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Another Year Behind Us

Dear colleagues,

The beginning of a new year is the best time to look back at the previous year. With this issue, the ICTE Journal has completed the sixth year of its existence. This past year was successful in a number of ways.

1. The ICTE Journal is now included in two more databases – DOAJ and Cabell's

Launched in 2003 at Lund University, Sweden, the former database indexes open access journals. It contains more than 10,500 journals. Cabell's database indexes a similar number of journals as the DOAJ database. Cabell's provides accurate, up-to-date details about academic journals to more than 750 universities world-wide. We hope that in the future, the ICTE Journal will be included in even more databases, thus making the research of our contributors available to as many scholars as possible.

2. The Editorial Board has been expanded

Peter Mozelius from Mid Sweden University has become a member of the Editorial Board. We look forward to working with him and hope that his input will help make our journal even better.

We hope that 2018 will be a successful year for the ICTE Journal and that 7 will turn out to be a lucky number.

On behalf of the Editorial Board, let me wish you a happy and healthy 2018. Moreover, let's hope the New Year will bring many quality papers.

Tomas Javorcik

Executive Editor

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SOCIAL NETWORKS AS A CONSTITUENT OF ELEARNING ENVIRONMENT

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ABSTRACT

The paper presents some results of the analysis of social networks as a constituent of e-learning environment. The paper defines the concept "social network", the basic principles and characteristics of social networks are singled out. Based on the analysis of the results of sociological research, it was discovered that social networks are a common type of network communication that is used by both teachers and students. The advantages and peculiarities of using social networks for educational purposes are established. The authors analyze prospects of using such social networking options and services as exchange of messages, documents and news; ways of boosting teamwork by creating interest groups in social networks; improving teacher-student interaction via personal pages for public and mass communication. The most problematic questions about the use of social networks in the educational process are singled out.

KEYWORDS

Social networks, educational process, team work, exchange of messages, communication.

1 INTRODUCTION

Social networks in the modern world are one of the most widespread phenomena, because there is definitely no person who has not participated in them. Annually we witness the increase in the number of social networks as well as their funcitions, opening up new opportunities. Environments like Facebook, Twitter, Instagram, Youtube are widely used by friends and relatives for prompt news, interesting information, educational videos and music to taste. However, the use of social networks in the educational process has not yet received such widespread use.

Various aspects of social networks are studied in pedagogical aspect by such scholars as M. Glazunov, S. Ivashnev, I. Karp, S. Kirilchuk, O. Klymenko, G. Kuchakovska, N. Matviychuk, N. Pazyura, M. Radchenko, O. Tishkova, O. Feshchenko, N. Shulskaya, O. Shcherbakov, G. Shcherbyna, A. Yatsyshyn and others.

From a sociological point of view, the social network is a social structure created by nodes, united by one or a few common traits and represented mostly by individual members or organizations. Social networks can be created against the background of commonality of values, friendship, kinship, hostility, conflict,

commerce, Internet connections, sexual relations, religious beliefs, or the like. For the first time the term "social network" was used in 1954 by a British sociologist, a representative of the Manchester School, J. Barnes to determine the samples of social ties that went against the traditional concepts for many sociologists such as limited groups (tribes, families) or such social categories as gender or ethnicity, etc.

In the modern world social networks have become an interactive Internet community of many users, separated by time, place of residence, sometimes even by native language, but united by some principle (for instance, common interests, common work, profession, academic interests, hobby, place of residence, etc.) and organized in the environment of a certain web resource, where the content is created by the users themselves. Social networks are designed to build, display and organize social relationships and are used to establish relationships between various users and information resources corresponding to their respective interests, presented on websites of the global network.

Social networks offer new information and communication channels, new ways to interact, special communication technologies and activities. In this case, the activity is exclusively voluntary, motivated both at the stage of choosing a social network and at the stages of the user's daily actions. According to a number of studies, the most popular social networks in the world and in Ukraine are Facebook, Twitter, Youtube , Tumblr, Instagram etc. (data for June 2017) (The most popular social networks).

Most researchers argue that the basic features of the social network are as follows:

1) identification – the ability to provide information about themselves (date of birth, favorite occupations, books, movies, skills, etc.), that is, create their own portfolio with their achievements and aspirations;

2) presence on the site – an opportunity to see who is currently online and engage in communication with them;

3) relationships – the ability to describe the relations between users (friends, family members, friends' friends, etc.);

4) communication – the ability to communicate with other members of the network synchronously and asynchronously (personal and group communication, commenting the posts from participants' personal pages, etc.);

5) mini-groups – the ability to form within the social network of community interest;

6)reputation – the openness of participants' status, their behavior within the social network;

7) exchange – the opportunity to share with other participants the materials important for them (photos, documents, links, presentations, etc.) (Klymenko, 2012).

For more detailed analysis of the current state of using social networks by the subjects of the educational process we conducted a sociological study to determine the scope of use of ICTs in various modes of professors' activity. The research was fulfilled within the framework of international research 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. Participants of the project are universities from Poland, Slovakia, Spain, Australia, Czech Republic, the Netherlands, Russian Federation and Ukraine.

Dniprovsk State Technical University is an official participant of the project, reflecting general trends of development in average technical universities of Ukraine. The sociological survey was conducted via a specially designed toolkit in May 2015 and suggested to professors and heads of structural units of the university . The survey was attended by 53 university staff members, of which 89% are scientific and pedagogical staff (59% associate professors, 26% lecturerss, 4% professors) and 11% heads of structural units.

According to the results of the survey it was found that social networks take the second position in the list of modes of network communication, since every fifth professor uses them in professional activity (Fig. 1). At the same time, the most widely used means for teacher-student communication remains the exchange of messages and instant messaging from DL platform, comfortable for almost half of professors (43,7%).

As for the use of social networks by modern students, it should be noted that they are usually used to communicate with friends and groupmates outside of school hours, and their potential as a resource for distance learning in Ukraine is only gaining momentum. Thus, according to another study conducted in Dniprovsk State Technical University within the framework of the IRNet project[1], it was found that only 15.15% of students used social networks to contact with faculty at extracurricular times. The most popular ways are personal meetings (31.31%), communication via e-mail (29.63%) and by telephone (22.56%).

