the really urgent problems is creating and using electronic resources by university professors in their teaching activities, these resources would allow to implement new effective teaching methods and could make a projection of the learning process to a new level. For a comprehensive analysis of this issue, we have done a series of sociological researches within the international project «International Research Network for study and development of new tools and methods for advanced pedagogical science in the field of ICT instruments, e-learning and intercultural competences». The project is financed by the European Commission under the 7th Framework Programme, within the Marie Curie Actions International Research Staff Exchange Scheme. The project participants are universities of, Poland, Portugal, Spain, the Slovak Republic, The Czech Republic, the Netherlands, Australia, Russia and Ukraine. One of the representatives of Ukraine in this project is Dniprodzerzhinsk State Technical University. The main objectives of the project are defined as follows:

1. To set up a thematic multidisciplinary joint exchange program dedicated to development of new tools for advanced pedagogical science in the field of ICT instruments, distance learning and intercultural competences in EU, Australia, Ukraine and Russia.
2. To strengthen collaboration between the EU and third country institutions through mutual secondments of researchers.

During the first phase in May 2014 the research team conducted an anonymous electronic survey among the students of Dniprodzerzhinsk State Technical University (6), aimed at revealing the level of intercultural competence of students and the development of their intercultural communication, evaluation of the university website, the attitude to e-learning systems and so on. In the result we defined ICT-competence, commitment and the willingness of students to learn within some e-learning system. It is proved that the use of elements of e-learning is a topical alternative teaching method, and also an essential complement to traditional education that provides more opportunities for students and teachers.

In the second phase in April-May 2015 with a specially developed questionnaire there was conducted an anonymous electronic survey for educational authorities and university teachers participating in the project IRNet in general and in Dniprodzerzhinsk State Technical University in particular, which was intended to analyze the current situation and identify the attitudes and suggestions of teachers in the following areas:

- the evaluation of the significance / importance of goals for the use of electronic educational resources in their teaching activities;

- the ways that teachers use information and communication technologies in teaching;
- the level of competence of teachers using different types of electronic educational resources in the university teaching activities.

In this work the authors aim to identify prospects and problems on the road to development, implementation and operation of electronic educational resources in Dniprodzerzhinsk State Technical University. Digital result of the research and analysis will enable to assess which ICTs teachers use in teaching, what are the reasons and consequences of the use of ICT.

The choice of professors of Dniprodzerzhinsk State Technical University as an object of study is due to the fact that this university by its characteristics is an average university of Ukraine, which allows extrapolating the results of analysis on a wide range of universities in Ukraine. The study involved 51 professors of the University, of which 58.8% were associate professors, 25.5% - teachers, 11.8% - heads of university departments and 3.9% - full professors.

In the first phase we have analyzed the importance of goals set by the teachers of higher educational establishment in terms of use of electronic resources in the pedagogical activity, namely the organization of independent work of students (individual objectives); provision of students with the necessary educational materials; provision of a package of collective tasks and group work; regulation of the student's own and its control; the provision of educational services through distance learning; increasing interest of students to research (additional literature, professional and scientific information).

Teachers were asked to rate the significance / importance of targets for the use of electronic educational resources in their teaching activities (see. Fig. 1)

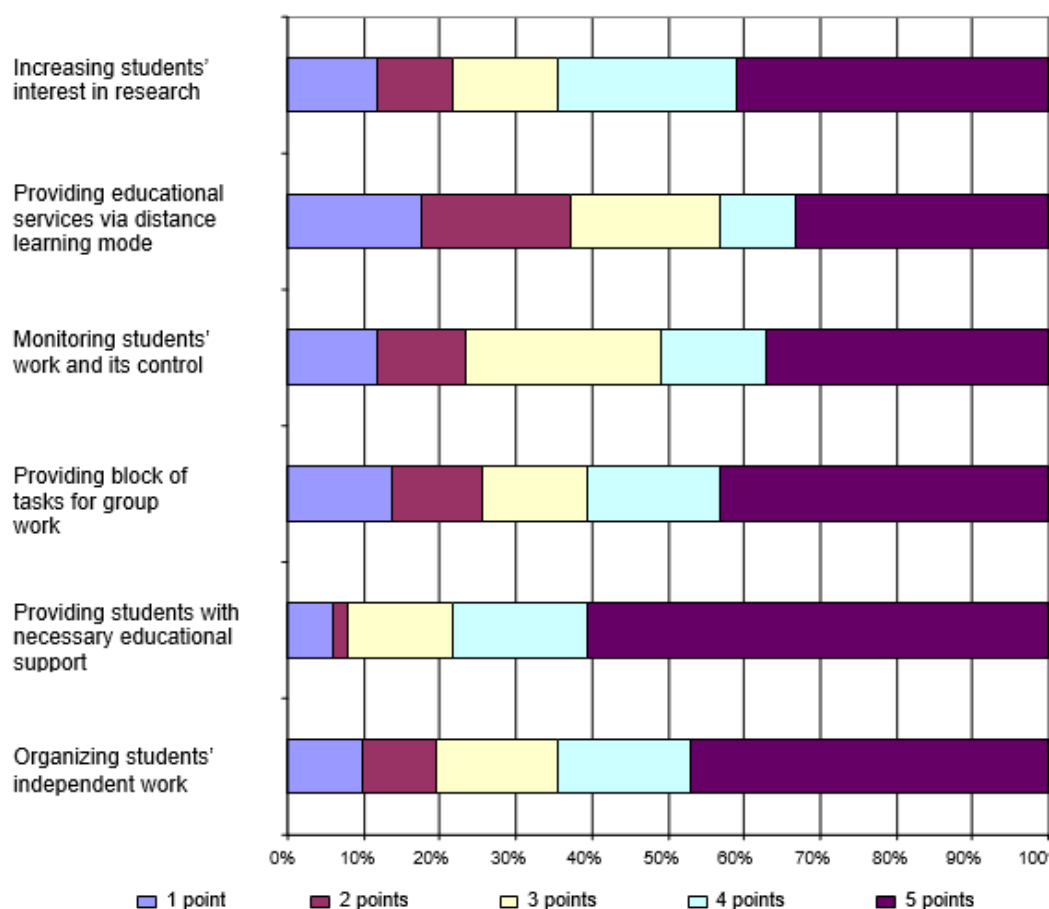


Fig. 1: The importance of ICT-related goals that university teachers set in the pedagogical activity

In this list the respondents displayed interest in objectives focused on providing students with educational materials (60.8%) and organization of independent work in the performance of individual tasks (47,1%). However, respondents also favored the supply of materials for students to organize their group and collective activities (43,1%). This again emphasizes the need for interaction between teachers, students and information and communication technologies, focused on ensuring the effectiveness of the educational process in higher educational establishment and expanding opportunities in managing students' individual work (activation of teaching and learning activities, increasing motivation to learn by innovative communication technologies, individualization of learning, etc.).

At the same time the respondents tend to set goals related to the provision of educational services using distance learning both at the lowest level of interest (1-2 points - 17.6% and 19.6% respectively) and the highest (4-5 points - 33.3%). This once again confirms the view that in this list objectives professors preferred e of that kind of distance learning, which in the context of today provide new, innovative, sounding very organization of educational process based on the use of information and communication technologies and the principles of self-study.

After determining the significance of the goals that teachers of higher educational institutions set in their educational activities using electronic educational resources, we have investigated in which way teachers use information and communication technologies in their practice. To this end, we analyzed firstly the scope of use of ICT tools in teaching subjects (presentations in student classrooms, the use of computer tests, exchange of information via email, etc.); secondly, whether professors develop e-courses on specific subjects using some software systems and, thirdly, whether professors create and support open educational resources at all (perhaps teacher conducts open online courses or has personal open educational resources (e-portfolio). Presented in Figure 2 is the analysis of university teachers' use of ICTs in their teaching activities:

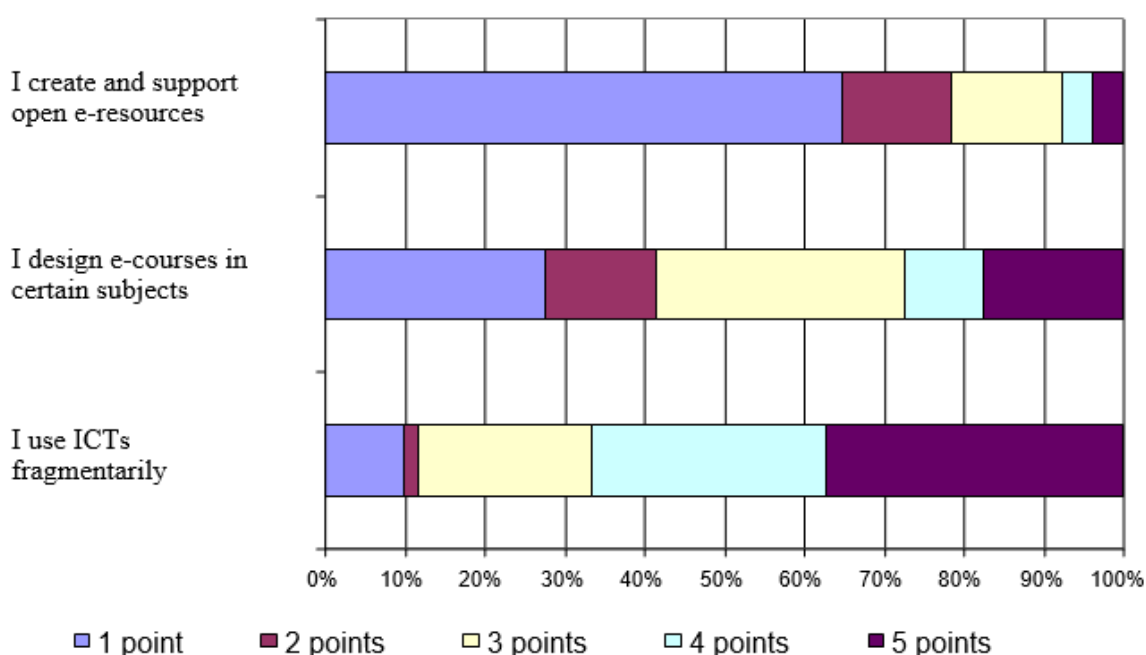


Fig.2: University teachers' use of ICTs in their teaching

Apparently, university teachers prefer fragmentary use of information tools in teaching certain subjects (information presentations in student classrooms, the use of computer tests, exchange of information via email, etc.). It should be noted that the frequency of this index increases gradually: 1point - 9.8%; 3p. - 21.6%; 4p. - 29.4%; 5p. - 37.3%.

Unlike the previous question, the next one about the development of e-courses in specific subjects was given three points by the majority of respondents (31.4%), and four - five points were given by 9.8% and 17.6% respectively.

As for the next indicator – about the creation and support of open educational resources (perhaps, the teacher holds open online courses or has a personal open educational resource - a major percentage of teachers evaluates this with only one point (64.7%). Further results look as follows: 2points - 13.7%; 3p. - 13.7%; 4p. - 3.9% 5p - 3.9%.

This suggests that the widespread use of ICTs requires above all the working out of general educational requirements, the familiarity with modern technologies of their testing and implementation, in-depth analysis and evaluation of their quality. Our next step was connected with university teachers' use of a variety of electronic educational resources in teaching. In this context, we analyzed the following indicators: self-developed digital materials to support classes (presentations, display materials) and digital materials for classes for individual students' independent work; elements of virtual laboratories (computer models to solve problems and research facilities studied); electronic textbooks; the use of annotations relevant to a particular discipline; topical websites; educational software; some digital multimedia training facilities; media resources (fragments of films, television programs, radio programs); personally developed e-courses using distance learning platforms; scientific resource databases, etc. (see Figure 3)

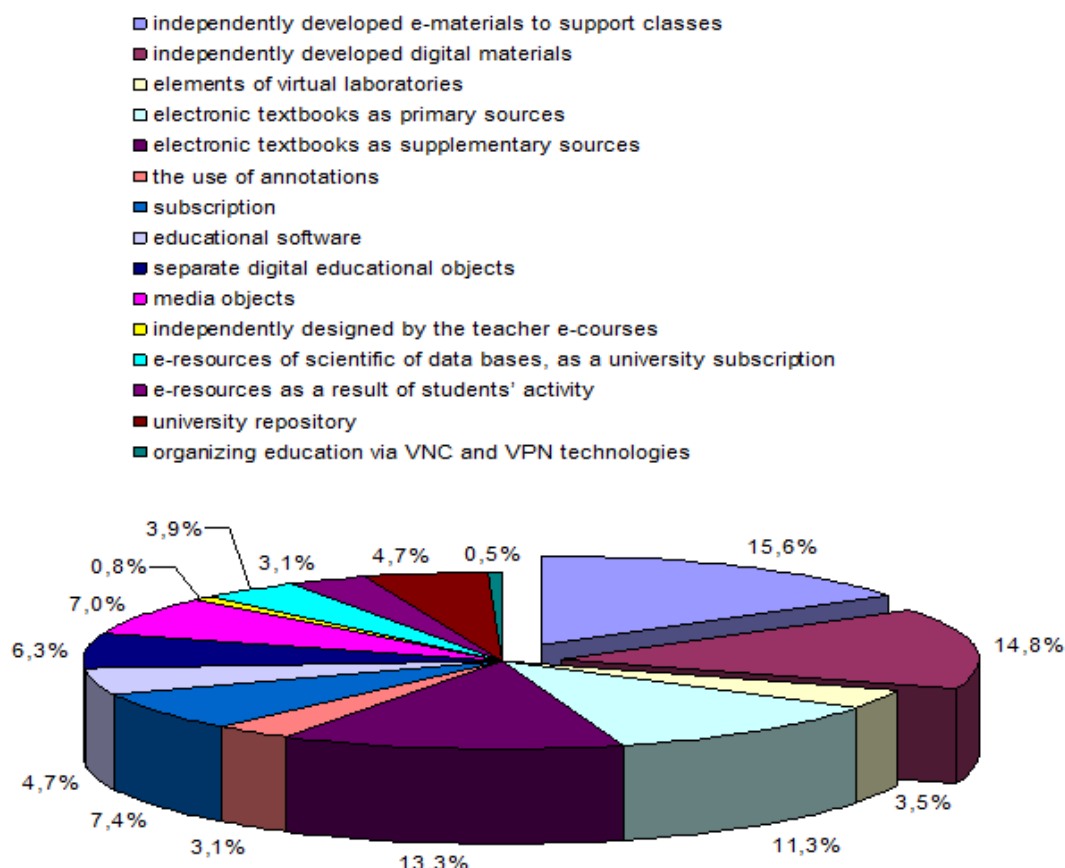


Fig. 3: University teachers' use of certain electronic educational resources in their teaching.

From Fig. 3 we can conclude that university teachers prefer self-developed digital materials to support training (15.6%), independently developed digital materials for classes for individual students' independent work, such as: digital textbooks, tests, individual assignments (14.8%) and they preferred electronic training manuals, textbooks recommended as the main list (11.3%) and additional one (13.3%).

It should be emphasized that other indicators have a very low impact (from 0.4% to 7%). Especially low points were given (0.8%) to e-courses personally designed by university teachers using electronic distance learning platforms (e.g., Moodle). This is because a deeper study should be held to study quantitative and qualitative side of the use of electronic courses using distance learning platforms in higher education, development of technologies of e-courses based on psychological and pedagogical requirements, and most importantly - the involvement of e-learning courses for training of future professionals.

Conclusion

Thus, in assessing the significance of the goals that university teachers set in their educational activities using electronic educational resources, we can conclude that the priorities are given to the following goals, firstly, providing students with the necessary educational materials; secondly, the organization of independent work of students, namely the search of forms and methods of individual tasks; and, thirdly, providing a package of collective tasks and group work.

University teachers using ICTs in teaching rather fragmentarily, namely: while presenting certain information to the audience, during the evaluation of students' progress (computer tests) and during the exchange of information via e-mail and etc.

As to the evaluation of university teachers' use of e-resources in their teaching activities, it should be noted that professors prefer independently developed digital materials to accompany the lessons (presentations, demonstration materials), digital materials for students' independent work and electronic textbooks.

Acknowledgments

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NETWORK LEARNING COMMUNITY OF STUDENTS - KNOWLEDGE-SHARING OPPORTUNITIES FOR PROFESSIONAL DEVELOPMENT

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Abstract

This article presents a diagnostic instrument and data analysis results within the European IRNet Project. The aims of the survey included the determination of students' attitude to collaboration, cooperation, knowledge sharing and virtual interactions within a university e-learning environment. The data can not only serve as the basis of determining the readiness of students to embrace networking, but can also help to identify ways to improve university electronic environments. The paper includes results from three universities - Herzen State Pedagogical University of Russia, St. Petersburg, The University of Silesia in Katowice, Poland and Constantine the Philosopher University in Nitra, Slovakia.

Keywords

network learning community, e-learning, students, professional competences

Introduction

A network learning community can act as the basis of pedagogical design of e-learning environment. Today, academic teachers consider an e-learning environment as not only a system of information conditions, providing educational process, but also as a means for learning and self-development, as well as an object of modelling, design and implementation (Noskova, 2007). For the pedagogical design of e-learning environment with specific characteristics, a prospective basis is the idea of a network community. Network communities are studied in different sciences. The development of network and online communities are today, perhaps, one of the leading factors affecting the socialization of young people.

Network learning community of students – contemporary approach

The idea of a network of learning community is very popular today. In particular, the phenomenon of “leadership” in cyberspace is studied as a kind of ability to share knowledge and skills, the ability to have social impact on the community (Bondarenko, 2004). An important element of a “collective memory” is a functioning community network (Nikolaev, 2010). Most modern trends in the electronic environment are related to social media, as well as to the prospects for the next stage of this environment development, conventionally called «Web 3.0» (Kommers, Isaias & Issa, 2015; Noskova, Pavlova & Iakoveva, 2015).

Network communities are based on the exchange of knowledge, cooperation, and interaction (Morze, Varchenko & Smyrnova-Trybulska, 2015). Research proves that knowledge sharing among students is one of the essential activities in learning. Besides face-to-face interactions, students also share their knowledge through online channels such as social software tools. Such characteristics of social software tools as informal setting,

communication, network and community, and user-generated content can positively influence students' knowledge sharing behaviour. It is proved that using “open” forums - forums available to the open internet - for teaching purposes across courses and programmes is very effective (Geelan, 2014). In this research, an open forum was created and used in courses across one year of science education, drawing in students in the courses, students in similar courses at other universities, alumni, teachers and science educators. The forum was available to all participants after they completed a particular course, or their programmes at the university, and will develop as a “living” educational community across multiple courses, levels and programmes.

Social media are likely to facilitate learning independently of time and place. They also encourage learners to be active and support peer and community learning. Social networking sites such as Facebook are more and more popular and are becoming part of our daily lives. Social networks not only enhance both teacher-student and student-student interactions through synchronous and asynchronous web-based communications, they help instructors connect with their students about assignments, upcoming events, and learning resources inside and outside the classroom. On the other hand, more and more cloud services can take an essential role in facilitating the creation of this kind of learning community. Cloud services offer many possibilities to educators, for example, sharing information and resources through cloud storage. The potential of social media and other cloud services to foster teaching and learning in teacher education courses is significant. (Lai, Wong, 2015). Students, feeling comfortable and connected to their online learning community, are much more likely to be active participants in that community, working together to develop and build knowledge systems (Kim, Glassman & Williams, 2015).

Network learning communities can be based on blogs (Noskova, Pavlova, Yakovleva & Sharova, 2014). In this case, students' communicative competence development occurs if students solve professional pedagogical problems, describe and discuss their experience in blogs. For each of the problem solved, students should have a specially developed activity algorithm, describing teachers' and students' actions, additional electronic resources, stages of monitoring activities, terms of effectiveness, as well as extracurricular activities assessment scale.

A network community (online community, virtual community) can be described as a group of users who not only communicate through a system of computer-mediated communication, but also have the following characteristics:

- have common goals, interests, and the need for a common activity, which is the main reason of their membership in the community;
- enter into an active and recurring interaction with strong emotional ties and shared activities taking place between the parties;
- have access to shared resources by certain rules that determine the conditions to access them;
- have a collaborate information exchange between participants and mutual support;
- have a common context of social conventions, common language and behaviour.

Thus, the overall activity of network community members is formed on the basis of shared goals and interests, shared resources created by members of the network community. (Lazar, Preece & Maloney-Krichmar, 2002).

A network learning community can be very effective to support students' self-guided work and research. During training and conducting their own research, students not only use resources offered by teachers, but also constantly expand and enrich their own e-learning environment, adding a touch of useful information and the results of its activities. In this

educational environment, special importance is taken on by a common space of cooperation for the exchange of experiences, knowledge and ideas. It helps to make productive use of a “collective potential” for the participants of the educational process, the use of the mechanisms for mutual learning, contributes to obtaining a synergistic effect. Students who join the interaction at any stage can use resources of such communities, for example, first year students can see how their predecessors performed.

This approach to the formation of the educational environment based on network communities is especially important for the rapidly developing fields of knowledge. In this case, a constant flow of new knowledge and information into the educational environment is of special significance. Network communication helps students to master scientific terminology, to use and to operate knowledge freely; to develop skills of independent thinking; to formulate their own professional position. Communication in a learning network community can be a model of scientific communication, which is understood as a set of professional communication types in the scientific community, as one of the main mechanisms for the development of science, a method of researchers’ interaction and research results expertise.

When participating in a network learning community, students learn to use scientific language correctly, to argue their views, to access effectively resources of a global information environment, to respond quickly to messages from other members of the community. In this aspect, the communication activity is considered as a means of developing a number of important competences - cultural, intercultural, and professional competences.

The criteria for the effectiveness of interactions in a network learning community can be used as follows:

- the number of active participants;
- functional orientation of communication (informational, methodical, consulting, expertise, and project-oriented);
- availability of a community knowledge base;
- information on internal and external community events and interaction with other communities in related areas.

When building a learning environment for students in accordance with the ideas of a network learning community, it is indispensable to perform additional functions of a teacher as a tutor, a facilitator, a moderator. Combining these functions involves improving pedagogical competence, which includes such aspects as understanding the essence of interactions within a network community; possession of relevant information and educational technologies; an interoperability based on partnership.

For teachers, being active in a network community helps to study students’ views and interests, to shorten the path of emerging knowledge from its source to the graduate students, to assess the contribution of each member of the community, to constantly improve professional skills, which are important for teachers in the process of continuing professional development (Noskova & Pavlova, 2013).

The attitude of students to collaboration and cooperation as the basis for a network learning community engagement

Collaboration and cooperation are important components of interaction within a network learning community. This is because the main strategy of communication resources development in a network learning community is the knowledge-sharing strategy. Communication resources are a special types of electronic educational resources, which are

designed for organization and maintaining communications during network educational activities, as well as the products of educational communication interactions accumulated in the Net (Noskova, 2011).