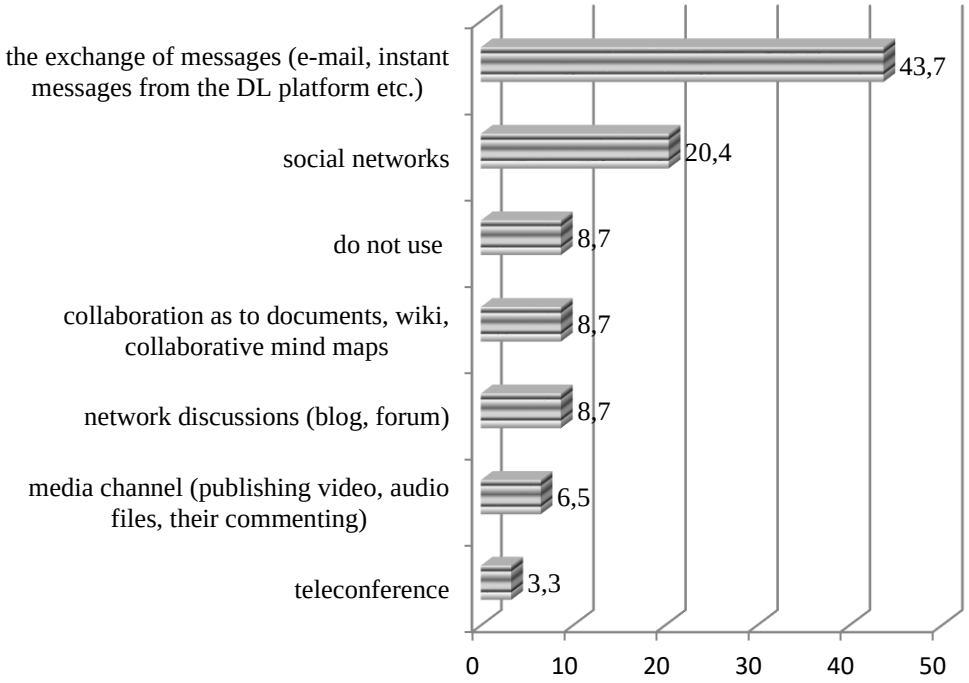

Figure 1 Kinds of network communication, used by professors in teaching, in %

Table 1 The most widely used e-resources for student-teacher interaction outside class hours

Answer	**%**
Personal interaction	31,31
By e-mail	29,63
By telephone	22,56
Via social networks	15,15
Via Moodle platform (or other DL platform)	1,35

Social networks are even less popular when it comes to transferring test papers to the teacher. By asking another question in the survey we were trying to see which ICT instruments the students actually use to

The survey was conducted anonymously in May 2014 by a computer questionnaire, developed within the framework of the IRNet project. Approximately 80% of students responded at home, while others did so after university classes. The survey was attended by 184 full-time and part-time students, of which 49.46% were women and 50.54% men. Regarding the courses, it should be said that among the 184 respondents, 75.54% were junior students (I-III year of study) and 24.46% - senior courses respectively (bachelors, specialists and masters).

deliver assignments to the professor and which ones are considered the most efficient but in practice used less widely. Only 9% of all respondents consider social networks to be effective in this context. Only 5.56% of students have experience of using social networks in learning (Fig. 2). Presumably, such low feedback about both efficiency and actual use reflects some degree of unfamiliarity with the potential of social networks as to creative tasks, file transfer, efficiency of media-enhanced communication in the field of learning.

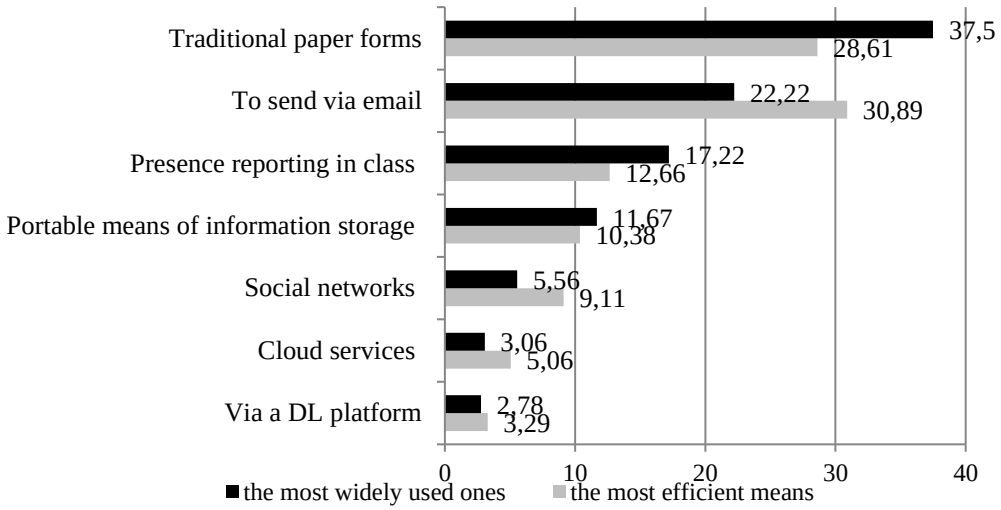

Figure 2 Comparison of the most effective and most commonly used methods of transferring completed assignments to the teacher (in %)

In connection with this in the modern scientific discourse there is a fierce debate about the efficiency of social networks for learning, given that social networks have always been used for leisure time and entertainment. Many researchers are stressing the benefits and potential of this ICT, while others, mainly elder teachers, emphasize its shortcomings. That is why, to objectively analyze the peculiarities of using ICT in higher education, we consider it logical to determine its advantages and disadvantages.

The disadvantages of social networking for education

The openness of network interaction can be perceived both positively and negatively when we deal with educational process. It is quite evident for some researchers that social networks can slow down the learning itself and can hardly become an extra teaching tool, because social communication is traditionally a virtual environment to spend free time. The main obstacles associated with using social networks in education are permanent connection to the social environment, expertise in the communication etiquette among participants, failure to constantly monitor the use of social networks for educational purposes, etc. Additionally, it will not always be possible to check the credibility of educational materials downloaded by the students (Kuchakovska, 2015).

It takes a lot of mental and emotional effort, but also time to organize and manage teaching in the network. Here it is worth stressing poor intsruments to assess teacher's efforts in social networks. In addition, limited access to social networks from university classrooms and unstable access to the Internet can lead to complications for students' learning tasks. Traditional assessment of students' work is also indirect and remains a bit of a challenge.

Apart from that, all participants of network communication need self-organization skills, which is a common problem of entire network communication. In these circumstances, where a message can be sent at any time interval (on business days and on weekends, during the day and at night, after a specified period), it is important for teachers to monitor and track the time when messages arrive, while for the students to limit their communication with professor by working hours. Professors are advised to develop a personalized timetable to deal with incoming messages (Strekalkova, 2016).

We should not forget that online networks are first of all perceived by students as an entertaining tool for online communication with friends. In this regard, researchers point out that students spend a lot of time on online games, various psychological tests, chats, etc. Numerous network applications take students' time, robbing them of concentration on their main learning assignment. Students also lose much time learning the personal information of their friends in order to improve their relationships in the social network (Prensky, 2006). To effectively solve this problem, the teacher must act as a motivator, encouraging students to discipline and rationally use time in the social network.

The lack of direct contact with the teacher and instant feedback also becomes a major obstacle, since the teacher is not able to determine whether the students correctly understand the material of the course, which is especially relevant for humanitarian disciplines, since the test form of the survey in this context is not always there applicable.

In the process of exchanging ideas and points of view on the Internet, students sometimes find it difficult to express complex and abstract ideas, which can lead to misunderstandings and incorrect perception of information. Full immersion of students into virtual space can generally lead to worsening of communication skills with real people and the development of Internet addiction. However, all these disadvantages can be avoided if the social networks are properly used in the educational process.