In order to identify possible ways to improve educational interactions in a network learning community, the survey data, obtained in the framework of Work Package 3 of the IRNet project (<http://www.irnet.us.edu.pl>) was analysed. Among the aims of the survey was to determine students' attitude to collaboration, cooperation, knowledge sharing and virtual interactions within a university e-learning environment. The data can not only form the basis of determining the readiness of students to networking, but can also help to identify ways to improve a university electronic environment. An electronic environment of a modern university should create opportunities for the development of the 21st century competencies, for the implementation of a lifelong learning strategy. In this paper we analyse the data obtained in several universities – the participants of the IRNet project: Herzen State Pedagogical University of Russia, St. Petersburg (HSPU), The University of Silesia in Katowice (US), Poland and Constantine the Philosopher University in Nitra (UKF), Slovakia. Each university provided at least 100 respondents – students of all stages education (bachelor degree students and master degree students).

It is important to mention that the WP3 of the IRNet project was dedicated to the analysis and evaluation of the ICT level, e-learning and intercultural developments in every participating countries and to the elaboration of the conceptual framework for a joint research project based on lasting collaboration with the project participants. It was assumed that participants of e-learning environment (academic teachers, students, administration) are involved in activities with following results:

- increase of scientific and educational process comfort, focus on lifelong learning goals;
- personalization of educational activities, individual request of e-learning;
- formation of new scientific and educational relations, cooperation, intercultural competence;
- empowerment of self-realization in educational and professional activities, support of initiatives;
- increase of the openness degree of scientific and educational environment, expanding the influence of the university to external cultural environment; positioning of the actors in the research and education community;
- enhancing self-organizational effects that support sustainable development of the educational environment of the university and its participants.

Consequently, all the listed objectives, on the one hand, should be accepted by the e-learning environment participants, and, on the other hand, be visible in this environment through the interactions of these participants.

In the following paper we will pay particular attention to the following outcomes: formation of new scientific and educational relations, cooperation, intercultural competence; empowerment of self-realization in educational and professional activities, support of initiatives; enhancing self-organizational effects that support sustainable development of the educational environment of the university and its participants.

The first group of questions was focused on students' attitude to scientific and educational relations, cooperation and their understanding the role of ICT in maintaining these activities. The sample questions and answers are given in Table 1.

Evaluate the need for cooperation in solving educational problems (group work and teamwork, etc.) (multiple choice question)			
	HSPU	US (Single choice question)	UKF
These objectives are not set by the teachers	12.9%	16%	17.4 %
Teachers offer tasks that require cooperation for successful solving	50%	33%	50.6%
I strive to cooperate and ask teachers to offer such tasks	21%	18%	21.5%
Such competences are needed to be successful in life	46%	22%	60.9%
Without such competences it is impossible to be successful in business, for example, when creating start-ups	12.1%	11%	13.5%
Do you use social services, such as social networks, for collaboration and teamwork? (Single choice question)			
	HSPU	US	UKF
No, I prefer face-to-face contact	10.5%	41%	10.6%
No, teachers do not give tasks, oriented at mediated interaction	7.3%	12%	59.4%
Yes, it is a fast, convenient and modern way	76.6%	42%	89.4%
Yes, teachers give tasks when such cooperation is necessary	5.6%	5%	40.6%
Specify the main reason for your participation in virtual communities of students (scientific, artistic, sports ones, etc.) in social networks or other Internet services (Single choice question)			
	HSPU	US	UKF
Getting additional cultural knowledge (learning about events, broadening outlook, adopting cultural experience)	42.7%	31%	27.1%

Helping with studies (sharing knowledge, asking for help)	33.1%	18%	51.5%
Finding new friends	2.4%	16%	3.2%
Demonstrating own personal experience, knowledge, achievements	2.4%	14%	4.1%
Organizing own events	1.6%	10%	3.2%
I do not participate in such communities	17.7%	11%	10.9%

Tab. 1: Students' attitude to cooperation and understanding the role of ICT.

The analysis of data obtained at HSPU shows that students understand that cooperation and collaboration competences are needed to be successful in life. They also note that teachers set tasks that require cooperation for successful solving, so they have all the opportunities to develop appropriate skills. Most of the students use social services for cooperation and teamwork, because it is a fast, convenient and modern way of cooperation. The main reasons for participation in virtual communities are getting additional cultural knowledge and sharing knowledge, asking for help. However, students are not active in producing own content within network learning communities (creating own events and demonstrating own personal experience, knowledge, and achievements). It means that although young people are generally active in network communities, they do not entirely transfer their everyday skills and activities from the "entertainment" sphere to the educational, learning and professional sphere.

The analysis of data obtained at US, the Faculty of Ethnology of Education, similarly shows that students understand that cooperation and collaboration competences are needed to be successful in life. Simultaneously young people are generally not only active in network communities for using new information, they do transfer their everyday skills and activities from "entertainment" sphere to the educational, learning and professional sphere. For example, on the 3rd question near 24% students check variants "Demonstrating own personal experience, knowledge, achievements" and "Organizing own events" and 16% - "Finding new friends". Of course maybe it is yet not enough, but relatively it is not a bad result.

Responses of students at UKF are close to responses at HSPU. Students agree that group and teamwork competencies are needed to be successful in life, but just a half of students say that teachers offer and require this form of work. Most of UKF students use social networks (almost 90%) but just 40% of teachers offer this type of communication. We are surprised that almost half of students say that social networks help them with studies. We think that students use social networks mainly for knowledge sharing and communication in their study group without the participation of the teacher. Similar to HSPU, students do not create content demonstrating own personal experience, knowledge, and achievements but they think that creating this kind of content can be beneficial when searching for employment as we can see in the second group of questions.

The second group of questions was focused on the empowerment of self-realization in educational and professional activities, support of initiatives. The sample questions and answers are given in Table 2.

Choose the reasons motivating you to demonstrate in the university electronic environment the results of your academic, artistic, sporting activities (on the university web site, in social networks, etc.) (Multiple choice question)			
	HSPU	US (single choice question)	UKF
Opportunity to present myself and my achievements to others	44.4%	26%	18.5%
Opportunity to be noticed by a potential employer	0%	18%	40.6%
Prerequisite of studying a particular discipline	29%	8%	2.4%
General interest	41.9%	19%	19.1%
Own status upgrade	0%	4%	2.4%
Opportunity to make new friends	32.3%	7%	1.8%
I do not want to show myself and my achievements to others, because I have nothing to show	12.9%	3%	5.3%
I do not want to show myself and my achievements to others, because I am not interested in it	28.2%	15%	10%
Choose which informational resources you use most often when doing assignments, doing research, preparing reports, etc. (Multiple choice question)			
	HSPU	US (single choice question)	UKF
Search engines (Google, Yandex, etc.) - Search by keywords	95.2%	45%	90%
Printed publications (books, journals, guidelines, etc.)	51.6%	16%	51.5%
Electronic scientific databases from your university library subscription (databases of electronic journals, full-text electronic resources, etc.)	23.4%	14%	31.2%
Digital libraries in the Internet	48.4%	10%	44.1%

Open storages of electronic educational resources (institutional repository, WIKI)	21.8%	5%	35.3%
Video channels (YouTube)	24.2%	6%	40%
File sharing, torrents	14.5%	4%	15.6%
Webinars, podcasts	5.6%		4.7%

Tab. 2: The empowerment of self-realization in educational and professional activities, support of initiatives

The results obtained at HSPU show that the most popular reasons motivating students to demonstrate in the university electronic environment the results of their activities are an opportunity to present own achievements to others, an opportunity to make new friends, general interest and a prerequisite of studying a particular discipline. Some of the students are not interested in demonstrating their own activities. However, this contradicts the contemporary tendency of large involvement of students in social services where they demonstrate themselves. The fact means that in the particular electronic environment students are not motivated or do not have the awareness of the goals and values and tools for demonstrating their achievements. The most used informational resources for completing assignments; research and preparing reports are search engines, printed publications and digital libraries. Some of the students use electronic scientific databases from the university library subscription and open storages of electronic educational resources.

The US students' answers on the single choice questions and generally their declaration of approach to the empowerment of self-realization in educational and professional activities, support of initiatives are similarly relatively high but not a well- organized, coordinated and consciously structured and targeted. At the same time, nearly 18% students on the 1st questions choose 'Opportunity to be noticed by a potential employer'. Probably this is a result of good activities of the Office of Careers University of Silesia in the area of students training and a lot of action concerning personal promotion of young people, in particular by Internet for finding a potential employer and increasing of competitiveness.

Students at UKF also do not want to share their activities although they use social networks like a usual part of their life. However, there are some students (40%) that understand that sharing the portfolio of their own work can help them to find a job after they finish studies. Some students use social networks, as it is a prerequisite for studying a particular discipline. This percentage is too low, and these results confirm the low attitude of teachers to requiring and using this way of communication with students. Similar to HSPU students, almost all students at UKF use common search engines to find relevant information to prepare their assignments and research. They do not focus just on information on the net, but half of students also use printed publication maybe as the more trusted source. The results show that the services of the University Library (access to scientific full-text databases, electronic resources, etc.) are well used at UKF.

The third group of questions was focused on the educational activities strategies that students prefer and their understanding the role of ICT in time and education activities management. The example is given in Table 3.

Select an educational activities strategy that you prefer (Single choice question)			
	HSPU	US	UKF
I prefer that teachers monitor (remind, set deadlines, etc.) my work and its results.	37.1%	28%	52.6%
I study independently and systematically, regularly perform tasks, plan my own time	58.9%	67%	40.9%
I take the example of classmates – I follow the way they learn	4%	5%	6.5%
Will the information technology instruments (electronic diaries, organizers, calendars, reminders, etc.) help you in the planning your own educational and extracurricular activities? (Single choice question)			
	HSPU	US	UKF
No, they will not make a significant effect	34.7%	25%	28.2%
Yes, they will help greatly in organizing	45.2%	59%	54.1%
My learning activities are already coordinated by teachers and administration	10.5%	8%	12.6%
I already use these instruments, but I find them hard to understand it	9.7%	8%	5%

Tab.3: Students' educational activities strategies and the role of ICT instruments

The aspect of education strategies is very interesting, especially in the context of lifelong learning. The results obtained at HSPU show that almost a half of the students study independently and systematically, regularly perform tasks, and plan their time. However, they still prefer that teachers monitor their work and results. In connection with this idea the use of IT instruments for managing time and different types of activities are very important for students. This is one of the tasks of the Information Technology course, which students have during their first year in the university.

At US we received generally similar results regarding the aspect of education strategies in opinion of students, which is very interesting, especially in the context of lifelong learning? Simultaneously most students - 2/3 (67%) prefer 'Study independently and systematically, regularly perform tasks, plan my own time'. On the question 'Will the information technology instruments (electronic diaries, organizers, calendars, reminders, etc.) help you in the planning your own educational and extracurricular activities? (Single choice question)' – 59% of young respondent's answers were 'Yes, they will help greatly in organizing'. It is possible that one of the reasons for such approach and opinion also is the introduction of an Information

Technology course, which students have during their first year in the university (30 hours) as at HSPU.

In contrast, students at UKF do not work so independently and individually. More than half of students need a teacher to control the process of study. Only 40% of students can work systematically and plan their own time. There is no such course as at the HPSU or the US at the UKF during the first year at the university. It is common that students tend to keep the study system the used at high school. It is interesting that almost 55% of students say that calendars and reminders help them to the plan educational and extracurricular activities but in fact, they do not plan and work systematically. Maybe they use those tools just to keep deadlines set by teachers.

The questions help to see the level of students' understanding of the opportunities and role of self-guided work, which has become very important for lifelong learning. In addition, we see the use of ICT in learning and in self-development, self-realization, research, scientific activities. It is obvious that students possess partly the motivation and skills for collaboration and cooperation; however, they still need to see and realize all the possible opportunities of cooperation in the university e-learning environment.

Examples of network learning communities in the universities, participation in the IRNet project

An example of a network learning community can be the interdisciplinary master degree training module "Information Technologies in Education", which is implemented at HSPU (<https://sites.google.com/site/magistraturaherzenuniversity/>).

Learning for a master degree is essentially different in comparison with the level of bachelor education. This level of education refers to adult education. Master degree students already have higher education and are focused on improving professional competencies, self-realization in career, and practical application of acquired knowledge. Often in the same educational team there are students who have recently received a bachelor degree and want to continue their education and professionals who have professional experience and have already formed a certain professional position. Motives of educational activity for these groups have differences. For the first group retains the features specific to the previous level of education - they are willing to "learn for the future" with the awareness of knowledge and skills, they will need in the future. For the second group of students the educational needs are largely connected with self-improvement and professional development. Consequently, in a master degree programme all these features must be taken into account, because the richer the motivation for education, the greater is the awareness of its values.

We can note several more features of master level training. Students may have a different basic training, not always fully corresponding to the current direction of the master program. In a short period (usually 2 years), they must not only "enter" the new science and professional field, but also perform qualified scientific research of selected problems. Master students from the first year are engaged not only in the educational process, but also in scientific work, joining the established interdepartmental team of researchers, united by similar issues and carrying out research activities within the same or related scientific fields. In such a situation, master degree students and academic teachers act as colleagues with different levels of professional and scientific expertise, but focused on solving common problems.

Moreover, one more important feature of a master course is the fact that students often combine study with work and a significant proportion in the curriculum is devoted to self-guided work.

Given these features, high-quality master education can only be achieved in a very intensive mode when all participants of educational interaction become the sources of information, useful experience and professional outlook. They can effectively use the potential of a global educational and professional information environment. Nevertheless, the main condition is to provide an active educational position to a student, to offer a high degree of individualization and independence of a student's activities.

The necessary conditions for the organization of the educational interactions are:

- Information resources with easy access mode, which can be adapted to address the individualized tasks;
- Flexible conditions for the educational process participants' interaction, opportunities for exchange of experience, knowledge and achievements;
- Possibility of self-evaluation and reflective management of own educational and research activities.

The educational space of these interactions should not be limited to the walls of the audience, and should use divergent communications capabilities of advanced network technologies.

In the process of interaction between academic teachers and students in a network community it is possible not only to solve educational problems related to particular courses, but also to reflect and substantiate the actuality of masters' studies, the progress of work on dissertations. It is possible to present and discuss intermediate results, to discuss empirical studies, research papers, and conference presentations on various topics. Of special value is the personal view of the professional experience of the participants of interaction and mutual assistance, a reflection of recent innovations in the study area. An important component is cooperation during the development of a module. The module as an education information environment is designed for continuous optimization and improvement. It is not only the development of the field of knowledge, but also the search field, and experience for the interaction of all participants. A personal initiative and self-management is also important.

In the first stage of the module design, the needs of academic teachers and students in network learning communities were examined. The following characteristics of educational cooperation participants were identified:

- Knowledge of network communication technologies.
- Readiness to use various opportunities for cooperation in the educational network space;
- Need for organization of the network information resources.

In the process of scientific and educational cooperation in the community undergraduates favoured the use of documents and sites with distributed access (70%), blogs (68%) and social networks (80%). But assessing their communications activity, students noted that 40% mainly used and added information resources in shared storage and individual portfolio and have not been active in online discussions (except conducted in frame of disciplines). But while nearly all active communicants stressed the particular value and utility of the experience acquired in network professional discussions (blog comments, discussion topics in the forum, online conferences). 65% of students said that cooperation in the educational community also allowed to acquire useful skills that they can apply in the perspective pedagogical activity.

In view of the data obtained in 2014 - 2015, the following structure of resources for the network learning community it was approved:

- Map of the educational module,
- News channel,
- Sites with distributed access and blogs for educational courses;
- Forum;
- Students portfolio
- Internet conference;
- Media channel;
- Collective database. In this database, the mode of multiple access allows users to add, comment, store and retrieve necessary resources. Each generation of students contributes to saturation of the resource base, using the experience and achievements of the preceding students. A personal initiative as well as reflexive management are important.

Students and teachers are involved in a common field of activity - students can learn and enrich their professional experience, and teachers receive not only an opportunity, but also an incentive to build the educational process with the support to the latest information and technologies that reflect the best professional experience.

Conclusion

The results obtained in this study allow us to formulate the following conclusions. Students, in general, demand the ability to be a member of a community, a common information space in the process of education. However, not all network communication opportunities are used in a modern university electronic environment, especially when we focus on educational cooperation. This is an indicator of the need to improve these aspects.

An information environment of a network learning community largely should be integrated into an information and communication environment of a university. The proposed variant of communication resources of a network learning community adequately meets the needs of students, interacting during their studies, research activities, master thesis, and personal professional development. The results can be used in the construction of educational environments for both bachelor and master training programs.

The main priorities for the network learning communities, accompanying training are as follows:

- Developing skills of independent cognitive and scientific activities, developing creative abilities,
- Amplifying professional self-development skills;
- Developing the abilities to set goals, plan activities and to choose the way to achieve results;
- Providing opportunities for individualization and time saving in terms of the community resources use;
- Developing the abilities to analyse own activity, to manifest oneself as active and evolving personality.

Acknowledgments

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DEVELOPING TECHNICAL SKILLS OF PUPILS IN PRIMARY AND SECONDARY SCHOOLS

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Abstract

The paper is aimed at the development of technical skills of pupils in primary and secondary schools. Technical courses are usually not popular among pupils. Therefore, within the scope of the “Windows of Science Wide Open” project, we prepared a number of activities, which should encourage pupils’ interest in the technical courses and help develop their technical skills. During the academic year we held several workshops for primary and secondary school pupils. The workshops contained activities such as the programming of robotic kits, the use of electric microscope in education, the use of measuring systems and a computer for the measuring of quantities around us, or the use of modern technology when creating an audiovisual project. Approximately 150 primary and secondary school pupils participated in the workshops.

Keywords

Robotic kit, EdLab measuring system, electric microscope, audiovisual technology, ICT.

1 Introduction

In the majority of cases, primary and secondary school pupils do not find instruction of technical courses attractive. Pupils and students lack the motivation and dedication to learn algorithmization, programming, physics and chemistry. (Nagyová, 2014) Only avid and enthusiastic pupils find these courses attractive. As a result, the technically-oriented secondary schools and universities have fewer applicants than the humanities-oriented schools. The aim of the “Windows of Science Wide Open” project is to make the technical courses more attractive to pupils and spark their interest in further study of those.

The “Windows of Science Wide Open” project is financed from the “Education for Competitiveness” Operational Program. The University of Ostrava is both the applicant and recipient of the project. The Faculty of Science and the Pedagogical Faculty of the University of Ostrava participate in the project.

Within the scope of one of the key activities, the “Windows of Science Wide Open” project aims to introduce primary and secondary school pupils to the technical courses, spark their interest in them and thus deny the established notion that they are difficult to learn. In so doing, the project uses ICT and technical devices in the teaching of courses such as informatics, physics, chemistry or biology. Within the scope of the project, pupils visited a specialized laboratory at the Pedagogical Faculty of the University of Ostrava where they participated in a number of activities aimed at the use of ICT for the programming of robotic kits, the measuring of physical and chemical quantities, the examination of microscopic preparations or the creation of an audiovisual project.

2 Technical Resources

The LEGO Mindstorms robotic kits and the EdLab measuring system are the key elements of the activities for pupils.

Nowadays, the robotic kits (LEGO Mindstorms) are used more frequently in schools. A number of researches were conducted, which focused on the use of robots as an educational support. The study comes to a conclusion that robots help pupils develop their logical and creative thinking, the ability to solve problems and to learn programming, mathematics and science. (Scaradozzi et al., 2015) For instance, a study documenting that a robotic kit competition helps increase pupils' interest in ICT in their university studies was conducted at the Department of Computer Science at Qatar University. (Qidway et al., 2013)

Primary and secondary schools can use virtual laboratories to conduct various physical and chemical experiments. (Bílek et al., 2010) Some of the currently used measuring systems – EdLab, Vernier, Pasco – can be used for illustrative and real experiments. (Oujezdský et al., 2015) These measuring systems have measuring sensors, a measuring interface and a computer which is used for visualization, archiving and analysis of data. As a result, the computer-supported experiments are becoming more attractive for pupils. (Koníček, 2014)

3 Activities for Pupils

The courses “A Day with a Robot” and “Measurement around Us”, which were realized during the course of the project, were attended by primary and secondary school pupils. From October 2014 to February 2015, 5 courses were held for the 5th, 6th and 7th grade primary school pupils and 2 courses for the secondary school pupils (the pupils from Secondary Grammar School of Prof. Otto Wichterle). During the courses, the following activities were prepared for pupils:

- Robotic kits Lego Mindstorms EV3,
- EdLab measuring system for the measuring of various quantities around us,
- Electric microscopes with preparations,
- Audiovisual technology for the creation of an audiovisual project.

3.1 Robotic Kits

Different activities for working with the LEGO Mindstorms EV3 robotic kit were prepared for both groups of pupils (i.e. from primary and secondary schools). The LEGO robotic kits enable the construction of various types of robots. The robot is controlled via a programmable cube, which operates the robot's drive motors (wheels, tracks, robotic hand) and subtracts and processes the values measured by the robot's sensors such as distance, luminosity, direction, etc.

Within the scope of “A Day with a Robot” the primary school pupils spent three hours with the robot. They were divided into groups of four to five pupils; each group worked with one robotic kit. Following the introduction and concise guidance, the pupils constructed the first robot according to the instructional manual in which the basic programs for the robotic cube are listed. After the pupils constructed one part of the robot, they tested the possibilities of a given program and then, according to further instructions, modified and expanded the basic program. The pupils were not limited in their work and some of them found the work

interesting. Those created complicated program constructions, built mazes and tried to guide the robot through them. Other pupils were interested in the construction process. Those added new parts (wings, scraper shovels, etc.) to the basic version of the robot.

After a short break, the pupils had the opportunity to create simple programs on a computer. Creating programs on a computer broadens the possibilities as the robot's actions are more precise and smoother. The pupils in groups could record a shout which the robot would produce while moving. They could also draw a logo which would be displayed on the robotic cube.

“A Day with a Robot” proved to be extremely demanding for the pupils. The instruction was divided into 90-minute blocks (which was unusual for the pupils as they were used to the 45-minute classes). However, it needs to be said that they succeeded and were often so drawn into the activities that they would not mind working even longer. On the other hand, in each group there were 3-5 pupils who did not find the work interesting.

The secondary school pupils participated in “A Day with a Robot” within the scope of their informatics class. As they had already been introduced to the basics of programming, the concept of working with the robots needed to be modified. Working in pairs on a computer, the pupils did not construct the robot, but only programmed it. They created the programs according to the assignments with each group solving tasks according to their interest. Some pupils worked with the light sensor and tried to control the robot via the colors on the mat. Others focused on the ultrasound sensor and tried to park the robot to its designated lot. The girls were interested in the possibility to write songs using notes and to adapt the robot's movement to the played melody. Each group created quality programs; the pupils drew on their prior knowledge of basic program structures (branching, repetition). At the end, the individual groups presented the work they had created.

Experience has shown that besides the educational value, “A Day with a Robot” also had informational and promotional values. Many pupils said that they would like to have a similar kit at home. While the LEGO robotic kits have existed for quite a while, their incorporation into the Czech education system is very slow.



Fig. 1: Construction of the robot

3.2 EdLab Measuring System

The EdLab measuring system is a special device that is used as an educational support in the natural history and technical courses in primary and secondary schools. It is used mainly in physics and chemistry classes where it helps conduct a number of experiments. The system consists of a measuring interface, which is connected to a computer through USB. Sensors for

the measuring of electric and non-electric quantities are connected to the interface. 6 analog and 2 digital sensors can be connected to the EdLab system.

Within the scope of the “Measurement around Us” day, a number of tasks with the EdLab system were prepared for the pupils. The pupils could measure quantities such as air temperature, humidity, static pressure, lighting in the room, noise in the room, but also the concentration of oxygen and carbon dioxide in the air. The EdLab measuring interface and several sensors were used for each task. The measured quantities were displayed on mobile computers.

The secondary school pupils were more inventive and creative. Not only were they interested in a particular task, but also in how the individual sensors worked. They tried to realize their own ideas such as the measuring of the telephone temperature by the infrared thermometer, depending on the CPU load. Another idea was to use the spirometer for the measuring of the volume of inhaled air of a smoker and nonsmoker.



Fig. 2: Measuring of noise by the sound level meter and the EdLab measuring interface

2.3 Electric Microscopes

For examining biological preparations the primary school pupils used electric microscopes equipped with a video camera that were connected to a computer. The pupils examined approximately 50 different biological preparations. The main advantage was that the preparations were displayed on a computer monitor so more pupils could see it. The pupils mastered the operation of both the microscopes and the software application for the displaying of the preparations. As a result, the microscopes and the biological preparations enabled them to visit the micro world. In one case, a biology teacher who accompanied the pupils was glad to join them in the process because their school did not have as many preparations.



Fig. 3: Examining a preparation by an electric microscope

3.4 Audiovisual Technology

The secondary school pupils expressed interest in modern audiovisual technology and wanted to create an audiovisual project. Using an HD video camera, a studio microphone and a green screen they made a video clip to a song which one of them sang. The entire project was realized according to a short script which was prepared by the pupils themselves. First they shot a dance performance (choreography by the pupils themselves) and then recorded the singing part using a prepared audio device. Using the chromatic key, they added the singer to the dance scene. The professional editing software application Adobe Premiere CS6 was used for the creation of the project. The pupils were creative and modern audiovisual technology enabled them to realize their ideas.

Conclusion

Within the scope of the “Windows of Science Wide Open” project the courses “A Day with a Robot” and “Measurement around Us” for the primary and secondary school pupils were realized. The aim of the courses was to motivate the pupils to use ICT in class and thus make the natural history and technical courses such as algorithmization, programming, physics or chemistry more attractive to them.

During the courses, more than 150 primary and secondary school pupils visited a specialized laboratory at the Pedagogical faculty of the University of Ostrava where they were engaged in a number of activities such as the programming of the LEGO Mindstorms EV3 robotic kits, the use of the EdLab measuring system for measuring quantities around us, the use of electric microscopes with a computer for examining biological preparations or the use of modern audiovisual technology for creating an audiovisual project.

The pupils were interested in working with ICT. Moreover, they enjoyed the programming of the robotic kit and even organized robot races. The secondary school pupils – who were more creative than the primary school pupils – invented their own measuring tasks and even created their own audiovisual project.

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TRANSFORMATION OF INFORMATION TO KNOWLEDGE THROUGH PROJECT-BASED EDUCATION

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Abstract

Information society continues in its intense development and there is an unprecedented technological progress in all areas of life. The focus has switched from a passive gathering of large amounts of data and information to their active using. An increasing importance of informatics education is undeniable and requirements for its quality should be a matter of course. We developed an innovative manner of informatics education based on project creation and modelling at our Faculty of Economics, Technical University in Košice. We are trying to transform problem solving process into an active process of cognition. Our teaching is focused on contextualization of learning content, gaining experience and transforming information to knowledge. The paper deals with the experience in teaching and it also discusses the body of knowledge and methods which have been implemented into the subject Informatics II.

Keywords

Informatics, education, project-based education, information, knowledge

Introduction

We work at the Faculty of Economics that is the reason why we often look at informatics education from the economists' and managers' point of view and we consider this interesting and useful.

It is the economy where knowledge is acquired, created, disseminated and used effectively to enhance economic development. Over the past quarter century, the rate of knowledge creation and dissemination has increased significantly. One reason is due to the rapid advances in information and communications technologies (ICT) that have decreased the costs of computing power and electronic networking. Modern ICT also enable people in all areas in different locations to work together, which consequently enhance their productivity, resulting in rapid advances in research, development and the generation of new knowledge and technologies.

A more and better educated population tends to be relatively more technologically sophisticated. This generates quality sensitive demand for advanced goods, which tends to stimulate firms to innovate. A well-educated and skilled population is essential to the efficient creation, acquisition, dissemination and utilization of relevant knowledge, which tends to increase total factor productivity and hence economic growth (Chen, Dahlman, 2006).

Growth is no longer based primarily on comparative advantages in labour or natural resources. Today the knowledge economy and the information society are the bases for future development (Asian Development Bank, 2014). Knowledge has become the heart and soul of this development. Comparative advantages in national institutional capacities to access,

assess, adapt, and adopt knowledge now drive the innovation that leads to productivity (World Bank, 2012).

Data, Information, Knowledge, and Wisdom

In order to understand terms (data, information, and knowledge) properly we present their short characteristics, according to (Révészová, Pařová, 2013) and (Cleveland, 1982).

On the lowest level there are **data**. Data reflect reality in details, they change quickly as details of objects states and processes around us change. They express facts in prescribed form so that it is possible to transfer and process them. Data comes about through research, creation, gathering, and discovery. (Example: It is raining.)

By adding a meaning, context and structure to data we get **information** - interpreted data. Information is therefore the result of data processing, they lower our uncertainty in certain conditions, they play a strategic part and very often they are crucial factor of success. Data is turned into information by organizing it so that we can easily draw conclusions. Data processing can be interpreted as „production process“ where data are ingredients and the product is information. (Example: The temperature dropped 15 degrees and then it started raining.)

Knowledge is processed information. We can understand this as a reproduction of a particular part of the world including rules and regularities that are applied there. **Knowledge comes out as a product of people's working, social and thinking activities.** Its characteristic is that it can be expressed by language. Knowledge is relatively stable, because it represents higher degree of abstraction, generalisation of processes and states in reality. It links to terms definitions, categorization, defining and deriving conclusions from available facts. Knowledge is final complex information with a hint of its practical usage. Knowledge has the complexity of experience, which come about by seeing it from different perspectives. **This is why training and education is difficult – one cannot count on one person's knowledge transferring to another. Knowledge is built from scratch by the learner through experience.** Information is static, but knowledge is dynamic as it lives within us. (Example: If the humidity is very high and the temperature drops substantially the atmospheres is often unlikely to be able to hold the moisture so it rains.)

Knowledge together with human's ability to apply experience, to understand the principles and boundaries, with the ability to learn from the past gives us a specific expertise - ability to solve problems on high, expert level sometimes referred to as **wisdom**. Wisdom is the ultimate level of understanding. As with knowledge, wisdom operates within us. We can share our experiences that create the building blocks for wisdom; however, it needs to be communicated with even more understanding of the personal contexts of our audience than with knowledge sharing. (Example: It rains because it rains. And this encompasses an understanding of all the interactions that happen between raining, evaporation, air currents, temperature gradients, changes, and raining.)

Data and information deal with the past. They are based on the gathering of facts and adding context. Knowledge deals with the present. However, when we gain wisdom, we start dealing with the future as we are able to vision and design for what will be, rather than for what is or was. Fig. 1 shows view of the Data, Information, Knowledge, and Wisdom (DIKW) hierarchy.

We also deal with abilities and competencies of our students. **Abilities** are general human capacities related to the performance of task. They develop over time through the interaction of heredity and experience, and are long lasting. (DeSimone, Werner, 2012) The main difference between a competency and ability is that **competencies** require continuing

education opportunities to maintain and they may disappear over time if not used. Abilities may also grow over the time, but they are normally relative permanent. Abilities are fairly stable traits, which in the adult, will not change very much unless the individual is subjected to some unusual environmental change. (Fleishman, 1962)

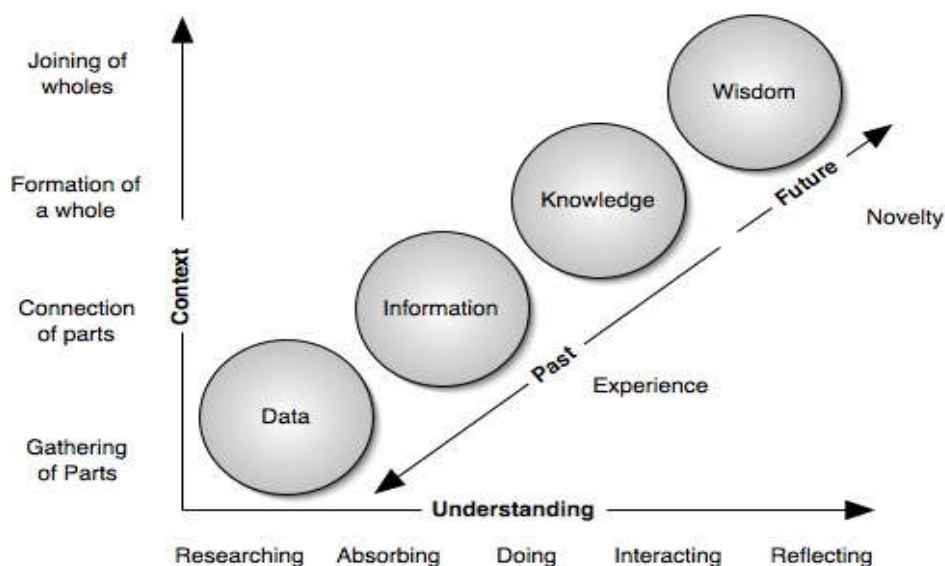


Fig. 1: DIKW hierarchy, source (Clark, 2004)

Real state of students' knowledge base

Our effort is focused on designing a modern education system for future advanced users in an area of “understanding and using informatics knowledge and ICT”. This means to provide education in accordance of demands of practice, on current knowledge basis of our students – graduates of secondary schools. The important queries of our research are: What is the students' knowledge base gained during their past education in the field of computer science/informatics? How can they use their information and skills?

In this paper we present part of our findings only in the field of information systems which are considered very important today. As the first step we did a content analysis of a textbook of the obligatory subject Informatics at secondary schools (Kalaš et al, 2001). We observed the occurrence of concepts: system and information system, examples of types of information systems. The occurrence of these terms is as follows:

- System: it occurs frequently in many different contexts in the textbook;
- Information system (IS): it occurs (explicitly) on pages. 16, 24, 25, 30, 38, 73, 84, 86, 91, 92, 95, 97, 98, 100, 108;
- Types of IS: (indirectly by examples) on pages 8, 93, 94, 95, 97, 98;

Strong connection with the term IS we found in the chapter "Information around us", and "Information in a computer". On the page 24 we found a text about "various essential tools that enable us to collect, store, process and distribute information better and faster." Also section "To repeat", which states "Computer programs and new technologies help us to acquire, process, store and disseminate information" essentially talks about IS.

Chapter "How do we keep and share information" is on page 27 and there is shown the knowledge associated with the modern electronic IS, although not named explicitly as knowledge of IS. The "Information and data. Data and files, " on page 38, describes the work

with information and data in the reservation systems. It tries to explain the difference between data and information, which we consider crucial for the teaching of the IS.

Direct mention of IS is in chapter "Software" on page 84. More detailed text about IS is in subsection entitled "Information systems". Information technologies that enable storage, transmission and processing of information, are considered to be most important today.

The economic point of view, access and work with economic IS and its components can be found on page 92. The office electronic system is described on page 93 in the "Computers and employment. Family. Handicapped". The whole part of "Trade, Finance and Industry," on page 95 explains the operation of IS in various fields and also mentions the link between different IS and the possibility of using these links. Equally significant direct and indirect IS descriptions are represented in the "Transport" and "Health", pages 97 and 98. In the "Computers in society", page 100, the attention is directly targeted on IS. The entire section describe the use of IS indirectly - the population register, census, taxation, military IS, etc.

An evaluation of students' abilities and competencies to use their information for transforming them to knowledge we consider to be a very important step in determining the content and method of our effective teaching at the university. That is why in the first seminar (in subject called Informatics I) students – secondary school graduates, fill in questionnaires which are focused on their general knowledge of informatics/computer science and their real problem solving skills.

In the field of IS we wanted students to solve the following problem: Define/describe (in text or graphically) user requirements for a simple information system (IS) in a little DVD rental where we want to install new and effective electronic IS based on modern ICT instead of "old-styled paper" IS.

We divided students' solutions of this problem according to their quality into following five levels:

- A – acceptable; it was possible to recognize functions and requirements of IS, there were structure and hierarchy between requirements;
- B – mostly continuous text with effort to design web site or database tables; partly incomplete;
- C – extensive continuous text with typical lack of exactness, structure, relationships; extent from ½ sheet to 2 sheets;
- D – text in extent from few lines to ½ of sheet; totally unsatisfactory;
- E – no elaboration; most of these students said: "I don't know what to write."

In Fig. 2 we present evaluation of students' solutions in the period 2003 - 2013 with participation of 1755 students.

Next tasks were: Characterize, define/describe by your own words what does the next concept mean in general: system and information system.

In evaluation of these tasks we divided students' answers according to their quality into the levels: satisfactory, partial and unsatisfactory. In case "system" we monitored an appearance of two basics components – elements and relations in the system. In the case "IS" we considered a satisfactory answer to be one which enumerates at least three functions of IS (collection, saving, processing, analysis, presenting, information provision).

Fig. 3 and Fig. 4 represent evaluation of 1608 students' answers in the period 2004 – 2013.

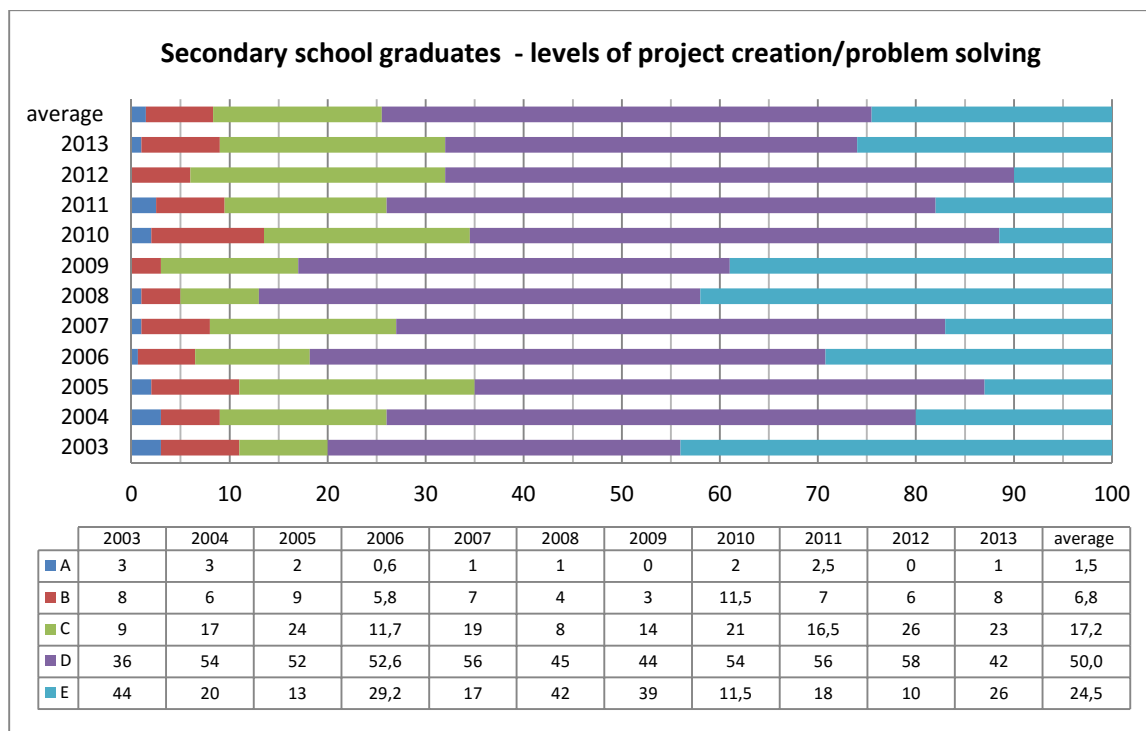


Fig. 2: Evaluation of students' solutions of user requirements description in percentage, source own

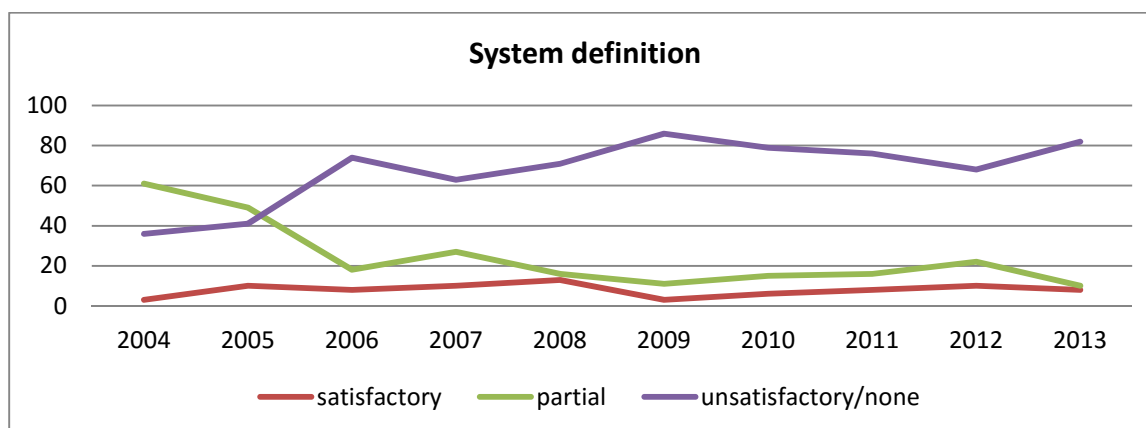


Fig. 3: Evaluation of students' answers – system definition in percentage, source own

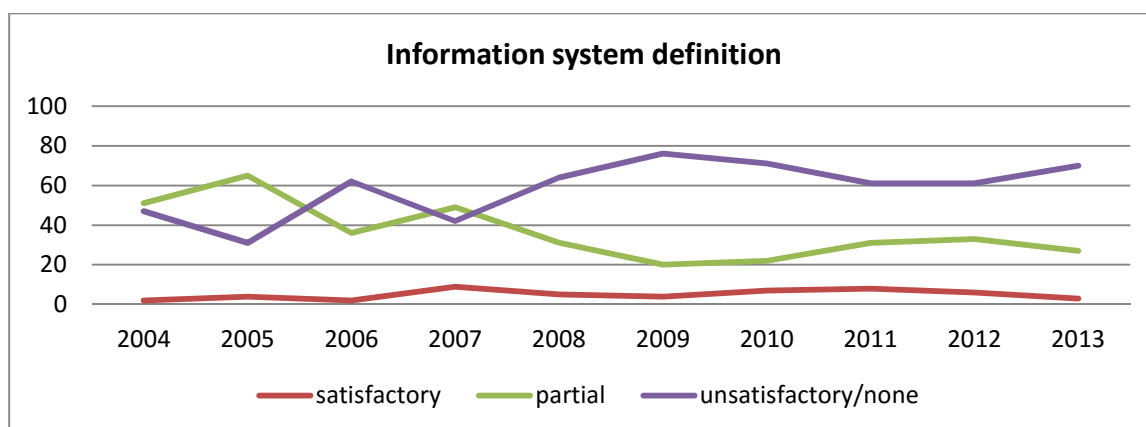


Fig. 4: Evaluation of students' answers – system definition in percentage, source own

Project-based education to support transformation information

From our annual analysis of students' knowledge level we have decided for a concept of education in two parallel levels. The first, considering big differences in knowledge and skills of secondary school graduates oblige us to keep the classic procedure in teaching the Informatics subjects. In structure very similar to ECDL standard students can learn basic terms used in the field of informatics, how to work in text editor environment, spread sheets, presentation software, database systems, and various web-services.

The second, parallel level, where the key theme is IS and effective using and implementation of ICT in the relation with modelling of the business processes. As a dominant method of teaching in this area we use problem-based education based on following sequence of activities and recommended structure of students' projects. The guiding principle behind project-based learning is to learn by doing. Real-world problems capture students' interest and provoke critical thinking as they acquire and apply new knowledge in relevant contexts.

Sequence of activities:

- Reasoning, motivation ... IS and processes around us; discussion, examples, pointing out their growing importance.
- Description of experience with IS. How does it work? Real IS used, pros, cons, benefits, risks, what is convenient, what does not work, what should have change ...
- Getting basic information, examples; we created two studying materials: Information systems for economists and Basics of business process modelling.
- Choosing theme of project. What are you interested in. Think, observe, criticize, summarize the current state, consider how to do it better.
- Feedback on the choice of topic of the project.
- Familiarize with best methods, project structures, and possibilities of modelling and description.
- Consult the parts of the project.
- Analyze the selected process and the related IS, consider who, when, why; what is difficult to divide into pieces, select only relevant information, and model in understandable way.
- Communicate, ask, consider possibilities, incorporate thoughts, ideas, use modern ICTs.
- Provide feedback.
- Formulate your thoughts, ideas, expressed them in a clear and transparent way.
- Present your solutions and suggestions, think about what you are saying.

Structure of user requirements project: Formulate user requirements for small IS. In the real process of IS development these requirements would be discussed with experts on the analysis of IS.

Part I: Describe in a text form characteristics and express in graphical form the essential process/ processes in the system, which will be described. Use the notation identical/similar to standards ARIS. For a description of the life cycle of the object/objects you can use a suitable UML diagram.

Part II: Name IS, formulate the problem, briefly describe the essential objectives (what, why), define the system users (who, when, how), list the most important parts and functions of the IS, find relationship with the existing systems and the requirements for the infrastructure (hardware, basic software, LAN ...), describe methodology of development, security and reliability of IS (data protection, security, ...), set deadlines and costs, explain the

IS implementation process (in parts, prototyping, trial operation, ...), describe requirements for documentation and training, perspectives of IS, IS development and maintenance.

Part III: Specify requirements for system functionality by use case diagrams: a list and brief description of the actors, a list and brief description of the use cases, scenarios for the use cases, Use Case diagram.

Part IV: Specify the basic classes of objects appearing in the description of IS. Describe the attributes of these classes of objects suitable for creating relational database tables.

Students are initiated by the sequence of activities to construct their own knowledge bases by transforming information to knowledge in the field of IS modelling and application of ICT.

The described project based education has been used in practise with some minor changes for more than ten years. Students perceive positively the practicality of the projects, high level of independence at solving the problems, opportunities to use e-learning, availability of studying materials and tasks 24/7 via LMS Moodle.