At the same time, the abundance of social networks is a real disadvantage for professors, who will always struggle in the amount of messages coming in different channels.

Social networks and their functions

Facebook as the world's most popular service was born in 2004 to serve just as an academic social network that was originally available only to Harvard students, then the registration was open to other Boston universities, and later to students from all US educational institutions, having an email address in the .edu domain. Thus, the students logged onto Facebook from university computers and used their academic e-mail address for the purpose (the same for announcements about the schedule of classes, academic plans and debts, educational materials, etc.). It is only since September 2006 (that is, 2.5 years after the opening), the website became accessible to all Internet users aged 13 and older who have an email address.

In the same way American scientists were among the first users of the social network Twitter. During the first year of its existence, reports of scientific conferences, symposiums, references to scientific works, etc. prevailed in it. From this we can conclude that in the American educational community, the use of the social network for educational purposes is perceived as an obvious and inalienable function [Shalimov, 2013].

The YouTube social network provides users with services of storage, delivery and demonstration of video. Users can download, view, rate, comment on, send messages and share their video clips. In particular, the use of video materials in the teaching of humanitarian disciplines helps to assimilate the abstract theoretical positions, and the decision of applied tasks. Due to the viewing of feature films, social reality is presented to students by a tangible and understandable object of sociology that helps their professional development (Korytnikova, 2012). Movies and videos contain examples of social life and interaction in a variety of situations and circumstances. Video materials allow you to analyze social statuses and social roles, to highlight examples of social mobility and stratification, to determine the specifics of a diverse society, and so on. The most successful work with films takes place during seminars as consolidation of theoretical knowledge, as well as in the context of independent work as a recollection of the lecture material. The use of films contributes to the development of analysis skills, the formation of their own thinking, the ability to argue their point of view. Of course, in order for the film to become a means of learning, and a tool for educating students, it is necessary not only to organize a productive discussion of what has been seen and to intensify the cognitive activity of students on problematic issues and special tasks, but also to correctly select the content of the film, as well as the place and time of its use (Rassudova, 2014).

The use of social networks in educational activities allows network members to create network educational content, provides the opportunity to perform group tasks, using such additional options as forums,

comments, polls, voting; simplifies the process of information exchange and provides for the implementation of the principle of continuous education. Here the preconditions are created for the formation of professional competencies of students as future managers: skills of interaction, self-organization, developing the skill of creative thinking (Kyrylchuk, 2015).

In this context, we consider it necessary to study in more detail the possibilities of using various social networking options and services in order to increase the communication efficiency for the participants of the educational environment, since teaching of each discipline can be improved profoundly through such social networking tools as the exchange of relevant announcements, messages, news; the ability to make audio and video recordings that can be accessed by all participants at any time of the day; creating groups and subgroups of interests; meeting new interesting people for further communication and exchange of experience, etc.

Such option as instant messaging is of paramount importance for the educational process. It is messaging that promotes regular operational formal and informal communication of subjects of the educational process for learning purposes in real time: teachers with students for consultations and permanent coordination of activities; teachers with teachers to exchange experiences and find innovative teaching methods; students with students to solve various issues and extracurricular communication; teachers and parents to inform the latter about the achievements of students, etc. With the help of the messaging service, you can freely transfer organizational and training information, send training materials and tasks, as well as review them, consult.

Thus, learning becomes more targeted and individualized, thus the delivered messages and materials are kept indefinitely and allow the students who did not have the opportunity to attend classroom to get acquainted with missing topics. All versions of the documents are available at the same time both to the teacher and the student, which solves the problem of backup and loss of electronic version of reports. The transfer of the tasks (abstracts, essays, coursework and master's theses) to the teacher for checking through social networks significantly reduces the expenses for printing the material. At the same time, the teachers does not need to carry heavy paper copies with him, because they can review the papers at any convenient time from laptop, tablet or smartphone, and immediately make comments in the document and at the same time ask students to clarify some points in the messenger. In addition, having an electronic version of the work, the teacher can immediately check it for plagiarism.

To unite students according to interests, to perform group tasks and form teamwork skills we can use a service that allows you to create groups in social networks. Through these groups it is possible to effectively organize the work of groups and sections, coordinate students' work on their own educational projects, discuss problems, organize educational and cultural events, which may include large audiences: authoritative scholars and public people, students from different universities, colleagues from abroad, parents, etc. Thus, from a personal social profile one can build a real educational (virtual) community (Radchenko, 2014).

The social network in this case can function as an endless forum – to permit to constantly create new topics, to comment on and discuss the posts of other users, to participate in the educational discussion, to fill the running news section with their own materials or interesting news, to comment on the educational materials of their colleagues from the community, etc. Thus, by attracting students to the network instructors stimulate them to scientific work and, at the same time, create for them the opportunity to be members of a prestigious community. Social networks were originally created specifically to stimulate social interaction, so using this opportunity will allow students to collaborate on projects in social networks. By creating a training group in a social network, teachers can significantly increase the level of motivation in a group and give students the opportunity to participate in multi-level interaction. It has been established that social networks allow each student to perform tasks at a rate corresponding to their individual characteristics and not dependent on more capable students (Pempek, Yermolaeva, Calvert, 2009).

Organizing students' work in groups will make learning more problem-oriented and student-centric, since each group can work on the task of seeking solutions to a problem situation or problem. Therefore, the

teaching materials and consultations in each group become more specific and without distraction. Owing to virtual learning groups it is possible to implement different tempos of student learning (moderate, medium, high), which are conditioned by different input competences, levels of motivation and subjective external circumstances of students. In groups of social networks we can continue the discussions that were initiated during classroom sessions and which raised some special interest in students, the ones which will provide more thorough mastering of the material. The support of the educational topic in the social network allows those who missed classes not to "fall out" from the topic, but to participate in discussions and perform tasks at home. Such groups can be created not only by teachers but also by students themselves, who can be their administrators. This contributes to the development of leadership qualities, improves social activity of students, the level of their self-organization and the implementation of the subject-subject paradigm of higher education. Students have the opportunity to use social networks to work together in the format of some initiative with bottom-up approach. Virtual social networks have created conditions for students to share what they learned and the interesting things they discovered on the net with their classmates and teachers.

Messaging as well as the wall of a personal page are a good service for individual communication, for public (mass) communication, since they allow to publish for a large number of students at less time - the teacher does not need to send a personal message to each student, but just publish it on the wall in public access. And students, in this case, can only put a "like", thereby affirming the fact of familiarity with the information and do not have to waste time creating a personal message. Messages about changes that are occurring in the learning process are displayed instantly, they are easily tracked due to the constant updating of the news feed. On their personal page, teachers can publish teaching and other informative materials, share interesting news, report important events, present links, and more. It is advisable to use the wall of your own page to remind of meetings, conferences, cultural events. Publications on the teacher's page allow students to learn more about the latest research of teachers and other professionals in a particular field of knowledge. Thanks to personal pages interpersonal relations between teachers and students are facilitated, effective communication is established, after reading the information about the teacher and reviewing his posts and photographs, students can find common interests with a teacher outside the discipline. Familiarization with students' pages allows the teacher to better understand the identity of the interlocutor, which leads to increased openness and informative communication. In turn, the evaluation ("likes", "preferences") of publications and photographs provides a natural desire to get an appropriate response to their actions and thus makes further communication more relaxed.