Conclusion

By our teaching method we are trying to support the development of intellectual and human capital, which in contemporary organizations operates at four levels (ordered by increasing importance) according to (Brnjas, Culahovic, 2009, p. 329):

1. Cognitive knowledge, or know what: This is the basic mastery of the discipline. It is essential but insufficient for commercial success.
2. Advanced skills, or know how: This is the translation of book learning into effective execution.
3. System understanding, or know why: This is knowledge of the cause-and-effect relationship underlying a discipline.
4. Self-motivated creativity, or care-why: This is the will, motivation, and adaptability needed for success. Creative and motivated groups outperform groups with greater financial or physical resources.

The proposed sequence of activities in our project-based education is consistent with the learning stages of cognitive process, according to (Linhart, 1986):

- motivation - an explanation of what IS means currently, the possibility to create something new, use previously acquired knowledge and present own solutions;
- creation of separate models (acquiring practical experience) - analysis of a complex problem, decomposition in to sub problems, try to understand reality;
- creation of a universal model (generalization of experience, abstraction) - the need for a holistic view - links between parts of the project, the synthesis of partial solutions into a functional unit;
- creation of knowledge - learning-by-doing.

Knowledge is the main engine of the future economic growth. Ability to create, expand and exploit the knowledge becomes more important and is often considered to be the crucial factor that determines (not only) economic growth, improvement of the quality of life and for social progress.

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ICT TEACHERS AND SOCIAL NETWORK SITES

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Abstract

The article looks at primary and secondary ICT teachers' attitude to social network sites and self-presentation on the Internet. Attention is devoted to student-teacher friendships within online network sites. The study includes a description of specific habits as well as a discussion of how teachers make decisions and what influences them.

Research has focused on ICT teachers with differing views on the issue in question, carrying out in-depth semi-structured interviews. Our investigations have been supported by triangulation, which involved accessing information about given teachers on social network sites. Data gained from interviews and triangulation has been processed using open coding.

Keywords

Social network sites, Facebook, ICT teachers, e-safety, routines, privacy, open coding.

Introduction

One of the current ICT issues is the protection of user privacy, particularly on social network sites (abbreviated SNS). The main emphasis is placed on children and youngsters, and their behaviour on SNS has been the subject of a number of studies such as (Hinduja and Patchin, 2008) and (Ofcom, 2011). A

s stated by Kapoun, Kapounová and Javorčík (2011), most young people use their computer on a daily basis as a means of communication. However, due to their lack of experience, knowledge and ability to cope with certain situations, they are relatively prone to threat (OECD, 2011). One example quoted by the OECD (2011) is that children often wrongly suppose that personal information posted online will not go any further than where it was sent.

Being the closest, parents should be approached when children need to ask for advice. However, they are often only familiar with the ICT they use at work (Kapoun, Kapounová and Javorčík, 2011) and feel unequipped to help children in the digital world (Byron, 2008). Ofcom (2011) has revealed that two thirds of parents believe that their children, aged 12 to 15, have a better knowledge of the Internet than they do. As children and young people need to be encouraged to stay safe (Byron, 2008), the role of the school needs to be prioritized. Becta (2005; 2007) claims that schools ought to take most responsibility for leading pupils to critical thinking and suitable behaviour that will protect them from the risks associated with internet use.

Social network sites in the school environment

A widespread trend in a number of schools is the regulation of pupils' use of the Internet, where they might block unsuitable websites and SNS (Sharples et al., 2009). However, as

suggested by Valcke et al. (2007), such interventions will not develop pupils' e-safety skills. The Federal Communication Commission (2012) is of the opinion that SNS do not need to be blocked but rather pupils need to be guided to use these technologies suitably. Moreover, SNS sites are considered by some researchers as education-friendly technologies (Maranto and Barton, 2010).

The teachers' personality has proved to be important as he should set his pupils examples in terms of privacy protection (Buettner et al., 2002). However, a number of teachers lack personal experience in terms of e-safety, not having gained enough background knowledge – indeed they have never personally formed online relationships themselves (Chou and Peng, 2011). Phippen (2011) found that about three fifths of teachers use Facebook, about a third of teachers use Skype and approximately one seventh of teachers use Twitter.

The risks of teachers' presence on social network sites

Teachers' use of SNS is a highly controversial issue and teachers are increasingly required not to be present on SNS like Facebook or MySpace (Simpson, 2008). There have been cases of teachers being dismissed because of their inappropriate behaviour on SNS and possible unprofessional contact with pupils (Simpson, 2008).

Although two thirds of teachers worldwide consider friendship with pupils on SNS risky, around one third of teachers worldwide have friendships with their pupils on SNS (Symantec Corporation, 2011). Teachers may become victims of abuse in the online environment, and Phippen (2011) claims that around a third of teachers or their colleagues have experienced this. Pupils were involved in two thirds of the attacks, their parents in one fifth and other staff in one in ten cases (Phippen, 2011). Sharples et al. (2009) claims that negative experiences caused by students using Web 2.0 were frequently encountered by one in twenty teachers, occasionally by one in five teachers and rarely by a quarter of teachers.

A study of ICT teachers' use of social network sites

Given the above mentioned findings, we decided to carry out a study focused on ICT teachers' use of SNS. Its aims are as follows:

- To map the use of SNS by ICT teachers
- To analyse teachers' reasons for using or not using these technologies
- To clarify what causes teachers to make friends with their pupils or why they reject such practice

Methods

The study was carried out at the same time as our research on knowledge and routines of ICT teachers in the area of technical e-safety (Šimandl, 2015), therefore the sample of study participants and used research methods are similar. The study was designed and carried out as qualitative. Participants chosen for the study were primary, lower secondary and high school teachers of Informatics, Information and Communication Technologies, ICT and other similar subjects. The study involved questioning 15 participants. These were chosen according to several factors – ICT teacher qualification, type of school (lower secondary or high school), length of service, size of towns teachers work in, age and gender.

Three study participants were chosen as qualified high school ICT teachers with relatively little experience in schools (approx. five years). Two participants were chosen as teachers teaching ICT for their first and third year but not qualified to do so, each with a very different approach to ICT self-study. Another two participants were chosen from trainees having completed lifelong education studies for ICT coordinators. Although neither of them is

a qualified ICT teacher, they have long-term experience of teaching ICT at high school, interest in the field and further education in it.

In order to include participants with experience at lower secondary schools in the study, two lower secondary school teachers were approached. They had already cooperated through short-term training programmes before. Both teachers taught in schools in smaller towns. Another participant was chosen due to his position as headmaster. Three teachers not qualified to teach ICT were added to the list of participants. For these three, there was no evidence of them having attended courses or training concerning ICT. These participants were chosen particularly on grounds of age, which ranged from around 35 to 65. The last study participant was selected for his enthusiasm towards SNS and pupil friendships in the online environment.

Data collection

Data collection involved individual meetings with each study participant. A semi-structured in-depth interview formed the basis of each meeting. Study participants were informed of the aims of the study and assured anonymity. They were subsequently requested to take part in the study and to agree to have their interview recorded on a voice recorder.

The triangulation concept was incorporated into data collection (Švaříček, 2007). Publically accessible information about the teacher's "virtual life" on the Internet was searched for, particularly on Facebook. Our focus of attention was placed on whether the teacher is registered on Facebook, what kind of information he presents there and whether he has friendships with his pupils. If we had been unable to find a particular teacher on Facebook before the interview itself and the teacher spoke of his activity on SNS during the interview, we made efforts to find him on Facebook subsequently.

Data analysis

Analysis of acquired data was based on the open coding method. The analysed text was divided into units and these units were allocated a certain code that represents a certain type of reply and differentiates it from the others (Šed'ová, 2007). Codes from the generated list were subsequently grouped into categories according to internal similarity (Strauss and Corbin, 1999). The principle of constant comparison was included in the process of overall analysis (Šed'ová, 2007). The aim of this comparison was to find differences within data sources relating to one study participant and within data concerning various participants.

Results

Analysis of the interviews identified several categories related to teachers' attitude to SNS sites (especially Facebook and Google+), maintenance of their privacy and how they are shaped. The most important categories are Specific protection routines on SNS and Causes of behaviour on SNS. There were also some other categories discovered during the study, some of them having been described in (Šimandl, 2015). The following text goes on to describe the individual categories mentioned above.

Specific protection routines on SNS

The category Specific protection routines on SNS concerns specific ways and to what extent ICT teachers use SNS, how they protect their privacy and whether they make friends with their pupils.

The extent ICT teachers use SNS. The teachers greatly differ as to the extent they use SNS. While some claim not to use SNS, others use SNS occasionally and another group use them often (as illustrated in Case study 1). There are also differences in the ways they use SNS.

Whereas some only use them for communicating via chat and possibly receiving information, others actively create content to be seen by others.

***Case study 1.** Having previously found out that one of the teachers used social network sites quite often, we looked at his Facebook profile. We discovered that 55 statuses had been placed in his profile in the last three months (not including possible comments under the status). Some of them were initiated by the teacher in question while others were posted on his wall by his friends.*

Although most teachers addressed by us use SNS for personal reasons, we did meet a teacher who sees his SNS profile as a work-hobby one and claims to not publish any personal information. Apart from that, some teachers use alternative SNS, which help them with their hobby (for example, the travel site Couchsurfing.com).

Privacy. Teachers usually try to protect their privacy on SNS. Some decided not to publish information about their private life via statuses, not even for their circle of friends. This is illustrated in the following citation: *“If I want people to know my current status, I tell them in person or I call them. Or I send a text message. Or I write it in a chat message. But I don’t have to post it on the wall”*. However, some of these teachers are willing to publish information which they regard as not being of a personal nature on SNS: *“I don’t see anything wrong in that, because I think that’s information which, if someone asked me, I would definitely tell him”*.

***Case study 2.** An interesting approach was encountered here - publishing messages on SNS in the form of allegories. As the teacher in question stated, although these messages can be seen by all friends, only close friends should be able to determine their real sense. People who the teacher does not keep in close contact with (the teacher’s pupils in this case) can only understand such a message at a superficial level and privacy is preserved.*

Other teachers do not object to publishing private information, but they do insist on such information being carefully selected and rights for chosen people being strictly set – an example being one of the teachers’ statements: *“You can show them what’s new but I would also insist on everything being as it should so that no stranger can see it, so that no one can get to it”*. Let us add that we have even encountered an example of a teacher who does not worry much about publishing information from his private life in his circle of friends on SNS: *“Sometimes I boast with my current status, when I get really angry and want to scream out loud to the world. Or with my status in the morning, if it is funny”*.

***Case study 3.** During our investigation we found a business card photograph in one of the teachers’ Facebook profile accessible to the public. The photograph portrayed the teacher in question with his dog and his car was standing in the background with a clearly visible registration number. Apart from the teacher’s full name, his address and mobile phone number had been inserted into the photograph. Other photographs also contained information about the teacher’s private life (his interest in cycling, ownership of a certain breed of dog, and car registration number). Having expressed during the interview that he protected his privacy, we confronted this teacher with the above mentioned findings. The teacher was surprised, explaining that access options for the photos must have been wrongly set and claiming that he knew nothing of the problem (the photographs had been posted on his profile for around two years). After being informed, he removed the business card photograph from his profile.*

Handling photographs. Teachers have differing perceptions of the publishing of photographs on SNS. Some of them refuse to publish photos in their profile whilst others do not

disapprove of publishing photos for their circle of friends. Some consider the Facebook option of labelling a certain person in a photo as risky in terms of privacy, because such photographs are made accessible to friends of the labelled person.

***Case study 4.** During our study, we encountered a teacher who posts photos of himself enjoying parties with friends. On being asked how he perceives these photos, he replied: “A photo of me holding a drink somewhere with someone doesn’t matter. But if it were a photo which could damage my private or work reputation way, then that would really get me”.*

Pupil friendships. The issue of pupil friendships on SNS is a current and sometimes controversial one for a number of teachers, but there are great differences in teacher behaviour. While some teachers strongly reject pupil friendships, others do not see the problem with such behaviour or do actually enter into friendships with their pupils under certain conditions. The most common requirement is not to reveal one’s private life to pupils. To achieve this aim, he might make efforts not to open up his private life (as discussed above) or to separate his virtual friends into certain groups with restricted access to each group’s posts. During our study, we encountered a teacher who opens up his private life to his pupils on SNS, as documented by Case study 5.

***Case study 5.** During our study, we encountered a teacher who enters into Facebook friendships with his pupils, adding posts of a personal nature too (see Case study 4). He claims not to have changed his behaviour on Facebook because of his pupils. On being asked how pupils reacted to these posts, he replied: “The statuses were (for them) attractive and they accepted it no worry, making fun of it, making light of it, so it didn’t go any further, as far as school is concerned and so on, it was just between us. Or, should I say, those who had seen it all. (...)”.*

A number of teachers become friends with their former pupils via SNS, as documented by the following citation: “*I have a rule where I wouldn’t add the person concerned if he were my student, but as soon as he ceased to be my student and he requested friendship, I would add him*”.

Causes of behaviour on SNS

The Causes of behaviour on SNS category looks at the circumstances which influence teachers’ decision making as regards whether and how to use SNS. This particularly concerns the benefits and risks of using SNS in the teacher’s personal life, the possibilities of including SNS in their teaching and the teacher’s approach.

Benefits of using SNS. One of the reasons for teachers using SNS is the possibility of private communication, particularly with friends or relatives. SNS enable teachers to gain information about people who they are not in contact with: “*If I haven’t heard from someone for a long time, I have a look at his profile to see if he’s written anything interesting about himself*”. This approach is used by some teachers to find out about their former pupils: “*I know where they (my former pupils) are and if they have children, I know what their kids look like and that kind of thing. It’s like a never-ending reunion. (...)*”. Let’s not forget that teachers also use SNS as a source of entertainment or interesting information: “*I often get involved like in discussions like around here and that sort of thing. Cause people publish interesting materials there (...)*”.

Risks of using SNS. Some of the teachers (without regard to whether they use SNS) worry about the security risks associated with using SNS. These include the risk of insecure data protection from intruders (from other users and hackers), the risk of identity theft or the use of fictive identities. Teachers are also concerned about the abuse of published data: “*I think you*

have to accept the risk of having any of the information you post used against you.” and about their privacy: “I don’t want strangers to look into my private life (...) I might have some kind of phobia but I don’t want just anyone to be able to find me and see what I look like, what my name is, where I live or what my house looks like. I simply don’t want that”. The above mentioned fears are multiplied due to the teacher’s position and some teachers are anxious about their pupils accessing their private content: “I think they (pupils) could get to it (my private photos). Because I wouldn’t post it there but a friend of my friend and his friend might”.

Scepticism towards SNS. Teachers who do not use SNS argue that they are not really interested in this service: “I don’t need to present myself on the Internet. If somebody needs to, why not...”. Some teachers are extremely sceptical towards SNS, though, arguing that so much time can be wasted on them: “The point is these kids spend so much time on Facebook ... I think it’s a waste and if I think it’s a waste, I won’t be using it”. We also recorded opinions on SNS criticizing their impersonal nature, superficial communication, lack of cooperation and the spreading of untruth and rumours among users. One teacher remarked: “I don’t think these social network sites actually meet up to what they were originally set out for, for cooperation. If you have a look at these social network sites, what’s going on there, they (users) are just chatting there (...)”.

Including SNS in teaching. Teachers have great differences of opinion on the use of SNS in the classroom. Some of them don’t expect to use SNS in the classroom: “As a teacher, I see my students every week, so I don’t need it (a social network site)”. Others regard SNS as a communication tool, enabling them to be accessed by their pupils: “(Pupils) asked me about something like regarding a test, that they’re writing a test after the weekend, so they asked for details (...)” or “It mainly served for kind of communication, like a note from a pupil saying he’s going to be absent tomorrow (...)”.

Teacher’s approach. To ensure professionalism, teachers adapt their behaviour on SNS (particularly with regard to teachers adding pupils as friends). Some teachers try to keep a certain distance from pupils in fear of losing authority: “If a student sees those photos of yours there or if he can comment on something about you, then let’s say that gap kind of disappears, it’s completely wiped out.” or in an effort to keep work and private life separate: “I don’t think I need to chat with them in my free time. My job is to teach here, so I teach, but it’s still only a job (...)”. We have recorded a contrasting opinion, though, where the teacher tried to become as close as possible with his pupils via SNS: “I like talking to them (to pupils), I want to find out how today’s teenagers behave, how they think. So (I try) to get in among them. It’s my kind of teacher strategy”.

Conclusion

Our study has led us to discover how teachers behave in a social network site environment and what motives there are for that behaviour. Teachers particularly appreciate SNS because of the possibility to communicate and stay in touch with people they know, including former pupils. Teachers are concerned about the risks associated with using SNS, particularly security risks and risks involving privacy, and they feel even more at threat due to their occupation. Some teachers decided not to reject friendships with their pupils for pedagogical reasons, SNS serving as a channel of communication to support teaching and learning. Our study has found that teacher-pupil friendships within SNS do not necessarily mean teachers inappropriately reveal their private lives – some teachers use their profile as a work one or at least do not present any personal information.

Future research will need to focus on teachers' behaviour regarding the issue of protection of privacy in the virtual environment and outside SNS, i.e. areas such as using photo galleries or giving personal data in online registrations.

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TEACHING ENGLISH PRONUNCIATION IN THE CLASSROOM USING ICT AND MOBILE TOUCH TECHNOLOGIES

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Abstract

Teaching and correcting English pronunciation is often at the periphery of teachers' interest in the Czech Republic. Not only it is usually not considered of the greatest importance but the teachers often lack the skills and self-confidence to actively and effectively correct pronunciation mistakes during regular lessons. However, there are several ICT tools capable of analysing and correcting the pronunciation mistakes in a very objective way. During one school year three different devices and methods of correcting pronunciation mistakes applying ICT are exploited, namely a dictaphone, a computer and a tablet in a grammar school English class of B1 level students. We monitored their responses, the impact on the flow of the lesson and its atmosphere as well as the students' motivation. In this article, the outcomes of this process and proposal of a new approach to methodology for teaching pronunciation and correcting pronunciation mistakes are presented.

Keywords

Pronunciation, feedback, tablet, ICT, iPad, mistake correction

Introduction

It has been almost a tradition in standard Czech schools to see the English pronunciation skills as one of the least important. The pronunciation skills of Czech teachers are often poor and according to a recent paper, this can even demotivate students (Toni Lai). Naturally, this was partly influenced by historical factors, as during the communist regime there were only limited opportunities to come in contact with the real English language and native speakers and teachers thus focused on grammar drill. Even though the generation of English teachers who studied in the last quarter of the 20th century is gradually leaving Czech schools, it takes longer than one generation to change this approach. Let us take the Framework Educational Programme for Secondary Schools as an example (Framework).

When we take a closer look at the expected outcomes described in the Productive Language Skills section of the Foreign Language chapter (Framework, 16), little is written about the phonetic aspect of the language. The requirements of correct pronunciation and intonation are merely implied by the following points:

- to formulate his/her opinion in such a way that **he/she is understood**, using correct grammar, spontaneously and **coherently**;
- to reproduce freely and **coherently** an authentic text with vocabulary and language structures characteristic of a rather demanding text which he/she has read or listened to;
- to present a **coherent** speech on an assigned topic (Framework, 16).

As we can see, only the general terms such as “coherently” and “in such a way that he/she is understood” are used in the document but e.g. the correct use of grammar, however, is mentioned explicitly, as :

- to receive information of a rather complex content with a good degree of comprehension and be able to convey it in such a way that he/she is understood **while using grammar correctly**. (Framework, 17)

The above mentioned little stress put on the adequate pronunciation skills is reflected in the teaching process and in common lessons taught by native Czech teachers of English. It would be foolish to see the only reason for this in the way the Framework Educational Programme is written. Reflecting the experience of a former language school and secondary school deputy headmaster and as a secondary school headmaster we have had the chance to monitor and evaluate lessons of approximately 30 teachers, as well as from the point of a person responsible for English teacher training internships the language skills of almost 100 university students – future English teachers were evaluated. Two general outcomes were detected in this process.

- a. Numerous native Czech teachers of English either lack proper pronunciation and intonation skills, or they lack self-confidence in terms of this aspect of language.
- b. Majority of native Czech teachers of English omit teaching pronunciation skills as an integral part of language acquisition and often do not even correct pronunciation mistakes in the lesson. The reason for this might be partly found in the point a.

As a consequence, we decided to test various methods of teaching pronunciation in lessons which are generally focused on all productive language skills. Our task was not to test whether there would be an improvement in students' pronunciation, as there are already studies showing positive results (Neri). The objective was to find a tool which would enable teachers of English to correct pronunciation mistakes in the same way and with the same stress as vocabulary, grammar or syntax mistakes without influencing the flow of the lesson. At the same time, we tried to minimize mistakes caused by my own pronunciation imperfections.

Choosing the proper tools

There definitely exist ICT tools suitable for teaching pronunciation. Their use, however, is mostly time consuming and it is very difficult to implement them in regular lessons which are not strictly focused on pronunciation skills. They are mostly language labs where students wear headphones and practice speaking model sentences. The effective pronunciation training, however, requires an immediate analysis and response of any spoken text. If a student makes a mistake, the mistake should be corrected immediately and the student should try to pronounce the word correctly.

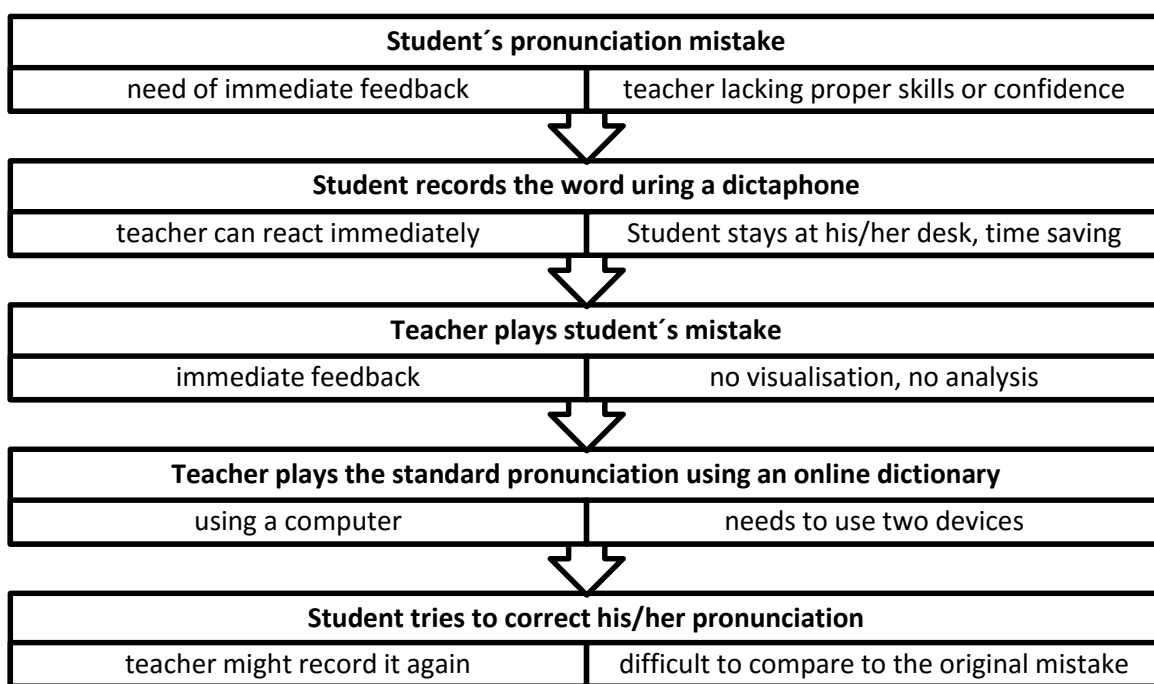
This can be naturally done by the teacher who simply corrects the student and ask him/her to repeat the word. Regarding what we said about the pronunciation skills of many Czech English language teachers, this might not be the best solution. Their pronunciation could be wrong or imperfect. If this is the case, not only could the students learn the wrong sounds, but they also might lose their motivation to improve their pronunciation.

Teachers are often aware of their own imperfect or even insufficient pronunciation skills. As a consequence, they do not practice pronunciation with their students, they do not correct their mistakes and again, the students might get the impression that pronunciation is not important.

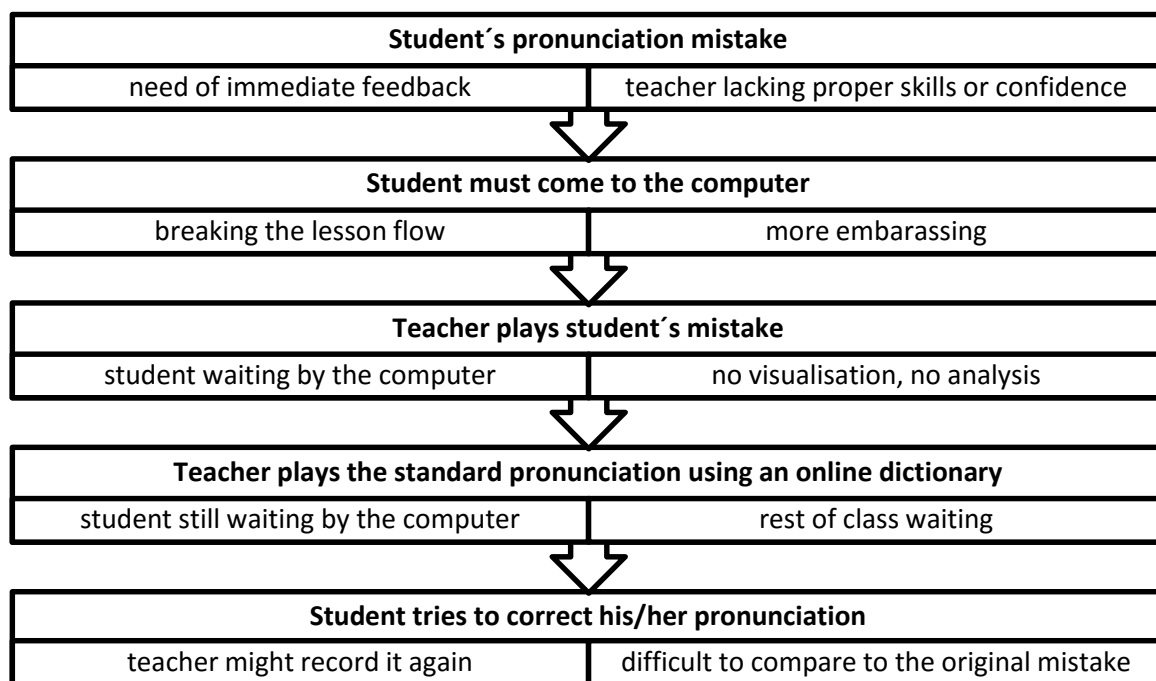
Following tools consider the fact that to work on student's pronunciation skills in the most effective and natural way we need the following:

- a. to be able to give the student an immediate feedback concerning his/her mistake or improvement;
- b. to be able to analyse student's pronunciation in an objective way immediately;
- c. to be able to compare student's pronunciation to the standard one immediately;
- d. to be able to analyse individual sounds;
- e. to show the student when he/she made an improvement.

To meet the above mentioned requirements, we obviously need a tool to record students' voice. This can be done by almost any recording tool, such as an old school tape recorder or a dictaphone (digital or analogue). These tools are limited to recording the student and playing his/her performance and thus provide the needed feedback. As we still need to provide students with the correct (standard) pronunciation, we would need another device. The easiest and most accessible tool would probably be an online dictionary with the voice option. Of course, the computer could be also used as a recording device (using a plugged in microphone), meaning we would not need a dictaphone. In such a case, however, we would need the student to come to the computer, which slows down the whole feedback process. Let's illustrate the process on a simple algorithm.



In case we use a computer as a recording device and for playing the standard version the algorithm changes slightly:



As you can see, such a way of correcting a pronunciation mistake might easily break the flow of the lesson and thus many teachers would see it as ineffective. Concerning our criteria, if applying this method we still would not get any objective analysis nor visualisation.

With the spread of mobile touch technologies, new applications appeared which can bring the desired effect. Special tools were for example created to test the potential impact of two distinct visualization styles for the learning of English pronunciation with the results recently published (DIBRA). As there are quite a few of them, below one of them was selected as an example of the workflow.

The application we have chosen allows the teacher to type any English word and then play its correct pronunciation. It is then possible to record your pronunciation just by tapping the microphone button. The application analyses the recording, divides it into individual sounds and compares them and the whole to the original. You can record the word again anytime just by tapping the microphone button again and get a new analysis and comparison. If the tablet/phone is connected to a proper visualisation and audio device, this process can be followed by the whole class.

Having a look at the process step by step, we can see it is structured into several steps. Based on a really good example from real class, the word “course” was selected to present the above mentioned. One student (B1 level) mispronounced the word in his presentation confusing the word “course” [ko:s] with the word “curse” [kə:s]. When corrected, however he could not realise that the difference was made by just one sound [o:] vs. [ə:]. By using the application running on a iPad mini to analyse his pronunciation, he was provided with following screenshots to demonstrate the process.

1. The word COURSE was taped in the app. The play button on the left plays the standardized pronunciation, the microphone button allows you to record your own.

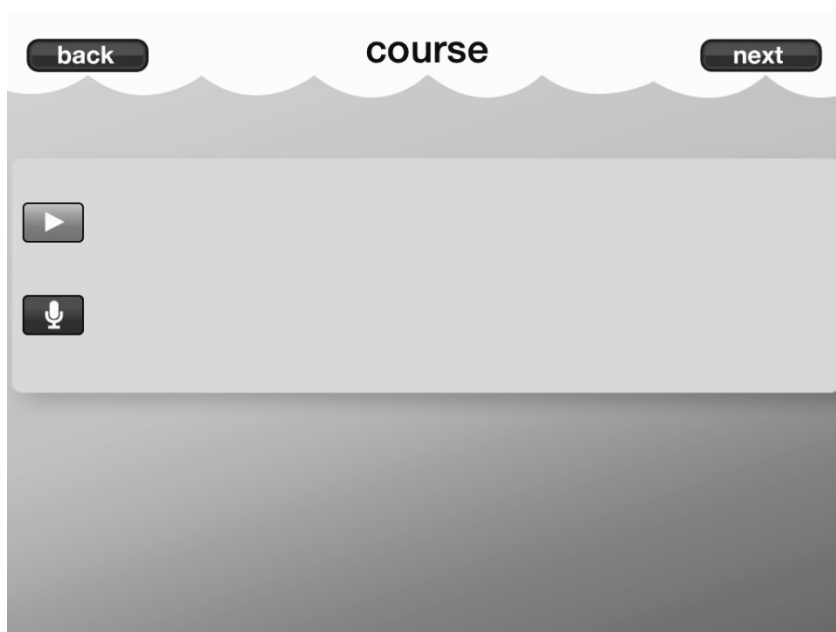


Fig. 1: Home screen of the app with the word typed in the top

2. The student was handed the iPad(the student did not have to move from his desk) and recorded the word written at the top with the mistake he kept making. You can see the word analysed in the bottom right part. The “A” marks a perfectly pronounced sound, while the “D” marks a completely wrong pronunciation. The scale ranges from “A” to “D” and of course, some sounds can be just slightly wrong meaning you would get a “B” as at school.

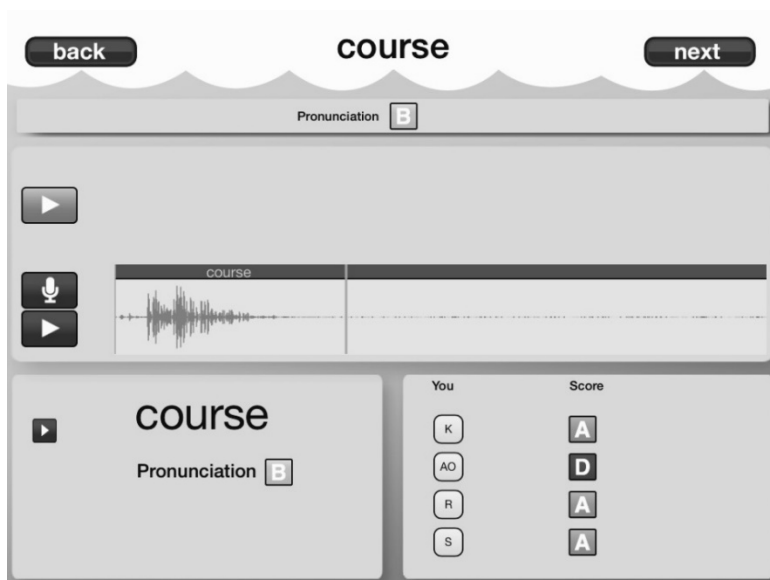


Fig. 2: The word analysis with the AO sound pronounced wrong

As it was mentioned above, the student confused the word “course” [ko:s] with the word “curse” [kə:s] which differ in a single sound (marked as AO in the picture). Thanks to the visualisation the student finally understood the difference. The teacher was able to play the

original and his recording several times by just tapping the play buttons and thus make him hear the mistake he was making.

3. The student recorded the word several times again and again, until he managed to get the optimal result as seen in the following picture.

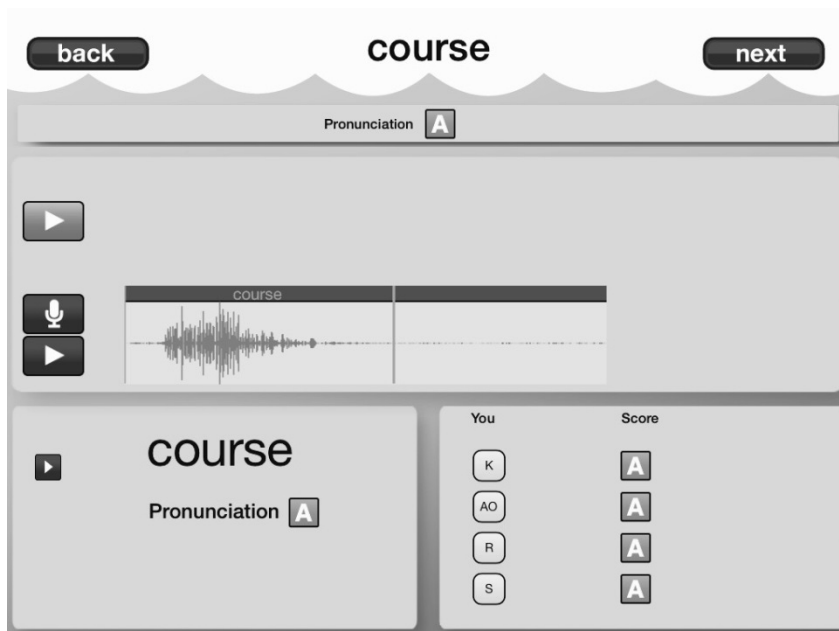


Fig. 3: Word analysis with the word pronounced perfectly

The whole process of pronunciation mistake correction took about 2 minutes and did not break the flow of the lesson very much as the student could stay at his desk and the other students could follow his performance on the screen.

Moreover, there was another outcome. As we have mentioned, the motivation to practice pronunciation is generally very low, both in case of a teacher and the students. The event happened during the first of a double lesson which was divided in two by a 15-minute break. As this class was taught in the one to one format (every student had his or her tablet to use), 12 out of 15 of them did not leave the classroom and spend the whole break practicing the pronunciation of various words, including some swearwords, of course.

Conclusion

The above described application is capable of analysing not only individual words but also phrases and whole sentences comparing even the rhythm of the whole clause. There are model sentences according to the topic or you can enter your own. However, its greatest advantage in the above described process of giving the students an immediate feedback in the classroom. Also, there are other applications able to analyse your pronunciation and compare it with the original. This work is not meant to be a review of any application, its goal was to compare the utilisation of a tablet/smartphone for pronunciation training with other digital or analogue means. The advantages described in this article do not merely come from the application but rather from the device itself as it can be used as a recording tool but also a tool for playing the correct pronunciation plus (using the right app) tool capable of analysing and comparing the pronounced text. The trainee does not have to leave his/her desk and the whole feedback and correction process takes only a couple of minutes, which allows the teacher to implement it in

any lesson activity. Pronunciation mistakes can be corrected during on the go even in the case when the teacher is not confident about his/her pronunciation skills or when the teacher simply does not have the required pronunciation skills.

Finally, we should not forget about the motivational aspect. Teaching and learning pronunciation has always been the boring part of language education and no tool capable of increasing the motivation of all participants should not be omitted.

Acknowledgement

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THE INQUIRY BASED APPROACH IN LEARNING OF MOBILE APPLICATIONS PROGRAMMING

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Abstract

In the paper we try to connect various modern aspects of didactics of informatics – the inquiry based approach to learning programming and science, development and using applications which are meaningful and useful in everyday life and new contents – programming mobile applications. In the first part of the paper we describe the methodology of teaching of mobile applications programming focused on creation of games, educational applications, simple useful applications, and inquiry based STEM (Science, Technology, Engineering, and Mathematics) applications. For better illustration we more describe life cycle of two STEM applications programming – data logger for the city traffic, pedometer or physical activities counter. At the end of the paper we give the ideas for mobile applications programming.

Keywords

Programming, Education, Inquiry-Based Learning, STEM, Mobile Applications, App Inventor

Introduction

Nowadays, mobile technology is widespread and is part of the lifestyle of young people. Thanks to their small size, additional sensors, multimedia and network communication support the mobile devices are exploitable in various fields of life, e.g. entertainment, work, commerce, arts, education. The propagation of mobile and touch technology in Slovakia greatly benefits from the projects “School on touch” (<http://akademia.edulab.sk/>) and “DigiSchool” (<http://www.digiskola.sk/>), which provide schools not only with the necessary technological infrastructure, software tools for support and management of learning, digital learning content for various subjects, but also organize training courses for teachers focused on using these technologies in education.

Mobile devices, e.g. tablets and smartphones, have a potential for development of useful applications by the pupils themselves, who also learn how to program and solve algorithmic problems. In our educational research, teaching at primary and secondary schools and also pre-service and in-service informatics teacher training we develop methodologies for inquiry-oriented teaching of programming of mobile applications ranging from the simplest ones to STEM (Science, Technology, Engineering, and Mathematics) projects.

In this paper we introduce methodological notes for teaching of programming of mobile applications in the MIT App Inventor 2 (abbreviated AI2). Using examples of two STEM projects we present the life cycle of mobile applications development contributing to the development of inquiry skills and deeper conceptual understanding of informatic and science concepts. At the end of the paper we present further ideas for STEM projects.

1 Methodology of teaching of mobile applications programming

We design a methodology of teaching of mobile application programming based on the Constructionist learning theory and inductive approach of teaching – the Inquiry-Based Learning (IBL). Constructionist learning theory claims that construction of knowledge is effective when a pupil is consciously and actively involved in a specific context and creates a product that is important not only for her/him but also for other people (KALAŠ, 2011).

IBL allows pupils to actively acquire knowledge, to understand concepts in depth, to develop their critical and logical thinking and inquiry skills – to identify a problem, formulate a hypothesis or theoretical model, design and conduct a scientific experiment, to collect, to organize and analyse data, to draw appropriate conclusions, to explain any unexpected results, report, present and defend the results obtained (WENNING, 2007). According to the amount of information provided by a teacher we distinguish four levels of inquiry – confirmation inquiry (questions, procedures and results are given), structured inquiry (questions and procedures are given), guided inquiry (only questions are given) and open inquiry (nothing is given, pupils act as real scientists) (BANCHI-BELL, 2008).

David Wolber recommends a *Build – Conceptualize – Customize – Create model* for teaching programming in AI2. After two-three iterations of the first three phases he recommends to carry out the fourth phase of the model, resulting in a creative product of pupil (WOLBER, 2015). Our approach to teaching programming AI2 (ŠNAJDER, 2015a) is inspired by David Wolber and has the following attributes:

- Pupils create programs solely for engaging and useful applications (e.g. games, teaching aids, assistants of sport activities, applications for the collection, visualization and evaluation of authentic data) using the specific functionalities of a mobile device. Such projects form a portfolio of pupil.
- In teaching of mobile applications programming at first there are introduced sensors and only later and gradually program constructions.
- Pupils follow worksheets in the process of an application development that contain elements of formative assessment, promote deeper conceptual understanding of knowledge and develop basic inquiry skills.
- Pupils create applications, whose basic versions can be programmed during one lesson and these application can be also extended, if necessary, to the STEM projects.
- Teachers are given methodologies related to worksheets, or training.

2 Programming of STEM applications

2.1 Using mobile devices in education

Data processing using spreadsheet is typical schoolwork. One of the problems, which a teacher has to solve, is what data they can offer to pupils. These are often fictional data, data taken over from other sources or just a small sample of data. Our aim is that pupils work with the original, real data. Pupils are thus addressing not only how to process data, but also how the data obtained. They often use electronic questionnaires (e.g. Google Documents, Facebook) or papery questionnaire when they collect data in the terrain. In the second case, it is difficult to rewrite all data to electronic form for further processing (prep time, error rate). One of the solutions is to use mobile devices, which are useful in the terrain and data can be stored directly in electronic form for further processing. Moreover, these devices have various sensors, so they can work as measuring instruments as well. The fact that the mobile device

will not be used just because we have it is also important. We use it because it is able to streamline our work.

2.2 Data logger for the city traffic

In the following text, we demonstrate how to use mobile devices for data collection. We chose one of the typical problems of traffic in the city – traffic density. It is an interesting ecological problem. The consequence of its solution can be a suggestion on how to speed up traffic in the city (change main and secondary roads, setting up traffic lights, etc.).

Pupils solve the typical STEM project consisting of two sub-problems:

1. Programmer problem: to create a mobile application for collecting data.
2. Scientific problem: to process data statistically (e.g. to verify the hypothesis, relationships, etc.), to find relationships between data, to design the improvement of the traffic in the city and so on.

Pupils do not have to solve both problems simultaneously. The creation of an application can be a task for older pupils in the programming theme. Learning can be particularly effective, due to the fact that pupils make something of value to others (constructionism). Younger pupils have used a prebuilt application and can focus solely on the data collection and processing. The text deals with the first part of the problem, creating mobile applications.

The solution includes a thorough analysis of the problem. Pupils ask themselves following questions during this analysis:

- What type of data is recorded and how to record data?
- Which data can be obtained automatically and which require the decision of man?
- What is the format of recorded data?
- Where will be the data stored?
- What functionality and interface should the application have?
- Which environment (language) will be used to create the application? (We assume AI2)
- Which previous decisions can we implement within the given environment? How to modify those we cannot implement?

Here are possible brief answers to some of the questions in the table below:

data	value	automatically / decision researcher
place of measuring	GPS receiver	automatically
time of measuring	system time	automatically
direction of car	in city, out of city	decision researcher
type of transport	passenger car, public transport or freight transport	decision researcher

Regarding the question, in what format, and where the data will be stored, pupils should explore the file formats with which the spreadsheet application can work, and Storage (category of components) possibilities in AI2. It is a suitable to choose, e.g. local file in CSV format (comma-separated values).

Pupils must consider a method of using the application when designing its interface. The user is working on a relatively small device with a touch screen and requires to record data relatively quickly. Text input should be kept to a minimum. The solution can be to use buttons. Each one will record a single data type. We have to use 6 buttons (3 for type of transport and 2 for direction).

The first version of application design may have the following appearance, Fig. 1, part 1:

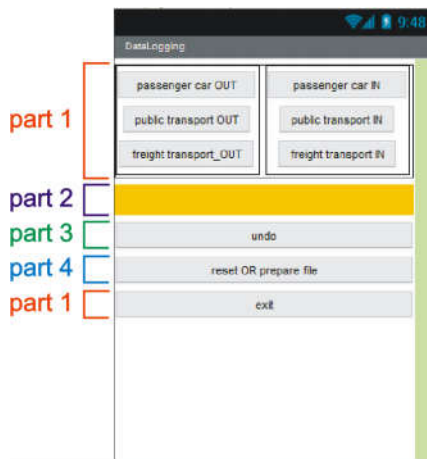


Fig. 1: Interface of a mobile application

The program code of the application includes Location Sensor switch on when the application starts and Exit button to close application.



Fig. 2: Initialization of location sensor and closing application

What follows is the specification of six buttons for data entry (for illustration the following displays only two of them):

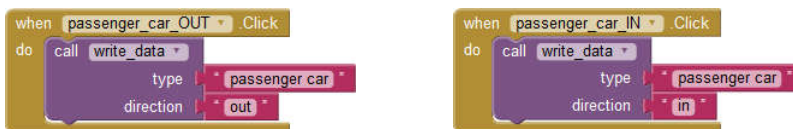


Fig. 3: Actions of buttons

Because writing data to file differs for the various buttons only in the written data (this is the result of problem analysis), it is advisable to define the procedure (write_data) for this purpose, Fig. 4.

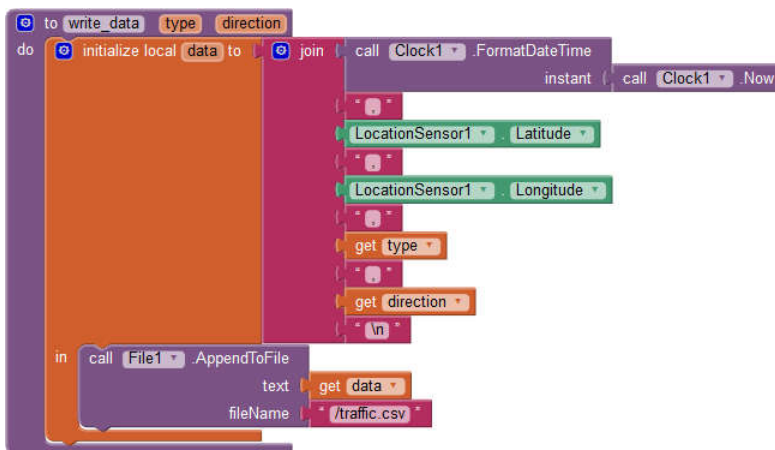


Fig. 4: Procedure write_data for writing data to a file

We have created a minimalistic but functional application. The beauty of the programming is also in that each product provides a room for improvement. It is up to the author to accept the challenge. Sometimes it takes just relatively little work to significantly improve the functionality and usage of the application. The same is true even in our created application. The users' experiences bring many improvements. This is a good opportunity to explore how users are using this application and what functionality is required. Here are some ideas on how to improve our application with a hint of solutions.