Significant advantages in attracting students and activating their thinking are audio and video records that can be distributed, either through the exchange of messages, or publication in groups or on their own pages. With this service, you can view and listen to educational videos posted on the network, as well as add your own. Visualization of materials to overcome the technical difficulties of properly equipping study groups for displaying visual materials in electronic form is one of the most important positive aspects of the use of virtual social networks in the educational process (Iatsyshyn, 2014). In this context, for the purpose of distance learning, the service of conducting group video conferences is of particular importance, which ensures interactive learning and conducting lectures and discussions in real time.

The advantages of social networking for education

The use of social networks for educational purposes apparently has the following benefits:
- cost-efficiency and affordability at any point, as access to all social networks is free of charge due to Internet technologies, and therefore the university does not need to buy special software. Due to the spread of the Internet it is possible to communicate and exchange information between students from different countries;

- the ease of registration and use, the convenience of distribution services and message information, user-friendly interface and good functionality, which allows students to feel comfortable in this environment;

- the formation of students' ICT competences necessary for life in the knowledge society;

- constant interaction of students and teachers in a convenient time outside the classroom, which promotes the unity of the student's group, giving them some experience of independent organization of their work;

- joint creation and improvement of educational content that promotes interest and motivation of students in studying the course, because instead of passive perception of lecture materials, students have the opportunity to discuss in forums, participate in polling or voting, exchange interesting and useful links;

- ensuring the development of the student's personalized learning environment, promoting self-study of students, since each of them needs to work at their own rhythm. Thanks to the person's identification in social networks, teachers have the opportunity to learn more about the student's personality, his or her individual characteristics and to offer them information, topics or tasks that should interest them;

- continuity of training, since it can be carried out in the on-line mode, which allows you to work and study even during illness;

- informal communication between a teacher and a student, since in a social network the teacher becomes an assistant, friend, mentor (Kuchakovska, 2015);

- in the organizational aspect social networks allow the prompt publication and receipt of information about the schedule of classes, training, tasks, etc.;

- availability of a mobile version of the pages of the virtual social community, ie access for students and teachers at a convenient time and in a convenient place from any mobile device (mobile phone, tablet, netbook, laptop, smartphone, etc.) connected to the Internet;

- visualization of materials that can overcome the technical difficulties of equipping the classrooms with the necessary equipment for displaying visual materials in electronic form (Iatsyshyn, 2014);

- regular use of social networks in the educational process promotes the formation of digital communication skills; develops communicative competence.

In pedagogical activity, the prospects of social networks can be used to solve a variety of tasks: to effectively organize collective work of a distributed training group, long-term project activity, international exchanges, including scientific and educational ones; to receive the opportunity of continuous education and self-education, network collaboration of people located in different countries, on different continents of the earth. It all speaks of great opportunities, as teachers can wisely plan their timetables, properly organize their schedule and achieve good results. Social networks allow you to optimize your own time expenditures and achieve an effect not only for yourself but for students, that is, to achieve the most important goal of the educational process. It is social networks, actively used recently, that are considered as a mechanism where students and teachers can find points of intersection of common interests within the learning process and maximize the effect on both sides. For the teacher, this is manifested in the optimization of time, and for students in achieving high qualitative and quantitative indicators.

The use of social networks gives the following benefits to the teacher: support for the teacher's professional activity; the possibility of self-realization and self-fulfillment through joint practical activity; creation and support of new educational initiatives; selection of optimal forms and rates of teaching; the use of those learning methods that are most relevant to the individual abilities of students; creation of a single informational pedagogical resource; organization of practical activity of teachers in the network; development and realization of creative skills of project participants.

It should be noted that the introduction of social networks into the educational process provides an opportunity for students: to study in depth individual disciplines, sections or topics; apply the learning methods most relevant to individual abilities; receive and send training information promptly; obtain a chance of self-realization and self-assertion through joint practical activity; participate in various projects of knowledge acquisition in various subject areas; to expand communicative communities, to cultivate

tolerance, to develop critical thinking; to choose the optimal forms and tempos of learning; develop autonomy and responsibility; skills of team work (Tishkova, 2014).

From the results of research on the use of social services in education in the United States it was concluded that first-year students who study using ICTs and especially social networks are more successful in learning than full-time students (Barnes). Currently, many university accounts are registered in different countries, where academic staff and students, independently or collaboratively, create educational content, which in turn stimulates independent cognitive activity in others. In Ukraine the practice of using social networks for educational purposes is rapidly gaining popularity.

The advantages of social networks as to improving the efficiency of teacher-student interaction lie in the fact that they represent a familiar environment for the students where they spend most of their time. They have a simple user interface; they incorporate many additional services that can be used to create their own educational content. All this allows you to save time bypassing the stage of adaptation of students to the new communicative space. This, in turn, contributes to improving students' interest in a particular subject. For a modern generation Z it is more interesting to search and learn educational material not in printed form, but through the Internet. It becomes possible to create educational content in collaboration (learner and teacher). Instead of simply consuming information, learners create messages, discussions and other resources. All this contributes to the enhancement of the communicative relationship between students, strengthens the student community, which learns to organize their own work outside the classroom. Social networks have the advantage from an economic point of view, because this service is free, which does not require expensive software for data storage (Kuchakovska, 2014).

The use of social networks as a communication platform allows to organize independent work of students in extra-curricular time. After all, methodically correct and purposeful involvement of online services in the educational process potentially promotes self-regulated self-study, since learning through electronic social networks is an active, dynamic process, initiated and managed by the students themselves. In addition, the use of network technology services as a modern educational tool improves the quality of educational process, promotes formation of media literacy in learners, which allows to quickly respond to the new requirements of the information society (Shulska, 2017).

With social networks as an instrument of learning, students develop the skills needed by the calls of the 21st century, that is, improving the skills of communication with other people, the skills to correctly and creatively use information to solve problematic issues. The social network empowers the teacher to see students interests' deeper through their interests, activities and communities. This permits the teachers to offer students the kind of information, topics or tasks that must be of interest to them.

Social networks offer profound opportunities for establishing communication between teachers and students' parents. Traditional means of communication with parents through the students themselves do not bring the desired effect, either due to the parents'work overload or to the student's reluctance to inform parents of not so positive news. Social networks transform parents from passive observers to active participants in the educational space, since they enable them to constantly keep abreast of events by discussing various situations in Facebook and similar groups in etc. Thanks to social networks, students, their parents and teachers will at any time be able to get acquainted with the success, attending classes, activities in the scientific life of the university (conferences, seminars, articles publications, internships). On the other hand, it disciplines students who understand that parents are aware of their educational achievements and disadvantages as well as teachers, as they are exposed to parental attention.