Problem 1: We do not have feedback when a button is pressed.

Solution: Response to the button press could be, e.g. a short vibration. Sound effect would be difficult to hear in a noisy traffic. We add component Media – sound. We launch vibration in response to the push of a button.

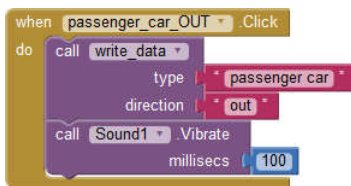


Fig. 5: Action of button with vibration effect

Problem 2: Although the button pressing causes the vibration, the user's eyes are watching the traffic. Sometimes the user may not be sure of which button was pressed.

Solution: The application could display information about which button was pressed last. We can add component User Interface – Label (named record), Fig. 1, part 2. When data is written to the file information about it appears in the component Label, e.g. "data is written".



Fig. 6: Procedure write_data – displaying data in label component

Problem 3: While watching it is possible that the observer presses the wrong button. Our application does not provide a repair option.

Solution: Instead of deleting record, we can write to file the information to ignore this record in data processing. We create additional button with which we will register this information, Fig. 1, part 3. We use already existing procedure write_data.



Fig. 7: Action of undo button – write information: delete record

Problem 4: When testing the application we cannot avoid the fact that we entered some test data to file. But these data should not be part of the data that we want to process later.

Solution: We insert the button to delete the contents of the file, Fig. 1, part 4.

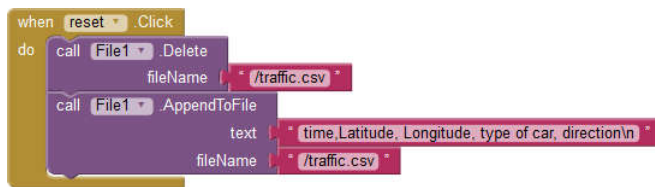


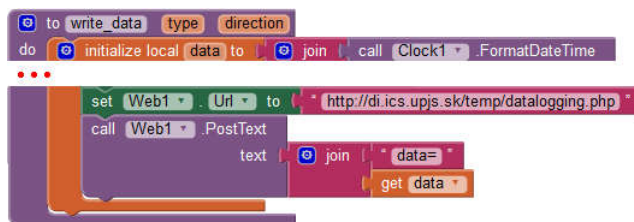
Fig. 8: Action of reset button – delete file and write header to new file

We can note that we expanded this possibility to include preparation of the file for writing and we wrote the header data in an empty file.

As mentioned above, the application can be continually improved. We will at least hint at one more improvement.

Problem 5: How can we combine data from more observers efficiently?

Solution: AI2 environment offers a choice of component Storage – TinyWebDB. But, it has a limit of 1000 entries. Therefore let's create our own storage space. However, capabilities of AI2 are no longer sufficient. We can use another tool, e.g. PHP. Created PHP script ensures to store data sent from applications to one data file on the server. Thanks to the synergistic effect the usefulness of the proposed application is thus greater than the sum usefulness of its parts. Application *Data logger for the city traffic* we published in AI2 Gallery (<http://ai2.appinventor.mit.edu/?galleryId=5079931179499520>).



```
<?php //datalogging.php script
if (isset($_POST['data'])){
    $data = $_POST['data'];
    $fp = fopen("data.csv", "a");
    if (flock($fp, LOCK_EX)) {
        fwrite($fp, $data);
        flock($fp, LOCK_UN);
    }
    fclose($fp);
}
?>
```

Fig. 9: Procedure write_data – sending data to PHP script and code of simple PHP script

We could make further developments here as well. What if the device is not connected to the Internet? Data from different users can be mixed. How to handle deleting data on the server? How to delete the test data on the server? In short programming and discovering is fun.

2.3 Pedometer or physical activities counter

In this part we show how to use a mobile device for checking of physical activity of a user who spends a lot of time sitting in front of a computer. Let us create a mobile application that will record the number of travelled footsteps (pedometer).

According to the IBL theory the mentioned assignment is a typical example of a guided inquiry, because we know only what we have to solve, but not know either methods or results.

Solving this problem we have to be aware of what are the requirements for the mobile application and by what means we can achieve them (assuming using of AI2):

- Find out the type of sensor suitable for recording changes in the movement speed – monitoring of values of various sensors during walking using one of the ready-made applications (e.g. AndroSensor, Sensor Box for Android, Android Sensors).

- Identify changes in the movement speed – mobile device has the Accelerometer and AI2 has commands to detect the components of acceleration sensor values (a_x , a_y , a_z).
- Display the value of acceleration sensor – AI2 has commands for writing or drawing acceleration sensor values to the Label or Canvas component.
- Find the number of steps travelled – AI2 has commands for calculation and testing of values.
- Keep measured data for further processing – AI2 has commands for storing and reading values to and from a text file.

Within our own guided inquiry, we gradually ask the following questions:

- How much the values of various sensors of mobile devices in the same situations differ?
- What trends have the components of acceleration measured by the sensor during walking? How much do they differ for different types of gait (e.g. slow / fast, the plane / uphill / downhill) and a variety of people (e.g. taller / shorter, healthy / limping)? Which of the components of acceleration will be taken into account?
- At what place and in what position we should fasten the mobile device to the human body to obtain the most accurate values from mobile application to measure the number of steps (e.g. at foot, hand, shoulder, in your pocket pants or shirt)?
- Which algorithm should we use to calculate the steps? We calculate the steps immediately, or from recorded values? Do we count the steps as the number of passes through certain threshold value of acceleration, or as a number of local maximum values of acceleration sensor? Do we calculate the steps from the original measured values, or from the processed values? Should we use some known algorithm (e.g. Fast Fourier Transform) for steps calculation?
- What other functionalities should the mobile application have (e.g. recording of measured values to a text file, drawing course of values, measuring the distance travelled, total time walking, calories burned, walking modes, automatic start and stop of measurements)?
- What other useful applications can be derived from this pedometer application (e.g. trainer of squats or other exercises, alert and localization of the fall of a person with osteoporosis, diagnosis of disorders of the joints and spine from registered irregularities of walking, measurement the uniformity of driving a car)?

Finding answers to these questions leads us gradually to solve the problem – to program the pedometer.

Based on our inquiry experience with programming of a pedometer and also on teaching a small group of 14-year-olds, we propose the following methodological approach of teaching of programming pedometer.

We introduce the problem of programming the pedometer as a STEM problem. During its solving, we need to take into account aspects from different areas – physics and technology (what physical quantities are measured by sensors of mobile devices), programming (how to detect, save and visualize values of the sensors), mathematics (how to calculate the number of walking steps), biology (which physical activities of a man and in which way contribute to the improvement of his or her health).

In a group of talented pupils in natural sciences, mathematics and programming we can lead teaching at the guided inquiry level. In teaching the general population we recommend using lower levels of inquiry – confirmation or structured inquiry. Pupils are provided with appropriate learning support (scaffolding) in the form of a series of partial tasks described in worksheets and guidance questions. The teacher at his or her own discretion, decides which knowledge let to pupils discover on their own, which one with a little help from a teacher and which knowledge teacher presents in the final form.

In teaching we proceed along the following points:

- Firstly we determine what sensors are on our mobile device and how they react on changing the speed of movement. For the experimenting we use some of mobile applications (e.g. AndroSensor, Sensor Box for Android, Android Sensors). While walking we watch how different sensors react. We find that various sensors react (e.g. magnetic field sensor, orientation sensor), but acceleration sensor responds the most intensely. Next, we focus on the acceleration sensor. Watching the chart with values of the acceleration sensor, we can conclude that this is a periodic course, where the number of steps is equal to number of repeating groups of values. When walking with strong footsteps the range of values of the acceleration is larger.
- In AI2 environment we create an application for displaying actual component values of acceleration sensor whose program code is shown on Fig. 10. Next we add the calculation and displaying maximum and minimum values of the acceleration sensor and its z-component which has the greatest range while walking. Screenshot of a modified application is shown on the left of Fig. 13.

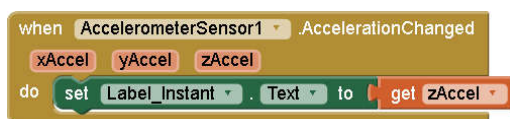


Fig. 10: Program code for displaying values of an acceleration sensor

- Experimenting with our and other ready-made applications we figured out that while walking the course of acceleration sensor values is almost periodic with a certain range of values. Number of travelled steps is determined as the number of passes through the certain threshold. Pairs of adjacent points indicating one step are shown on Fig. 11.

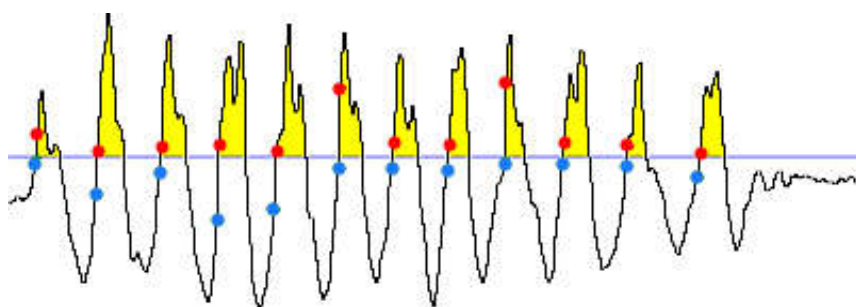


Fig. 11: The course of acceleration sensor values with pairs of adjacent points indicating the steps

- When measuring the number of steps travelled we use the timer event and the absolute value of the acceleration vector $\sqrt{a_x^2 + a_y^2 + a_z^2}$ instead of its z-component a_z . A key part of the program for the pedometer is shown on Fig. 12.

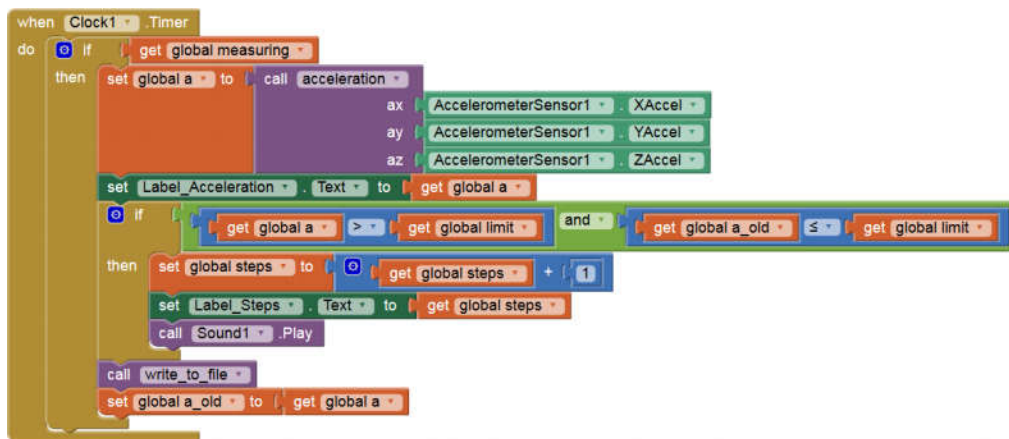


Fig. 12: Key part of program code for pedometer

- Further we add other features to the application, e.g. setting sensitivity threshold of the pedometer and recording of measured data to a text file. Screenshots of this application are listed to the right on Fig. 13. Application *Pedometer* we published in AI2 Gallery (<http://ai2.appinventor.mit.edu/?galleryId=6283550952259584>).

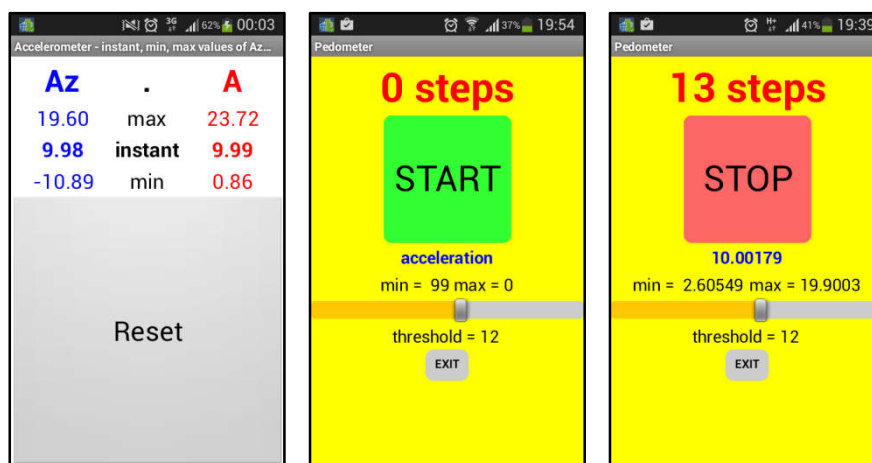


Fig. 13: Screenshots of mobile applications – measuring of acceleration and pedometer

Finally the pedometer application can be expanded by additional functionality – displaying of the total time travelled steps, specifying the file name according to the type of activity (e.g. the stairs, brisk walking), displaying of the accelerometer values and its components on a chart. These functionalities allow us to experiment with different types of walking and different placements of the mobile device on our body. On the basis of analysing the recorded data we can improve the pedometer application. Moreover, this application can be the basis for other applications, e.g. for counting of squats, to determine the pace of selected training exercises, for diagnosing of pathological shakiness, or lameness.

2.3 Suggestions for further projects in AI2 programming

We recommend the teachers to teach programming by means of creation of projects that are useful in everyday practice and by utilizing specific features of a mobile device, e.g. touch screen, play and record audio or video or photo, acceleration, location and orientation sensor (GPS), speech recognition and synthesis, receiving and sending SMS messages, saving and loading data to or from mobile devices running other mobile applications.

- Multimedia notepad for young journalists (for taking photos with recorded date, time, GPS position, personal notes and additional drawings).
- Talking compass for visually impaired persons (using speech synthesis).
- SMS loud reader for visually impaired or very busy persons (using speech synthesis and SMS functionality of a mobile device).
- Detector of falls for seniors (sending SMS to specified person with recorded information about GPS position, orientation and time of a fall).
- Treasure hunting game (using GPS sensor, orientation sensor, and bar code reader).

Solutions to some of these projects with the teaching methodology and worksheets are listed on the website (ŠNAJDER, 2015b). Paper (TOMCSÁNYIOVÁ-TOMCSÁNYI, 2015) provides further interesting project ideas for programming in AI2, e.g. Digital clock, Multiply and tell, Put together face of clown, Buddy list.

3 Conclusions

We mentioned examples of how to effectively and meaningfully integrate mobile devices into the learning process of pupils in this article. Using mobile devices in the classroom should be a consequence of the need to solve a problem or address the problem more effectively. The device by itself is not a reason for its use in the classroom.

A necessary condition for the use of mobile devices in the classroom is also the didactic and professional competence of the teacher. Teaching and training for it, however, can be challenging. Thusly prepared teaching can develop additional competencies of pupils, such as investigative skills or academic disciplines of science, technology, engineering and mathematics (STEM).

Currently, in the framework of the VEMIV project we work on preparing methodologies for teachers who are interested in integration of mobile devices directly into teaching. Within the framework of the project “School to touch – University” we are preparing publication for pupils, which provides interesting ideas for using mobile applications.

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HOW TO USE OPEN BADGES?

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Abstract

Important part of the teacher's work is motivating students. Web technologies provide a lot of tools made for this purpose, including digital badges. The most widely used digital badges are Open Badges from Mozilla, an open source technology. In this paper we show several examples of use and how to use them in class as a supplementary assessment. We also propose our scheme of Open Badges behaviour in portal matfyz.sk. We designed interactions of different types of users with the badges proceeded in the system. Important part of design is using the portability of Open Badges. Possibility of showing digital badges earned at school not only in our portal but anywhere on the Internet where Open Badges are supported may be motivating factor for students. Also possibility of showing badges from other systems in our portal can increase the attractiveness of these badges.

Keywords

Open Badges, assessment, motivation, education, badges

Introduction

Motivation as a key factor in educational process influences the learner's interest in the subject, her activity and concentration as well as her overall approach to study duties. Recently, the term gamification is often used in the context of motivation and presented as one of effective ways of motivation boosting. The term itself can be explained as using game mechanics, dynamics and constructs in non-game contexts.

One of the possibilities how to introduce game elements into education is to use badges and achievements as an alternative or complementary form of assessment. Present trend in this area is using digital badges [1,2,3,10,11]. According to broader and broader integration of digital technologies, Internet and social media in school and also in everyday life of our students, the digital form of badges is a natural concept for them.

In this paper we introduce badges, shortly refer to their history, we suggest several ways how to use them in educational process and point out their benefits. Further we characterize the digital badges and present the concept of Open Badges. Since we consider Open Badges to be a useful tool for building up students' motivation, we started to prepare their implementation at our educational portal. In the paper we describe the design of upcoming web application. Our preliminary implementation of "paper badges" in classroom is also discussed.

Badges

According to Lobkowitz [5], the history of badges began in ancient times. They served Roman soldiers as an award for a specific act of bravery or service but also were possibly worn as a symbol of rank or the soldier's affiliation to a troop. In middle ages, badges counted for heraldic symbols and were worn as jewellery and later as symbols of allegiance to a political figure [3].

Several authors [1, 2, 3, 10, etc.] pointed out the shift in badges use in the settings of scout community, where they began to serve as a symbol of success achieved in a strictly appointed field, e.g. acquiring of a particular skill or knowledge at some predefined level. Since the advent of video-games and computer games badges began to represent achievements related to accomplishing a game level, overcoming an obstacle, meeting a challenge. Internet penetration enabled the user to present her acquired badges to other users on the outside, create leaderboards, etc.

Also in the current context of social media, badges are interpreted and used in the same way – as a symbol of completing a task, achieving success, or gaining an experience. They can be handed out by an institution, organization, group or an individual as well, therefore they started to be used as a motivation factor also in a broader context, even in spheres which are primarily not related to the acquisition of new knowledge and skills. A good example is their use in Internet-banking. For example, an account holder in mBank is awarded by several kinds of badges for various operations connected with her Internet-banking account setting and using, with credit card payments, with saving plan, etc. (see Fig.1). This way, the banks obviously strive to motivate their clients to more often financial transactions at their accounts.



Fig. 1: Badges used in Internet-banking (mBank).

For our purposes, it is important that the above mentioned model of awarding badges in the scouting or in computer games is well-corresponding to rewarding in the educational environment.

Badges in Education

The use of badges in educational activities in school is rather straightforward. Students are awarded a symbolic prize for solved tasks, achieved knowledge, skills or other success similarly to getting a grade or a certificate nowadays. The award symbol – a badge – can be then made accessible to the others, to let them know about the badge-owner's knowledge or skills.

Badges can be implemented rather simply using the students list at the notice board in the classroom where the teacher pins assigned badges in the form of pictures representing the respective activity. The drawbacks of this simple approach reside in the possibility to move a badge pinned at the notice board to another place or remove it at all as well as in the fact that the badges represented only by pictures do not reflect precisely the activities they were awarded for. To make the meaning of badges apt enough, the teacher should also add the description of the assignments at the notice board which could cause confusion, especially for larger number of activities.

Nowadays, when digital technologies count for an inherent part of our everyday professional as well as personal life and they also break more and more into education, digital badges become the preferred form of badges used within the evaluation. A digital badge is a visual representation of the student's performance which certifies her skills and ability and is accessible online. It could be implemented simply by a picture but recently, digital badges containing meta-data are more and more often used. Meta-data is information explaining in details what the owner learned, including the description of assignment and link to the result of her work.

The employment of badges into education can follow various methodologies. Badges can be:

- used as an alternative or complementary form of evaluation;
- used for the evaluation of all activities in the class or just for the selected ones;
- granted directly for the performance in educational activities and/or for other than educational activities (e.g., for the help to a classmate by the problem solving);
- given for activities within study duties or beyond them;
- granted automatically after fulfilling a given activity or based on teacher's approval;
- given only by a teacher or students can also hand them out to their peers;
- given to individuals or to groups;
- granted separately or in series which can cover part by part some entire area, etc.

Previous alternatives of badges usage can bring about different results. The teacher should decide among them based on the goals she wants to achieve in the class as well as to the particularities of every class.

The digital badges usage can positively influence the educational process in several respects:

Increasing motivation for learning. While badges are used in class, several factors affect the students' motivation. One of the basic principles of increasing the motivation is *immediate feedback*. Badges given to students promptly after fulfilling a task can guarantee this factor.

To collect badges and to see them on their educational profile is not only playful and amusing for students, it even brings *competitiveness element* into learning. This motivates students to collect additional badges which they are able to attain only by further study and by fulfilling their study duties. Therefore the collecting of badges leads them to further acquiring of knowledge and skills.

In the case of series of badges, the meta-data of every badge can point to the next step needed for obtaining the next badge. This way the *gradual acquiring of knowledge* in the area covered by badge series is better explained and made easier for students [3].

Monitoring of learning state and progress. A continuous awarding students the badges provides them not only with an immediate feedback, but gives them (and also to the others) a chance to *directly visually track their progress* in learning. Besides the assignment description, a digital badge contain in its meta-data a direct link to the work it was assigned for or, possibly other collection of data needed for evaluation of the results of the task it was assigned for. This enables the teacher to evaluate also such skills which usually are not a subject to evaluation, e.g., social skills, collaborative work, etc. It is also possible to assign them a digital badge containing a link to a video with the record of respective skills or activities [3].

Digital badges can also support the identity building and relationship development in social networks. A profile with digital badges enables the owner to build the reputation and helps the others to find profiles with similar interests or skills.

Evidence of achievements. Digital badges with their meta-data and linking to the results of students work offer a simple and transparent possibility to present acquired knowledge and skills to open audience. A suitable implementation of badges can also allow the audience to evaluate the owners work.

A significant benefit of this approach is the accessibility of study outcomes together with the descriptions of the assignments and also with particular outputs to possible interested persons

or organizations, e.g., a school at higher educational level, potential future employer, professional social network, etc.

As showed in several studies [1,3,11], using badges in education motivates students to continue learning even in the case, when educational activity is in conflict with other student's priorities. Despite the fact that badges are an external reward it seems they can turn to the internal motivation [10].

Open Badges

Open Badges are type of digital badges made by Mozilla. The idea behind them was to make the skills and achievements gained outside of the school system recognizable. In many countries students need a lot of money to pay for their education, which means they have to take on large loan to get a degree. Mozilla wants to help people who provide free education and also those who learn from them to assess and be assessed by their digital badges. Besides free education, Open Badges can be awarded also for the paid one.

Mozilla's vision is to replace curriculum vitae by Open Badges, which represent user's skills. This is possible because it is easy to verify the issuer of the badge and the output or performance it was issued for. Moreover, Mozilla offers access to the source code for the badges. As they say, "it should not be up to individuals to have to craft their own infrastructures and mechanisms to make their learning visible" [4]. Open Badges infrastructure wants to be as decentralized as possible to give earners control and support of the entire ecosystem.