CONCLUSION

Consequently, the use of social networks in the educational process of higher education institutions has many advantages, first of all related to the development of communication skills and information competences of students and teachers. With the help of social networks, the teacher can significantly simplify the procedures for informing students about current events and plans; provide methodical manuals

and educational materials; share additional instructions; teachers can accept, review and edit students' assignments in electronic form; they can continually counsel students on problem issues individually. Social services allow you to save time, overcome territorial and communicative barriers, organize discussions on educational topics, and therefore can successfully supplement modern teaching aids. However, the practice of using such services in the learning environment has not yet become widespread, which is conditioned by the lack of methodology to use social networks as a means of training. Besides, educational management or professors themselves need to set the rules of this communication – decide upon the channel of network communication and oblige students use only the one suggested, otherwise this communication will rob professors of precious time and will turn all communication into a chaos, a communication noise.

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PROCEDURAL TERRAIN GENERATION AND PATH SEARCHING IN EDUCATION

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ABSTRACT

This paper is primarily devoted to development of an educational desktop application, that describes terrain generating and pathfinding to students. The application is meant for lessons of Artificial Intelligence, that is one of compulsory optional subjects on Department of Informatics and Computers, University of Ostrava. Selected implemented algorithms enable to generate a terrain with adjustable parameters in three different implementations and it also enables pathfinding in three different ways. Used methods are compared according to different criteria for better understanding. Algorithms used in the application for terrain generating are fault method, hill algorithm and value noise. For pathfinding, there were used Dijkstra algorithm, A* and breadth-first search. The application enables camera movement around the terrain and graphical projection of costs of edges for pathfinding.

KEYWORDS

Terrain generating, terrain editing, pathfinding

1 INTRODUCTION

In today´s computer games, algorithms for terrain generating and pathfinding are used very often. Although this field is well known, there is still room for improvement, mainly because of time and space complexity or realistic terrain appearance.

Talking about available terrain generators, most of them provide procedural terrain creation followed by free editing. This ensures that terrain meets our requirements and we don´t have to create everything manually, which results in time saving. Most of current terrain generators doesn´t create real 3D landscape. In fact, it is only pseudo 3D terrain, sometimes called 2.5D. 2.5D is used in presented application. Noise functions are often used for terrain creating. However, you can use them for example to simulate handwriting or texture creation. As for pathfinding, we can see it not only in computer games, but also in the real world. These are, for example robotic vacuum cleaners looking for optimal routes or navigation systems.

Main reason of creation of the application was an attempt to give students an idea about possibilities in the field of terrain generating and pathfinding. Graphical output provides better understanding of used methods, thanks to their visual representation.

2 TERRAIN GENERATION POSSIBILITIES

There are many ways, how to deal with the generation of terrain. However, the methods try to do the same, creating something that resembles real terrain. The degree of similarity depends on purpose for which the terrain is created. In computer games, there is sometimes excessive realistic undesirable and landscape is often required to be adapted for fast processing and gamer´s walk-through of game.

The first option, how to create terrain is to generate it from curves. Unfortunately, in this case, it is difficult to simulate impression of randomness and the description of the terrain is also very complex. Generally, this approach isn´t used very often. The second way, and the more frequent, is "pure" procedural generation. Here are procedures using fractal geometry.

First mentioned method is fault method, which has a very simple procedure. First, a matrix of points is created, where each point has height set to zero. Subsequently, the area of matrix is divided into two parts, most often by a single line. The height of a part increases by some value and the height of the other is reduced by the same value. The procedure is then repeated, until we get desired appearance. We don´t need to work only with lines. Any shape can be used to divide area into two parts. Besides the variation, when we change height like in previous text, we can use other possibilities, to create a smoother surface. For this we use for example the sinus or the cosine functions (Fernandes, n.d.).

The second option for terrain creation is diamond-square algorithm. A condition of its use is to work with square array, but nothing prevents us from creating large square array and after procedure of creating terrain, we can "cut out" a rectangle or other non-square shape. The main principle is that we assign height values first to the centre of the square and then to the centres of sides of this square. Than we repeat process for newly created squares. Everything is repeated until the whole field is full of values of height.

Another here presented option is hill algorithm. It works by randomly choosing locations on which it creates hills. We can influence parameters of the hills such as location and size. If the new hill interferes with any of the previous, the final height of the collective points is sum of the height of point from an original hill and a new hill. We can affect the appearance of terrain by adjusting the range of random values or decreasing the maximum possible radius value with each new paraboloid or reducing it only for the certain number of new paraboloids (Nystrom, n.d.).

Value noise is another option. It is based on a composition of several grids together. Grids are generated with decreasing spacing between selected grid vertices. For the first octave, this spacing is the largest possible – grid size – meaning only four vertices are selected. Height of selected grid vertices is randomly generated from predetermined range and height of vertices between them interpolated. Appearance can be easily improved be creating one or more new octaves with a smaller spacing. The more octaves are created, the more it looks realistic. These octaves are eventually added together to build the final terrain. It should be noted, that every other octave has a higher frequency (smaller spacing) and a lower amplitude (smaller random height interval), otherwise summation of octaves wouldn´t have desired impact (Code.google.com, 2011).

Very popular technique is use of a Perlin noise, as it can be generally used in any number of dimensions. But we work most often only maximally with three dimensions. The main idea is that, for example for 2D, the function accepts parameters *x, y* and returns a single value, as well as in 1D or any other dimension. Returned value is always from <-1,1>. It should also be noted that for the same input values the function always returns the same output value (Biagioli, 2014). For more info about an improved Perlin noise see (Perlin, 2002).

Ken Perlin, author of Perlin´s noise, also created a simplex noise. Although the Perlin´s noise is abundantly used, it suffers from several ailments, that the simplex noise tries to remove. The main differences are lower computational difficulty and the fact that its generalization to higher dimensions is computationally less demanding than for original Perlin noise (Gustavson, 2005).

Terrain editing and completing

Already created terrain can be modified by below mentioned methods to meet our ideas. We can, for example, try to increase valleys. This can be done simply by raising normalized values of height of each point to the power of two. This step affects more lowest values and higher values only a little bit. If larger valleys are needed, it is possible to use raising to the power of three, etc. (Nystrom, n.d.).

For the creation of islands is suitable hill algorithm. The goal is to prevent the hills from being placed in contact with the edge of the terrain. This will create an island. Of course, we can set the island´s minimum distance from the edge arbitrarily. With enough hills in the centre of area, it looks like the island.

Mountains generated by the above-mentioned methods, unlike the true mountains in nature, look like mountains even turned upside down. Only geologically young objects achieve this in the real world. Therefore, it is necessary to use for example erosion algorithms on the generated terrain to make the mountains different from the valleys. The main three groups of erosion used it terrain editing are thermal erosion, hydro erosion and wind erosion (Žára, 2004).