One of the biggest differences between Open Badges and ordinary digital badges is meta-data. In the meta-data it is able to store a lot of information. The badge meta-data is defined as assertion – the representation of the awarded badge. Here the issuer must provide information about the recipient identity (represented by her email), data helping third party to verify the assertion, date when the badge was awarded, unique identifier for the badge and badge class information. The badge class information includes badge name, a brief description, an image, criteria for badge obtaining, and the name and URL of the issuer. Meta-data can contain also optional information, e.g. a list of objects describing educational standards this badge aligns to and a list of tags that describe the type of achievement [7].

There are three roles in the Open Badges system [8]:

- a) Earner – someone who earns a badge.
- b) Issuer – organization or individual who issues Open Badges. The issuer is responsible for defining badges, making them available to earners and awarding badges to them.
- c) Displayer – a website, organization, or person who accesses publicly shared Open Badges and displays them. She is also responsible for badges verification.

Another user of the system, who participates only passive, is anyone who looks through earner's badges, for example potential employer or school where earner applies.

Open Badges have a lot of benefits. One of them is exactness of assessment. If someone gets a degree, people outside of the school usually cannot tell which skills, abilities or knowledge does degree holder have [12]. On the other hand, if someone owns a badge stating that earner had to prove she can use variables, regular expressions and for-loops in JavaScript anyone can assume what is the badge holder capable of. Another benefit of Open Badges is that they can be awarded not only for hard skills but also for soft skills. For example, teacher at school can easily assess child's creativity, activity or willingness to help schoolmates. Soft skills such as teamwork are also very valued in a lot of employments. There is also the benefit of

implementing “trial and error” idea, especially when they are used in schools. If a student did not fulfill the criteria for the first time, she can try again and again until she fulfills them. Through this process, student learns proposed skills or knowledge.

There are also few critical statements. One of these communicates that the free education is still free because it has no commercial value. If it gets some commercial value through Open Badges, it will no longer be free. Another one states that there is a risk of wiping out the joy from doing things. If there will be the badge for every activity – sports, arts and everything that people do as a hobby – people will no longer participate in these activities only for their enjoyment, but they will do it to earn a badge [9].

Nowadays, it is already possible to find a lot of Open Badges Issuers online. People can earn badges for taking part in some courses or terms at schools, for example at MLHS Online Academy⁵, for participation in conferences and workshops like the ones organized by MCN⁶ or participating in some online courses. There are differences in these courses. In Peer 2 Peer University⁷ there are some badges that users can award to each other. In the course Badges: New Currency for Professional Credentials⁸, lecturers assess student's work and award them badge and there are also courses, where the work is evaluated automatically by computer program, like BuzzMath⁹. Sometimes students can earn badges not only for their work but also for their behaviour through working process, good example of these badges are in the BuzzMath portal.

Open Badges are rather widely used and there is a big chance that their user base will still grow. They are open, they hold a lot of information that can be verified and they can be attractive and fun to earn if they are used wisely. Due to their benefits, we decided to employ Open Badges in school to motivate our students to study. In the next section we describe our approach to introducing badges in classroom.

Badges at Secondary School

As soon as we decided to use Open Badges in secondary school, we started to design their implementation at our web portal. More about this process will be described in the next section. Since we are still working on design, we decided to run first iteration of badges at secondary school on paper. Badges were put on in the subject of Informatics in two study groups. Other two groups where badges are not used serve as control groups. Both, experimental and control groups are from the same grade. Badges are used as a supplementary assessment tool – they will not affect students' grading.

In the end of the school year, all of the student's badges will be counted together. For the “big” badge, student will get two points and for the “small” one, they will get one point. Student with the biggest score will win the surprise. We designed several types of badges (Fig.2):

- Homework – the small one; students can earn it for doing bonus homework or bonus part of regular homework. The important part is that homework must be done on time.
- Good Work – this is not a badge but one subcategory of small badges that can be earned for good behaviour in the class. There are five badges in here:

⁵ <http://blogs.mtlakes.org/onlineacademy/>

⁶ <http://mcnpro.org/>

⁷ <https://p2pu.org/en/>

⁸ https://www.coursesites.com/webapps/Bb-sites-course-creation-BLEARN/courseHomepage.htmlx?course_id=_264998_1

⁹ <https://www.buzzmath.com/>

- Help – for helping schoolmates under the rules of class,
- Activity – for active participation in the class activities,
- Creativity – for outstanding products,
- Self-direction – can be earned by student that knows perfectly some part of the subject matter before the lesson or can operate computer program used currently in the lesson on high level,
- Innovation – if student can operate more professional program with the same use than is taught in class, she can earn this badge.
- Exam – big badge; it can be earned for the topic exam if the result is better than 95% or it was at least 20% improved compared to previous big exam.
- Topic – big badge, it can be earned for successful learning through the whole topic. It means that the student had to earn more than 75% for the topic exam, at least 80% for every homework and she had to submit all of the bonus homework to earn this badge. Interesting attribute of this badge is that its visual design is different for every topic, although the other badges have the same graphic design for the one type.

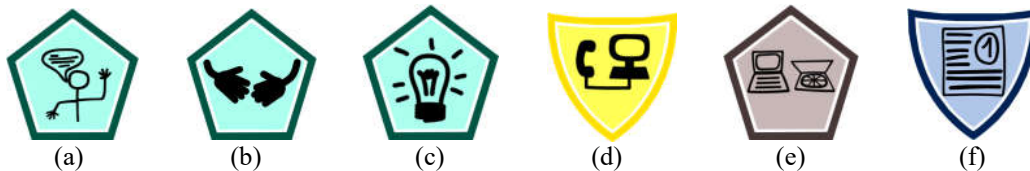


Fig. 2: Badges for: (a) activity, (b) help, (c) innovation, (d) communication, (e) homework and (f) exam.

These badges are currently showed only on paper on the school notice board. In the next research we want to improve our design of this collection and we also want to move badges online as Open Badges. Our system design is proposed in the next section.

Open Badges at Matfyz.sk Portal

Since we are trying to implement a badge system into matfyz.sk portal we need to suggest the whole functionality first. We have to design it from a teacher's point of view as well as from the student's point of view. Some inspiration for our functionality comes from Moodle [6], other things were designed based on our own needs and ideas.

First thing we have to do is a management page which allows users to manage their badges. There will be two main types of users - teachers and students. Teachers are primarily the ones who create and grant badges (Fig. 3 (a)), students mainly collect them. Therefore there will be much less functions available for students.

Teacher's View

Teachers' main management page will allow her to create a brand new badge and then show a list of all badges created by her for a particular course. Every badge will be represented by its icon and name and it will also offer several options for a teacher - it can be deleted, edited, duplicated, its visibility can be changed and it will be possible to display all of the badge's owners. Creating, editing and duplicating will be pretty similar. The system will redirect user to the page where all editable attributes of a single badge can be changed - name, picture, visibility and criteria for earning it. The visibility setting displays or hides a badge in the course page. Criteria could be written as a simple text in case a teacher decides to grant that particular badge manually. They could be also set automatically as a score limit that student

needs to exceed to gain the badge or it can be earned automatically as soon as the teacher checks students' assignment and finds it to be okay.

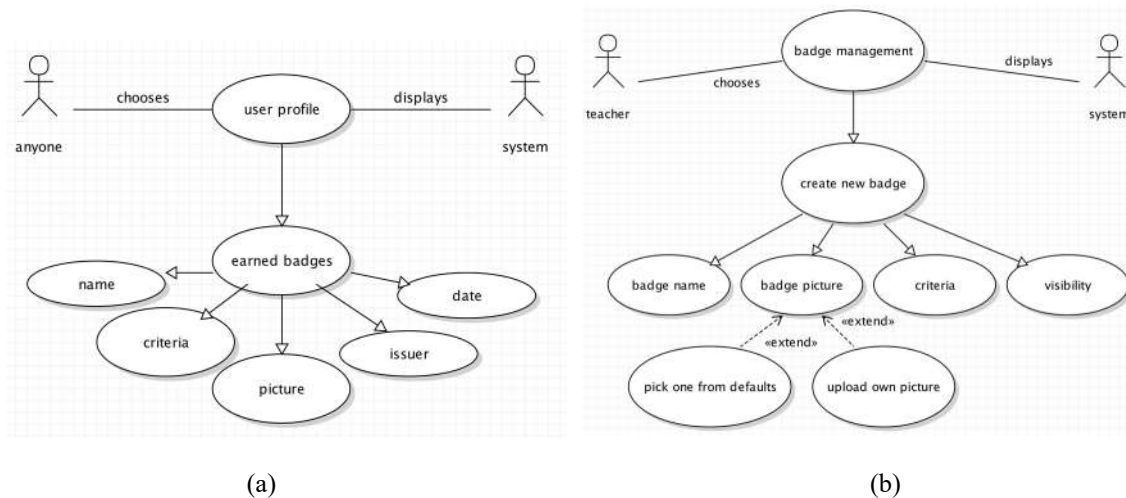


Fig. 3: Use cases of badges: (a) creating a badge and (b) displaying information about earned badges.

In case of creating a new badge the fields in the badge change page will be empty. On the other hand, in case of editing and duplicating they will be already pre-filled. The problem with Mozilla Open Badges is that they cannot be edited once they are acquired by at least one student. So this will be also our own system's limitation for editing. However, duplication will not meet this limitation because it will basically create a whole new badge with pre-filled data from the duplicated one. We also want to provide the teacher with an option to delete a badge. In this case, the badge will not be actually deleted from our database, it will merely change its status to 'deleted' and the teacher will not see it in her badge list as well as students will not have any chance to gain it anymore. This action will be irreversible but also will not have any influence on already acquired instances of that badge.

For every badge on the management page there will be a button allowing teacher to display a list of all students who have already earned it. This screen could also provide some interesting statistics about percentage of students earning a specific badge, their breakdown by gender and much more for possible further analysis.

On the assignment page a teacher will be able to link a particular badge to this assignment. When he or she will click the link button, the system will show him or her the options available - to create a brand new badge, to duplicate badge from existing ones and the list of existing badges for this course which are invisible, not yet assigned and with no criteria yet that she can use as an outline.

Student's View

Students are primarily the ones who collect badges so the system will show their rewards represented by an icon on a personal profile page. Any visitor will be able to click on any displayed badge to see further information about it. If the student is logged in, she can set the visibility of any particular badge on her profile page.

Student can also see every badge that can be earned in the course. The badges that she owns are displayed normally and the badges that she has not earned yet are in the gray scale. Beside this summary, there will be a small image of the badge next to every assignment that can be assessed by this badge.

Conclusion

In this article we showed digital badges and how they are used in the education. In the beginning we described badges, their brief history and their use in a lot of different concepts. Then we introduced their educational use and positive effects they can maintain in class. We also showed Open Badges, their original purpose, benefits, critical statements about them, their use in educational context and some necessary technical details.

We proposed our current work in progress - paper badges in secondary school designed for motivating students and suggested functionality for Open Badges in our portal where we want to integrate them in the next part of research.

In our future work, besides implementing Open Badges to our portal, we want to design different types of badges for various educational activities and then examine their effect on the motivation of students at the secondary school.

Acknowledgement

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CREATING MOBILE APPLICATIONS IN APP INVENTOR

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Abstract

App Inventor is an on-line integrated development environment (IDE) that allows less experienced programmers creating mobile applications for the Android platform. Programming in this environment means designing the app by adding visual and non-visual objects to it and then defining their behavior by adding event handlers to them. We know the kinds of these objects and their basic purpose from our everyday use of mobile devices. This way we can control and make use of the built-in camera or the virtual keyboard or even the built-in accelerometer or GPS sensor. The event handlers are assembled from readymade cards (jigsaw puzzle pieces) containing commands and parameters, so that we do not need to know all the commands in advance neither any syntactic rules of a programming language. Another advantage of the IDE is that the program is actually running on a connected mobile device all the time as we are constructing it, so we can see whether it behaves like we expected. In our paper we present a review of papers, web pages and articles dealing with the use of App Inventor in schools as well as we introduce our sample applications that are suitable as an introduction to more advanced topics of App Inventor, namely the use of lists and the built-in database engine of the mobile device.

Keywords

Mobile devices, apps, visual programming, list data structure, database.

Introduction

The strong educative potential of App Inventor (referred as AI) is one of the reasons for using it when developing mobile applications. App Inventor allows teaching many computer science concepts (see [1]):

- operators and built-in functions – simple set of string and list functions and math operators,
- iterators – while, for next, for each,
- conditionals – if, if else, Boolean and relational,
- modularity – procedures (within app only, no user defined libraries),
- databases – TinyDB (local – key-based access), TinyWebDB (cloud – key-based access),
- sensors – haptic (vibration – need phone), gyroscope/accelerometer (need phone), location (GPS),
- phone libraries – texting (SMS),
- other libraries – text to speech, Bluetooth, Lego Mindstorms, Web services, websites, other apps, Fusion Tables,
- graphics – sprites, movement and collision detection,
- user interfaces – multiple screens, scoping,
- input – buttons, textboxes, checkboxes, list picker, canvas and sprites, location, motion, collision and edge detection,
- output – labels, colors, sound, vibration (haptic).

On the other hand some informatics and programming concepts are not well represented in AI, for example data types (numbers and text only) or data structures (lists only), but the choices that App Inventor offers are sufficient for teaching the basics of computer science [1].

Even if App Inventor contains some elements of object oriented-programming, it is not suited (and not meant) for introducing pupils into the theory and praxis of object oriented design. It is also not suited for creating large projects or 3D games [1].

Programming in App Inventor can prepare students for programming in Java, Python or JavaScript. Programming in AI develops creativity, it teaches the pupils formulate their ideas and develops problem solving abilities [2].

App development life cycle

Many authors suggest that the life cycle of an app should be as it is depicted on Fig. 1.

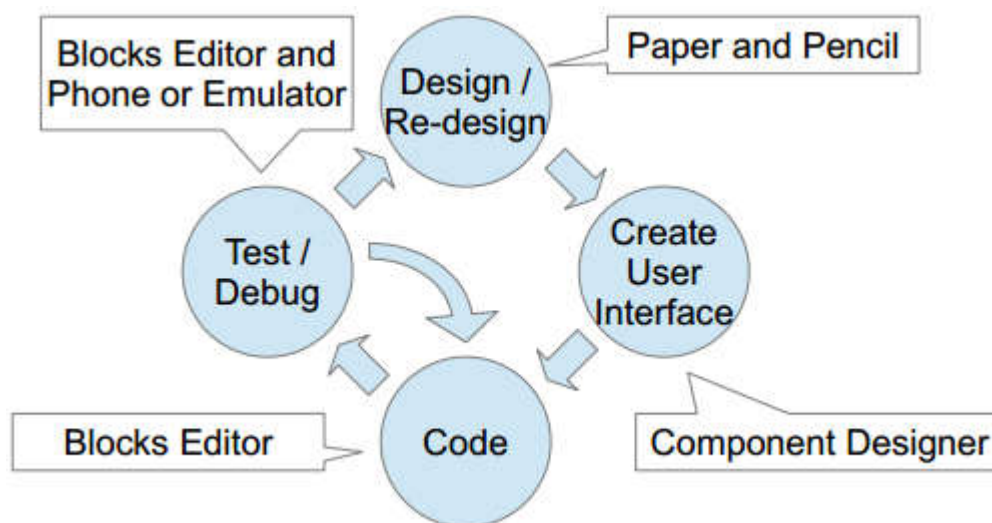


Fig. 1: The app life cycle [1]

In the first phase (see Design/re-design on Fig. 1) the whole app is designed without the use of AI itself. Sometimes paper and pencil is used, sometimes specialized software may be useful, too, e.g. Balsamiq Mockups [3], that offers tools for mobile application development. Some authors pay significant attention to this phase of the app's design. One of their reasoning is that during the preparation phase the programmer better understands not only if his app will run in portrait mode or in landscape mode, but also what particular functions will be performed by each element of the user interface – buttons, texts, canvas.

In our opinion, an advantage of AI is that its Component Designer enables the pupils to prepare the design of their app and that the design is carried out by interactively manipulating the visual and non-visual objects of their future app, so there is usually no need for an additional tool. So we prefer starting with AI itself eliminating the need of one extra off-computer phase, or in other words – we suggest merging the Design/re-design phase into the Create User Interface phase.

In the next phase (Code) the programmer designs the function of each visual and non-visual elements by attaching some code (event handlers) to events generated by them. In AI the code is interactively assembled by arranging puzzle-like pieces that contain individual commands and their parameters.

The next step in the development of a mobile app is its testing and debugging. The advantage of AI is that the programmers can immediately test their apps on the attached mobile device, so they can immediately see if it works like they expected. If so then they can go on by adding more elements of their app (i.e. start a next life cycle round for new components). If not, then they can try to correct the problems (usually going back to Coding, see the arrow in Fig. 1) and see immediately whether they succeeded or not. This highly interactive way of operating is usually very attractive to pupils.

After finishing the app they can immediately create an installable APK file directly from the AI's environment and sent it to their friends.

App Inventor in ISCED 3 schools

The Slovak ISCED 3 curriculum for informatics [4] is divided into 5 main topics. One of them is “Problem solving and algorithmic thinking”. Programming classes that use App Inventor can be a mean that enables the pupils to achieve some of the goals of that topic. Pupils can “express problem solutions in a programming language, search for errors and correct them”, they can also “understand readymade programs, define the properties of their inputs, outputs and the relations between them, know how to test and modify the programs”.

The currently available textbooks, tutorials and papers concentrate especially on developing apps and teaching basics of programming in AI to undergraduate university students that have little or no experience in programming.

According to [5]: *“The visual approach of App Inventor would help students not to focus on programming and the syntax of coding. Instead, they would concentrate more on the logic and events of the application. Students usually comment that they like the blocks because they don't get stuck reviewing code for missing semi-colon, braces or for misspelled code.”* On the other hand authors describe their experience with using AI for students that already have some experiences in programming and state: *“some App Inventor components require a great deal of computing skills such as SQL and database design.”* [5].

The authors of [6] prepared an e-learning training material in which “educators with limited programming experiences learned to design mobile apps through peer support and instructor guidance.”

Based on available materials from the Internet, textbooks and by considering the requirements of Slovak ISCED 3 informatics curriculum we developed a sequence of several apps, that can make pupils of the age 15 to 17 years acquainted with the environment of AI as well as with programing in that environment. We have prepared tutorials that contain step by step guides for developing those apps [7].

We are preparing an e-learning training material for pre-service teacher training for future teachers of the informatics subject as well as for students of applied computer science at our faculty, which are interested in creating small educative apps. The material will cover not only AI programming basics, but also some intermediate topics like using data structures (lists) and databases.

The List data structure and the TinyDB component

In the next paragraphs we would like to show our approach to teaching the pupils the principles of storing structured data during the execution of the app and also storing data that should remain intact even after the app stops its execution. We well also how to achieve implement this functionality using the List data structure and the local TinyDB database.

We start with a simple app that stores a list of friends on the mobile device. Later the pupils can utilize Lists in their next apps.

Fig. 2 shows the basic list processing commands of AI. We can explain the list data structure by showing some examples of lists that the pupils know and that they actually use. A good example is the directory of contacts in any mobile device, a shopping list or a list of items that one should bring to a summer camp.

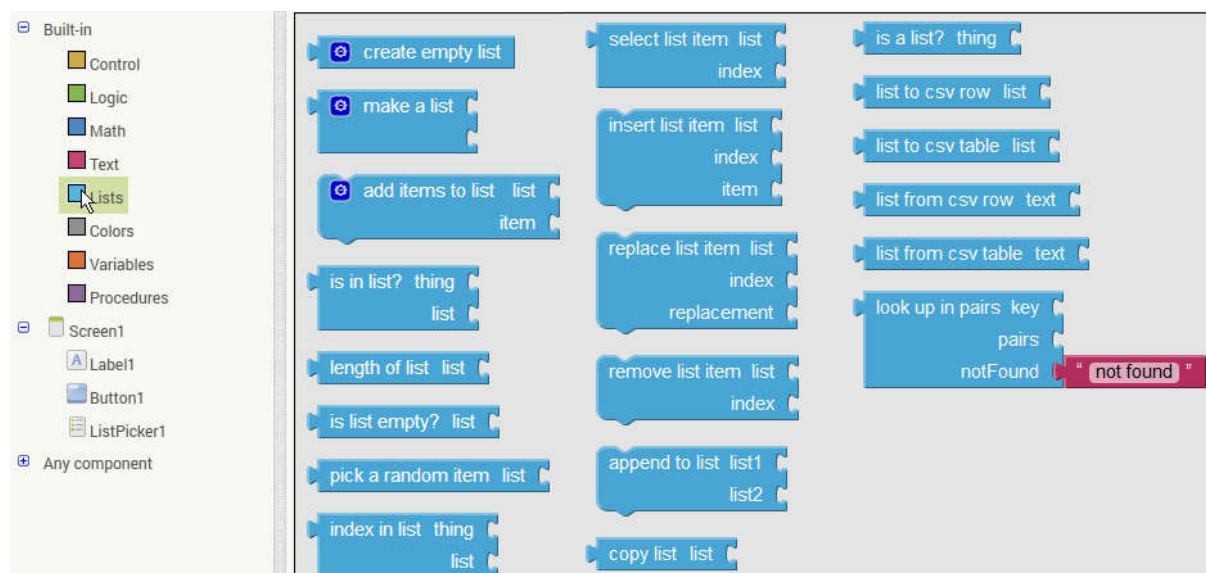


Fig. 2: The commands associated with the List data structure

The List of Friends App

In this introductory app we will use only a few list processing commands. At first we construct a list out of its elements using the “make a list” command and assign it to a global variable.

For testing the app we need to show the list on the screen. We can use either a Label component or a ListPicker component. The latter is actually better suited for lists because it can show all the elements of a List structure in a pop-up window above the main screen of the app. It can even let the user scroll the items vertically by the usual sweep gesture if they do not all fit into the screen's height, see Fig. 3



Fig. 3: Creating a global List variable and showing its content in a ListPicker component

When pupils try out the app, they apparently realize that the list of friends is fixed, i.e. that everybody who runs the app will see the same list of friends (see Fig 3) and there is no way for the user of the app to change them.

Therefore we want the app to be able to input and store new friends. For adding a new friend we create a simple user interface – we add a TextBox and a Button and we construct a small piece of program that handles the event when the button is pressed.

If we try the enhanced app then we can see that we are able to add the name of a new friend and we can see its name when showing the list of all friends. But next time we run the app we see again the original unchanged list.

This is the point where an idea of a database can be explained to pupils. AI includes a TinyDB component that can store data in (tag, value) pairs into the device's local database so that they survive the application's termination. Fig. 4 shows parts of the modified program that extract data from the database when the app starts (the Screen1.Initialize event handler) and store each change into the database (the Button1.Click event handler).