3 PATHFINDING

Finding paths in a map means finding paths in graphs by using graph algorithms. All points, that we can find during searching are represented as nodes of graph. Connections between nodes are represented as edges.

Well-known pathfinding algorithm is the breadth-first search. Graph is searched symmetrically. This means, that it spreads equally into all sides. It doesn´t favor any of his neighbors. So, we can say, that algorithm always extends into nodes lying in the distance *v* sooner than in distance *v+1*. Other well-known possibility is the depth-first search. It, as well as the breadth-first search, is uninformed method as it doesn´t take into account the location of target node and doesn´t use heuristic. This algorithm may not find the shortest path from start to end. This is ensured only if graph is tree-shaped and start node is root node (Kolář, 2000).

Dijkstra algorithm works with values of edges. It is used to find shortest path in weighted graphs. Weight of edge can´t be negative number. It is not necessary for the shortest path to have the least possible number of nodes, but sum of values of edges is always the least possible (Kolář, 2000). We can also use Bellman-Ford algorithm. This method can be used also for unweighted graphs, which is the main difference over Dijkstra algorithm.

A* algorithm is in the category of informed algorithms because, unlike those already mentioned, it uses a position of a target node. We can say, it looks for optimal path and explores less nodes than Dijkstra algorithm. Algorithm uses function *f(u)*, so-called heuristic function, which is for each node determined as follows:

$$f(u) = s(u) + c(u) \tag{1}$$

Value *s(u)* is distance between used node and start node. For this number we can use value calculated as in Dijkstra algorithm. Value *c(u)* is an estimate of distance from used node and the target. For the estimate of the distance we can use for example Manhattan metric or Euclidean metric (Kolář, 2000).

SMA* is abbreviation for Simplified Memory Bounded A*, it is an algorithm based on A*. Main significant difference, is that the algorithm has a limited memory size compared to A*. Therefore, it is necessary to define which nodes are stored in memory and which are removed (Russell, & Norvig, 1995).

4 APPLICATION

The application is written using the Java programming language, version 8. OpenGL (Open Graphic Library) was also used, accessed through the LWJGL (Lightweight Java Game Library). Application can be found at: http://www1.osu.cz/~svabek/TerrainApplication.zip

Application environment

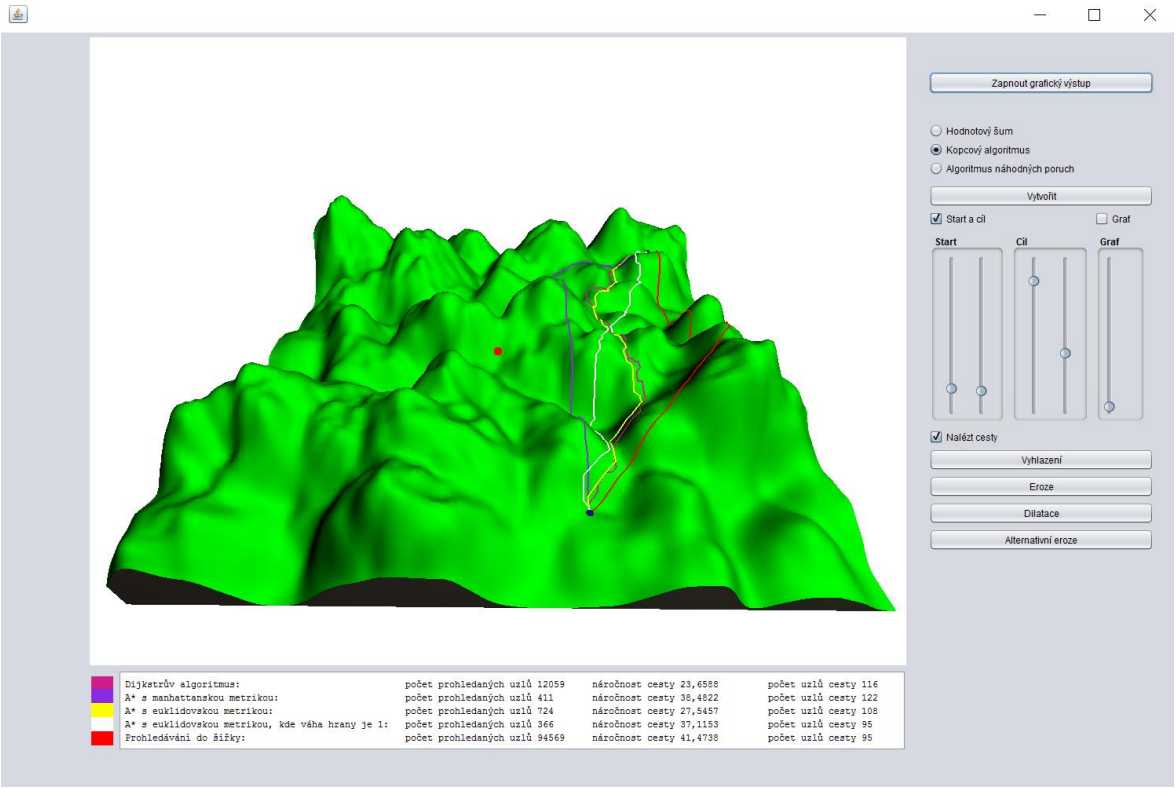

Figure 1 GUI

The application consists of three main parts. The first part is a window for terrain. The second part is section located on the right side, enabling to user interact with program. Last part is a text listing below the main window, where we can see the result values for each algorithm after pathfinding.

Application control

The application is controlled by elements on the right side of the window, a keyboard and a mouse. The *Turn on graphic output* button displays the terrain created by the value noise. Switching between different terrains is done by selecting *Value noise*, *Hill algorithm* or *Fault algorithm*. When the *Create* button is pressed, the terrain is replaced by a new one. The *Start and finish* checkbox highlights two blue spheres that represent the start and finish of the path. Their starting position is in the upper left corner, unless the terrain is rotated differently. By selecting the *Graph* checkbox, a chart appears over the terrain. It represents difficulty of transition between nodes by its color. The sliders in the Start and Finnish sections allow user to set the starting position and destination for the pathfinding. In each section, one slider represents coordinate on the x-axis and the second on the z-axis. The slider in the *Graph* section deals with the y-axis. It increases and decreases the offset from the terrain of the chart as well as of the start and finish spheres and found paths, if they are visible. The *Find path* checkbox will search for paths between start and finish with use of predefined algorithms. These paths are displayed in the terrain and some of their values are listed in the text box below the terrain window. Found paths differ in color. How colors are assigned to individual algorithms can be seen next to the text box. The *Smoothing*, *Erosion*, *Dilatation* and *Alternative erosion* buttons are used to adjust the generated terrain. Through their proper combination we can achieve much nicer and more natural terrain than the initial terrain provides.

When user click on the window where the graphical output is displayed, it is possible to rotate, move and zoom the terrain. The *w*, *s*, *a*, *d* keypad keys make the camera move forward, back, left and right. The upper and lower arrow keys allow to move the camera up and down. The movement of the mouse controls the

overall position of the camera, which rotates around the red dot, which is the center of the view. The mouse wheel controls zooming in and zooming away from the center of view.