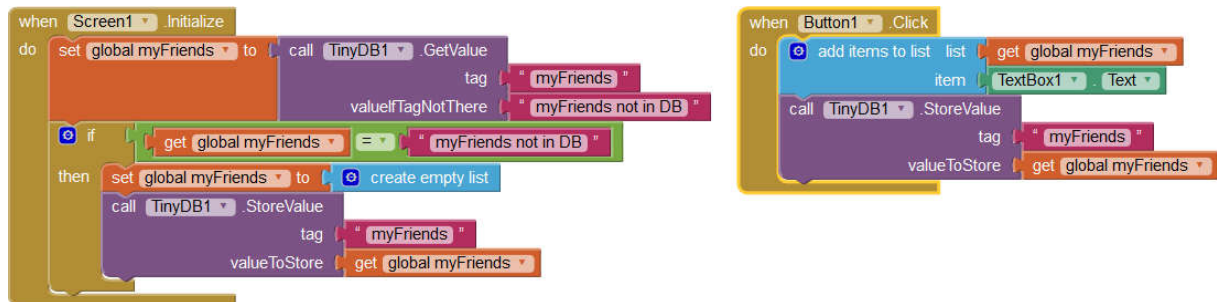


Fig. 4: Saving a list into the local database of the mobile device

The Guess the Word Game

The next program uses and enhances the knowledge about lists and local database. It's a party game named Taboo (for example [8]).

The players sit in a circle. One of them (the guesser) places a mobile phone at his/her forehead so that others can see its screen but the guesser cannot. The app will show a word that the guesser must guess. Others (that see the word) help the guesser by saying clues that indirectly describe the work on the screen.

In order to implement the game we will not only need creating lists and using the local database (as we learned while creating the previous game), but we will also need to teach the pupils how to randomly choose an element from a list and also how to erase an element from a copy of the list so that the same word is not repeated in the same game until all words were used. The pupils may enhance the game so that for each word there is a list of other words that must not be told when helping the guesser (namely this is the way how the original version of the game, which uses paper cards, works).



Fig. 5: Designing the user interface for Guess the Word

The Full House Puzzle Game

Games for which it is important to remember the initial placement of elements (e.g. walls in a maze) can also benefit from saving data in lists. Our example for such a game is the Full House Puzzle [9].

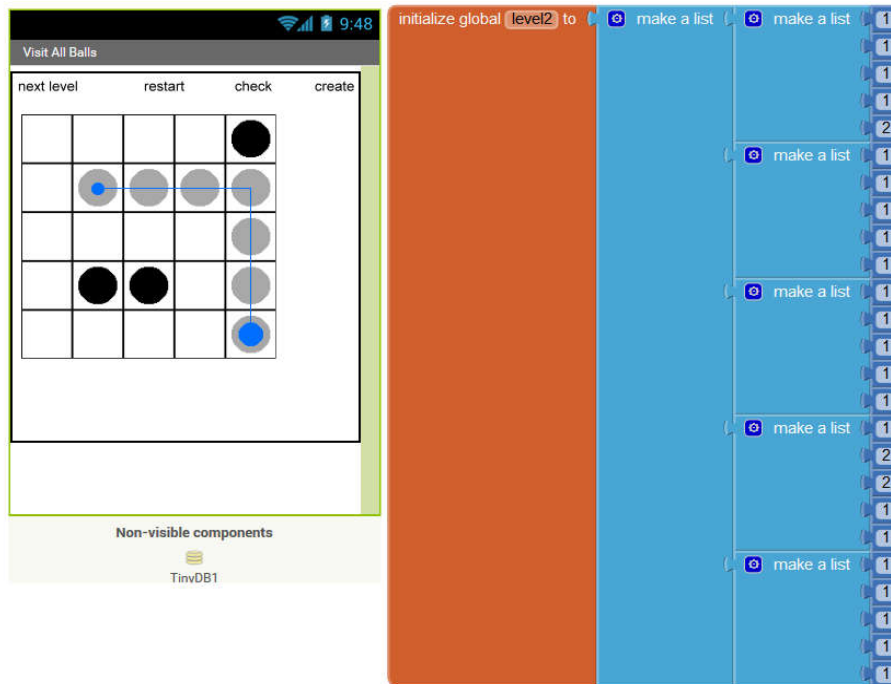


Fig. 6: The design of the user interface and creating the list that stores the setup of one level of the game.

The game's screen shows a grid containing obstacles (black circles), empty cells (empty squares) and cells that were already visited in the course of the game (gray circles).

The setup of a level is remembered in a list of lists. It is because one row of the grid is remembered in a list where 1 stands for an empty cell and 2 stands for an obstacle. The information about all the rows are then stored as a list of row setups, which is technically a list of lists, see Fig. 6.

The game can be extended so that the player can design its own level of game (the Create button in the right upper corner) and the app will remember it in the mobile device using the TinyDB component.

The details of the above apps can be found in tutorials that we made publicly available [10].

Transiting from AI to textual programming

AI can quickly and easily create small apps. Therefore it is a great tool for introducing pupils into programming apps for mobile devices. But after a while they may start feeling the limitations of block-based programming like

- sometimes too many drag and drop mouse movements are needed in order to construct a quite trivial program,
- sometimes it is hard to reuse pieces of code without making copies of it,
- it is hard to share pieces of code,
- non-trivial pieces of code may not fit to screen without careful arranging.

Therefore some pupils would like to continue to something more advanced. And then both the pupils and their teachers ask about a suitable follow-up language.

The Java Bridge Projects(s)

Java Bridge is one of the projects that try to fill this gap. It was created by some members of the original App Inventor team. The original project [11] seems to be not functional. There are several follower projects, some of them seem to still work to some extent, for example [12].

Java is the usual choice for professional programmers who want to program for Android devices. Therefore the main idea is to guide the pupils from AI (the beginners programming environment) to Java (the “adult” environment). It provides Java classes that have the same name and the same functionality as the AI components (like Button, Canvas, Sprite etc.). All these classes are packaged into a Java JAR file. So a pupil can install the Software development Kit (SDK) from Google [<https://developer.android.com/sdk/index.html>], create a project then add the Java Bridge JAR file into it and then start building an application. There are video tutorials that help to begin with this approach [13]. The pupil needs basic knowledge of the Java programming language, but the project can be created without specific knowledge about Android programming in Java. It is because for creating the user interface of the app the pupil can use the components he/she is already familiar with from AI.

Some authors report their experience when using it with pupils, usually older ones or more experienced ones, e.g. *“From our experience in teaching Android programming to college seniors using the traditional Android SDK with Java, we found the Java Bridge to be a much simpler way to program Android apps and an excellent transition tool for students learning Java”* [14] or *“For more advanced programming courses, students could use App Inventor Java Bridge to write code and integrate it with App Inventor, which could help to overcome the limitation of programming in an object-oriented style and working collaboratively to create applications.”* [6].

Textual replacement of the block language

When programming in AI the project is saved into a file with .aia type. The file is in fact a zip file that contains a textual form of all the user interface elements and blocks used in the program. This fact has urged some developers (usually students) to create their own textual descriptions (conversions) of the blocks. The main idea of these trials is that the textual description may be better readable in some situations or for some kinds of pupils and that it may serve as an alternative approach to easy programming for mobile platforms. The most remarkable work is the thesis of Karishma Chadha from Wellesley College [15]. She implemented a language named TAIL that corresponds one-to-one to App Inventor 2 blocks.

Conclusion

We have researched papers and articles that deal with utilizing the App Inventor development environment either in higher secondary (ISCED 3) schools or in the introductory courses of undergraduate programs as well as in e-learning classes for in-service teacher training.

We see a big potential of AI that allows the pupils become acquainted with the way mobile application are designed and implemented. We believe that thanks to the fact that young people use their mobile devices every day programming these devices may be motivating and that using AI they will want and be able to develop their own apps. We also believe that they can learn a lot in this process.

We all can see that the way of teaching where the teacher and the pupil are in ceaseless direct face-to-face contact is shifting and the teacher needs not literally stand next to the pupil. We

all can learn by watching tutorials, solving problems and sending their solutions for grading in e-learning systems. While learning we use searching for information and we also use open environments for manipulation with objects that we learn about. We gain our knowledge while commenting texts written by others, when we review the work of fellow trainees or when posting questions to discussions groups and fora.

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ASSESSING ROBOTICS LEARNING AT LOWER SECONDARY SCHOOL

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Abstract

There are many different aspects of teaching and learning with educational robotics. Assessing robotics learning can take many teachers into unknown domain. This involves several assessment approaches, which usually are not often appear in common educational settings. In this article we describe various types of assessment within robotics learning at lower secondary school. This assessment is part of our curriculum for educational robotics, which we have been developing within our doctoral research. In our research we have been using qualitative methods of data collection and data analysis. Based on results of data analysis we designed our own rubric, which can provide the bases for consistent, objective evaluation. In this rubric we evaluate pupils' work from three points of view: building robotic model, programming it and presenting program to control it. In the conclusion of article we mention also our remarks and recommendations for assessing different types of activities in robotics learning.

Keywords

Educational robotics, LEGO WeDo, assessing robotics learning, lower secondary school.

Introduction

In the last ten years robotics learning has become popular tool to engage pupils' interests in various areas of education from children at kindergartens to university students (Bers et al., 2014; Benitti, 2012; Demo et al., 2009). Pupils in primary and secondary school can often encounter with robotic activities in robotic competitions. However implementation of robotics learning in school settings is still rare. Assessing robotics learning can also take many teachers into unknown domain. This involves several assessment approaches, which usually not often appear in common educational settings (Mayerová, 2013; Gura, 2011). Teachers have to decide what domains of this specific learning should be assessed. Teachers can assess team work, time management, journals (consisted from planning, construction, testing, and modifications of robotic model), tangible construction and functions of robotic model and others (Gura, 2011). However assessment should pertain to the teaching and learning goals and objectives of the particular class. Assessment is an important part of robotics-based learning and can tack a great deal to the whole experience (Gura, 2011).

Materials & methods

For over three years we have been developing curriculum for educational robotics with robotic kit LEGO WeDo at lower secondary school, which is part of our doctoral research. In our research we have been using qualitative data collection and data analysis (Švaříček et al., 2007): observations (fieldnotes and transcriptions), audio-visual material (photographs and recorded videos of pupils' work and pupils' product). We also have been developing our curriculum within design based research, in which we currently are in its third phase – it

means that we have been testing and modifying whole curriculum a third time. Our curriculum consists from:

- description of iteratively developed activities with selected robotic kit, which develop at the same time specific educational aims of informatics and also 21st century skills,
- description of iteratively created assessment for developed activities,
- methodological materials with concrete advices and recommendations for teachers.

We have been implementing this curriculum with fifth and sixth grade pupils at lower secondary school in small town Stupava, which is situated near the capital city of Slovakia. Designed activities were taught by selected teacher from mentioned school. This teacher have been teaching according our methodological materials, which included worksheets and instructions to build robotic models for pupils and also various types of assessment for different types of activities. This teacher has been teaching one lesson created by us per week and there were approximately from eight to twelve pupils in one class (girls and boys in different ratio each week). In this classes were also present two (sometimes one) researchers, which were collecting data.

Activities with LEGO WeDo

During designing of activities for pupils at lower secondary school we adhered principles of design of learning activities according Pasch (2005). We created activities with regard of revised learning taxonomy for educational robotics (Kalaš et al., 2014), which presented learning aims and it served as a resource for our next iteration within developing lessons for educational robotics. It also helps us to create various types of activities for clarification and deeper understanding of several construction and programming concepts (Kalaš et al., 2014). In most of activities we tried to embed constructionist ideas (Rusk et al., 2007; Papert), where role of teacher was to encourage pupils to discover function of different commands in software for LEGO WeDo. In some activities we also used instructive elements of teaching. During activities within creating own robotic models we followed principles of “creative robotics for all” according (Rusk et al., 2007): focus on the theme, combine art and engineering, support storytelling, organize exhibitions.

Lessons with LEGO WeDo

We designed 11 lessons for educational robotics (one lesson = 45 minutes) and during all these lessons pupils have been working in pairs. Within next phase of our research we probably are going to modify number of lessons and also its sequence.

Current design of created lessons:

1. Creating mind maps about concept robot and clarifying this concept in real world situations
2. Building robotic model (The dream car) according instructions and acquainting with software for LEGO WeDo (acquainting with icons applied to control motor)
3. Building robotic model (The cabin on robotic leg) according instructions and programming it according worksheet (acquainting with icon count loop)
4. Building and programming own robotic model within selected theme (The best helper)

5. Building simple robotic model with motion sensor (The hovercraft from future) according instructions and programming it according worksheet (programming oriented on motion sensor)
6. Building (with motor and motion sensor) own robotic model within selected theme (The intelligent servant) and programming it with conditions (program must consist from icons: count loop, motor power, motor on for, sounds and motion sensor)
7. Building part of robotic model according prepared picture (consisting of motion sensor and LEGO Bricks), completing it with motor and programming it according worksheet
8. Programming robotic model (The modern turtle) with tilt sensor according to worksheet
9. Final project part 1: Designing own construction and behaviour of robotic model within selected theme (Fairylend)
10. Final project part 2: Building and programming robotic model according to design form previous lesson
11. Final project part 3: Presenting whole robotic project in presentation software

Assessing activities

We divided mentioned lessons based on developing assessment into activities in which we used: peer assessment, norm-referenced assessment, rubric for assess own robotic model, rubric with assessment according to worksheet and assessment of final project. There were also activities, where we did not use any type of assessment. These included activities, where pupils were acquainting with (for the first time)

- concept robot via creating mind maps about it,
- building robotic model according instruction,
- software for robotic kit (acquainting with commands applied to control motor),
- selected components of robotic kit, which include motion and tilt sensor,
- commands, which can be used to control motion and tilt sensor.

Peer assessment

We used this type of assessment when we tried to assess pupils first own work. We applied it during three types of activities: creating definition of robot, creating their first robotic model and developing design of robotic model during final robotic project. Within mentioned type of assessment pupils wrote names of two robotic models on piece of paper, so it was resembling secret voting, where only winner received the best grade. We instructed pupils to vote for two robotic models, because based on data analysis from previous iterations of our research and our own experiences, when pupils voted only for one robotic model, they often voted only for themselves.

Norm-referenced assessment

We applied norm-referenced assessment within assessing only according to worksheets created by us. This assessment based on mutual comparison of pupils' outcomes (Pasch, 2005). Only team with the most correctly completed tasks in worksheet had the best grade. We provided description of several types of activities from worksheets in (Veselovská, 2015a; Veselovská, 2015b). We also used this type of assessment when we were detecting how many

tasks pupils manage to solve during one lesson (45 minutes). We applied it when pupils were building robotic model according to instructions and when they were programming it according to tasks in worksheets. It was during third, fifth and eighth lesson.

Rubrics for assessing own robotic model

Rubric provides the basis for consistent and complex evaluation of pupils' knowledge (Gura, 2011). It is specific kind of evaluation methodology which is using table of created criteria. We created our own rubric on based on observed mistakes, which pupils most often made during work on robotic models. These mistakes we described in detail in our publications (Veselovská, 2015a; Veselovská, 2015b). We have been assessing pupils' robotic models with our created rubric from three points of view: building robotic model, programming robotic model and presenting program which control robotic model. So we divided our rubric into three main sections (see Tab. 1), where we assessed construction of robotic model, program which control robotic model and presentation of this particular program.

For each section pupils could obtain specific number of points (from zero to four points) and its total sum equalled final grade. We created this rubric mainly for assessment of pupils' own robotic model and we are going to modify it within last phase of our research. We applied it during sixth and tenth lessons.

Number of points	Construction	Program	Presentation
4	It contains all required components and it is stable (it does not fall apart when program starts).	It contains all required commands, which are connected in correct order.	It contains correct description of all used commands in program.
3	It contains all required components, but it is falling apart when program starts.	It does not contain all required commands, but remained commands are connected in correct order.	It contains correct description of only some commands used in program.
2	It does not contain all required components, but it is stable (it does not fall apart when program starts).	It contains all required commands, which are not in correct order.	It contains partial correct description of all commands used in program.
1	It does not contain all required components and it is falling apart when program starts.	It does not contain all required commands and they are not in correct order.	It contains partial correct description of only some commands used in program.
0	It does not contain any required components.	It does not contain any required commands.	It does not contain correct description of any commands used in program.

Tab. 1: Rubric for assess own robotic model

During sixth lesson pupils were building their own robotic models within theme The intelligent servant and they were creating it with two criteria: it had to contain motor and motion sensor (see finished robotics models on Fig. 1). They were also programming them with requirement of usage of specific icons included count loop, motor power, motor on for, sounds and motion sensor. We decided to apply requirements for construction and also for program to control robotic model, because based on our experience and data analysis we observed several characteristic situations:

We often had to remind pupils, that their robotic model must contain motor or sensors, when they want to control it with software.

Pupils often did not use sensors in their construction of robotic model, but they wanted to use them in program.

Pupils' robotic model contained one sensor; but they often did not program it.

When we applied mandatory criteria, we did not observe mentioned situations. We described this lesson in detail in our publication (Veselovská, 2015a).

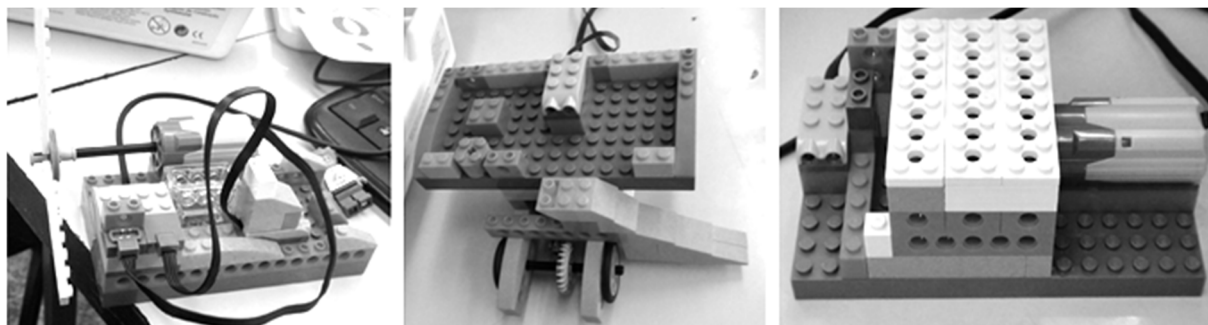


Fig. 1: Examples of three pupils' own robotic models from sixth lesson

During tenth lesson pupils were building and programing robotic models according to theirs designs from previous lesson with several requirements, which we are describing here in the section Assessment of final robotic model.

Rubric with assessment according to worksheet

During seventh lesson pupils were building part of robotic model according to picture (see left part of Fig. 2) and then they were completing it according to their imagination, but it had to include motor. We can see examples of two finished robotic models in the middle and in right part of Fig. 2. This type of activity we assessed with one column (see column Construction in Tab. 1) from our rubric. Then pupils were programming their robots according to six different tasks in prepared worksheet. Accordingly pupils' final grade consisted from two parts: 40 % of assessment was construction of robotic model and remaining 60 % was assessment of their work with worksheet. We described whole lesson in detail in publication (Veselovská, 2015a).

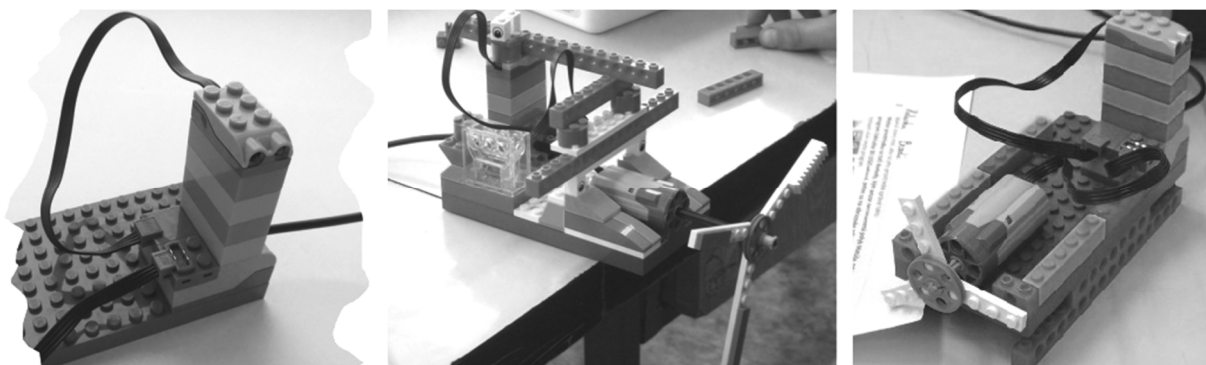


Fig. 2: Examples of two robotic models, which pupils completed from picture (on left)

Assessment of the final project

In our curriculum we intended to conduct larger robotic project, which would take more than one lesson and pupils could demonstrate all their acquired knowledge in it. So we divided whole final project into three lessons:

- creating design of robotic model – drawing a sketch of it (see left part of Fig. 3), describing programs to control it (see detailed description of the first draft of this lesson in our previous publication (Veselovská, 2014)),
- building and programming robotic model according to created design (see right part of Fig. 3),
- presenting whole robotic project with usage of presentation software.

We also decided to assess each lesson separately. In first lesson we used peer assessment as we mentioned earlier. In second lesson we assessed pupils' work according to our rubric and also we were comparing pupils' design of robotic model with its realization. It means we were comparing construction of robotic model (see right part of Fig. 3) with its sketch (see left part of Fig. 3). Then we were comparing program created in software and written description of program from created design. However we focused mainly on assessment within our rubric. In construction of robotic model there were two criteria: it had to contain motor and one sensor (pupils could choose from two sensors). In example we can see that pupils chose tilt sensor in Fig. 3. During programming of robotic model pupils had to follow their created design from previous lesson: description of robots' reaction on selected sensor and description of its three other functions. We can see example of pupils' program on Fig. 4. In final lesson we assessed pupils' work in presentation software and also their oral presentation.

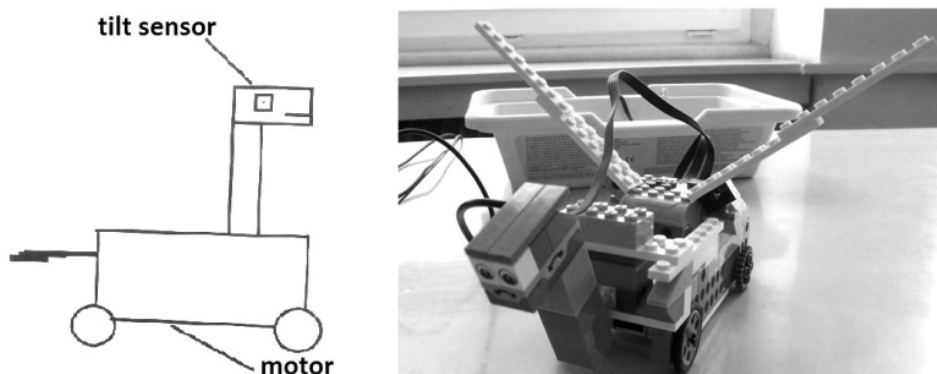


Fig. 3: Example of pupils' sketch of Dragon (on left) and their robotic model which was built according it (on right)

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