Specification of text output

The text output contains four columns. The first one specifies algorithm used for the path. The second one stands for number of scanned nodes. This value increases when algorithm finds unexplored node and changes the values of its variables. The third column represents difficulty of the path. It is the sum of difficulties of edges that creates path. The last column is number of nodes of path. This number indicates, how many nodes the path contains.

It is possible to have objection, that algorithm find the shortest path only if it explores all nodes. That is true, but for the testing purpose and specially to see savings in nodes exploring for A* versus Dijkstra algorithm, a variant of the so-called early termination was chosen. So, the search ends when the finish node is found.

Graph

Each node in the graph is linked to nodes in its immediate vicinity. If we don´t take into consideration nodes on edges of space for terrain generating, then the number of neighbors is always eight. The color of the edge between two adjacent nodes indicates, how difficult it is for the search algorithm to use it. We can say that green means rather a flat surface and red means steep edge. This is based on used evaluation function (2).

$$y = \frac{1}{-(|b_y - a_y| + 1)} + 1 \tag{2}$$

Here b_y stands for height value of node, a_y stands for height of one of his neighbors. Since absolute value is always greater or equal to zero, y is always positive number in the interval <0, 1). The y value is than used for assign color to edge by command GL11.glColor3f(y, 1-y, 0). Function glColor3f accepts the red, green and blue values of color as parameters in range <0, 1>.

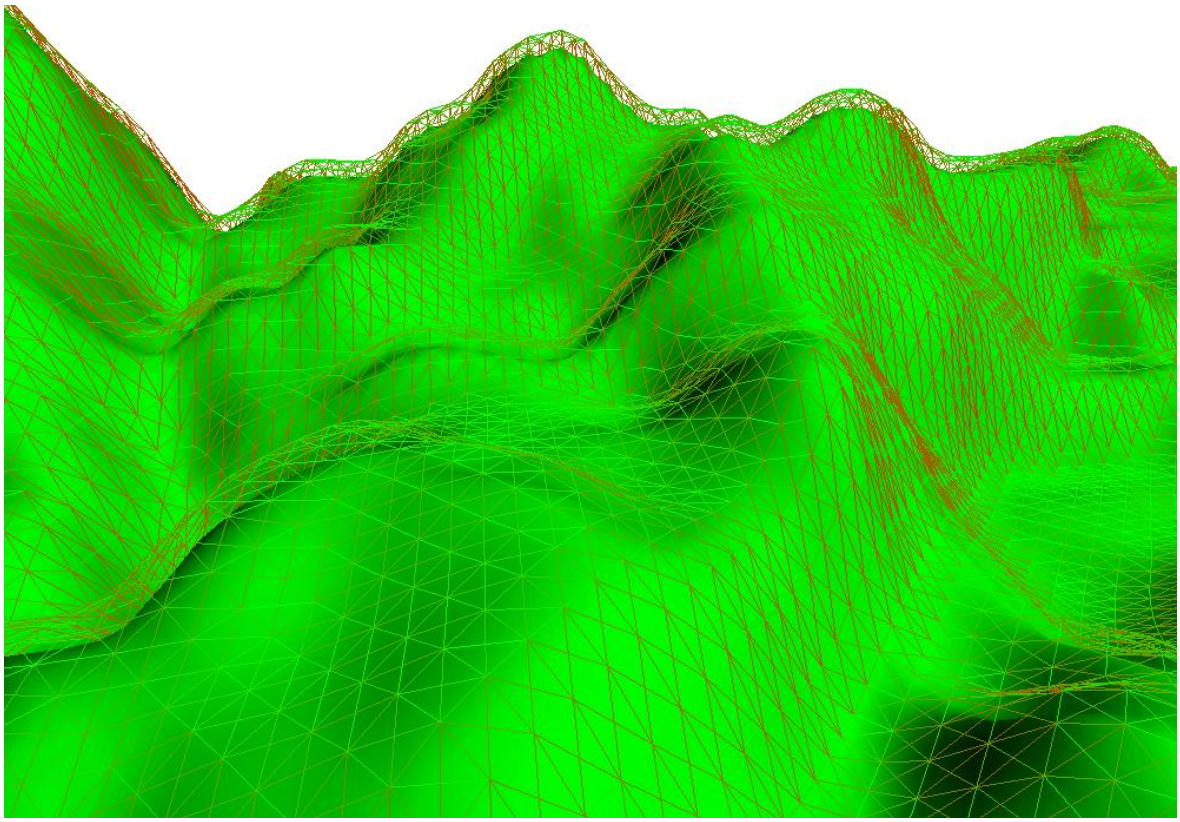

Figure 2 Colored edges

Generation of terrain

Application implements three methods: fault algorithm, hill algorithm and value noise. The reason for this choice was the fact, that these methods don´t provide the satisfying terrain unlike the Perlin´s noise. The main aim was to find out, if we can get a good-looking terrain from them thank to the follow-up adjustments. All three algorithms use a random number generator in their implementation to ensure that each terrain is original.

The terrain is a field of vertexes (129*129). Vertexes at the extreme edges are not rendered and serve only for calculations. Each vertex has value of its height. That´s why we´re talking about creating 2.5D terrain and not about the real 3D. We can never create caves or overhangs. Vertexes are grouped into strips of triangles and these are then rendered in the graphical output window. The following are examples of each algorithm without any modification.

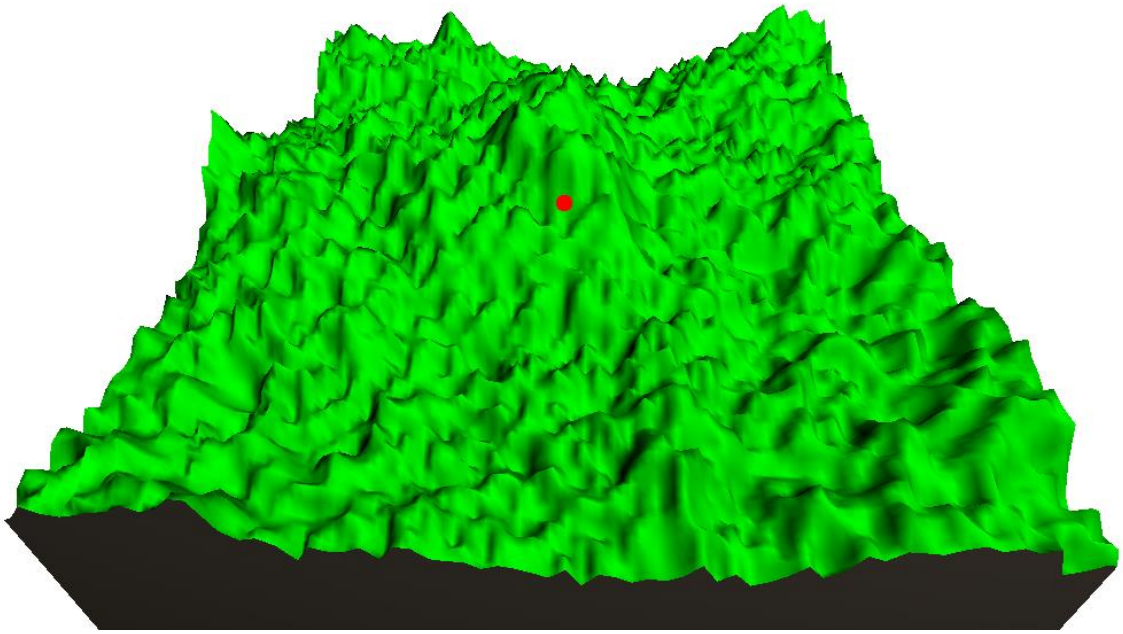

Figure 3 Value noise

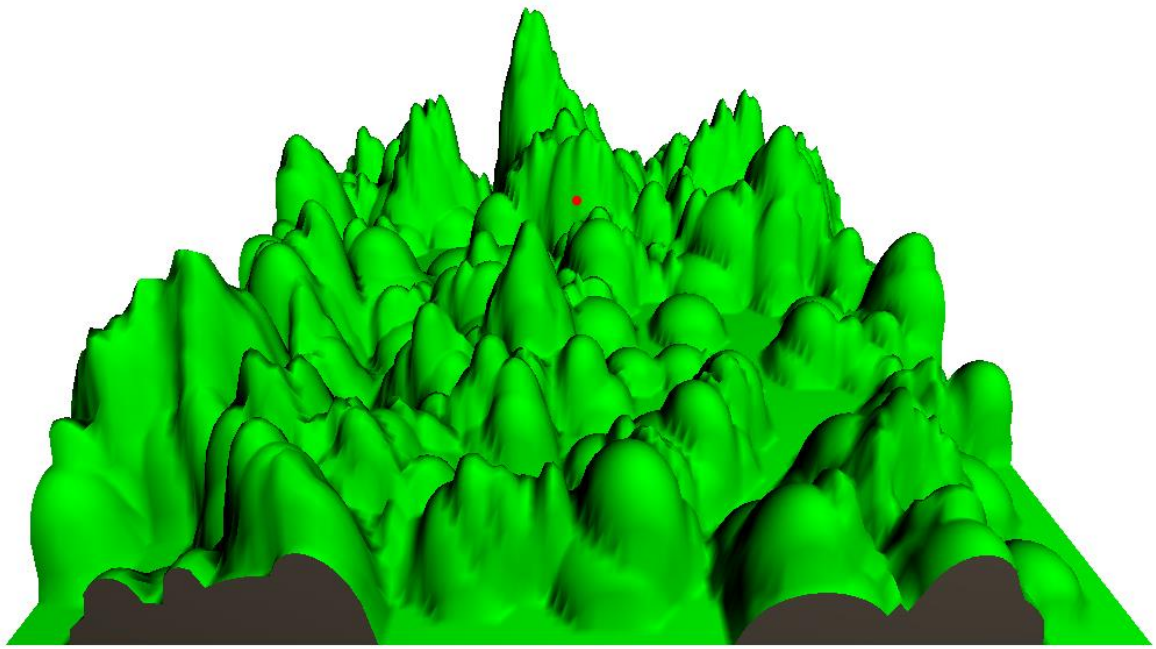

Figure 4 Hill algorithm

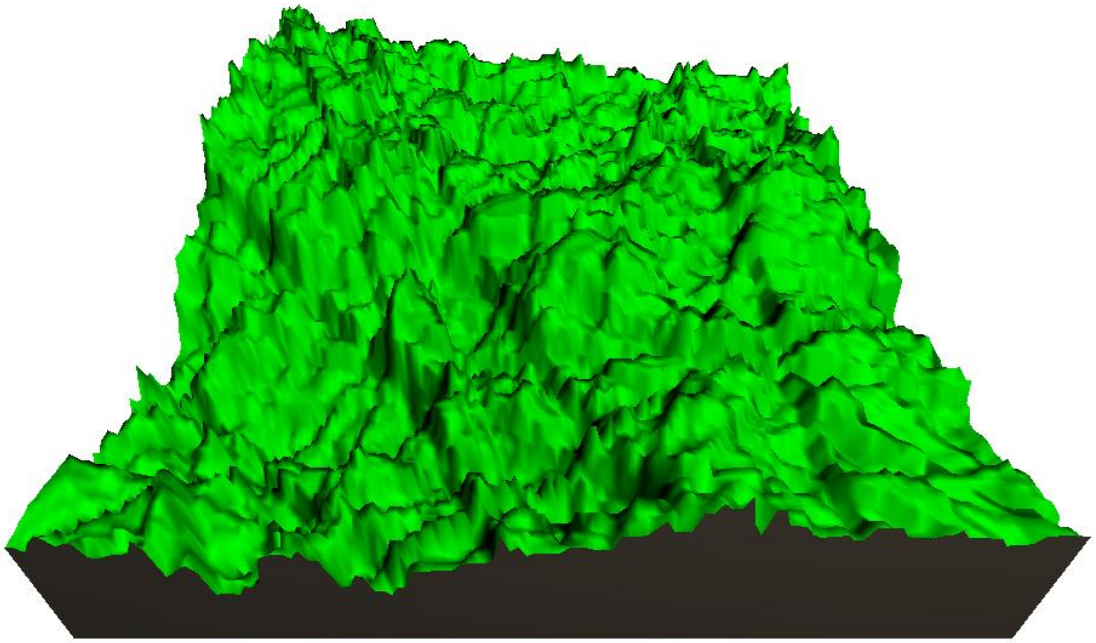

Figure 5 Fault algorithm

Editing of terrain

An appropriate combination of modifications creates a wide range of different shapes. All terrain adjustments implemented in program are based on a principle, that the new height value for vertex is created by height values of surrounding vertexes and its own height.

During smoothing we make an average of 8 neighbors and twice the middle vertex itself. For vertices that lie on the edge of field, we work with smaller neighborhood. The central vertex is counted twice to increase its influence, eventually reducing smoothing effect.

Erosion works only slightly differently. We again work with one vertex and its neighborhood. But now we add only values of height, that are smaller than height of central vertex, and twice the height of central vertex itself. The sum is again divided by the number of used vertices. This modification used multiple times results in creation of craters.

Dilatation of the terrain causes its visual swelling and aligning. The sum in this case includes vertexes whose height is greater than value of central vertex.

The last created option is an alternative erosion. Compared to the previous one, it uses randomness. The vertex height is used only if random value generated from the interval <0, 1> is greater than 0.8. Final value is equal to sum of used vertexes divided by their number plus one plus random value from <0, 1>.

To avoid unwanted visual artefacts or terrain behaviour, such as waves, it is necessary not to change values of vertexes immediately. Therefore, the second field of vertexes with the same size is created and newly calculated values are stored in it. Finally, these two fields are swapped.

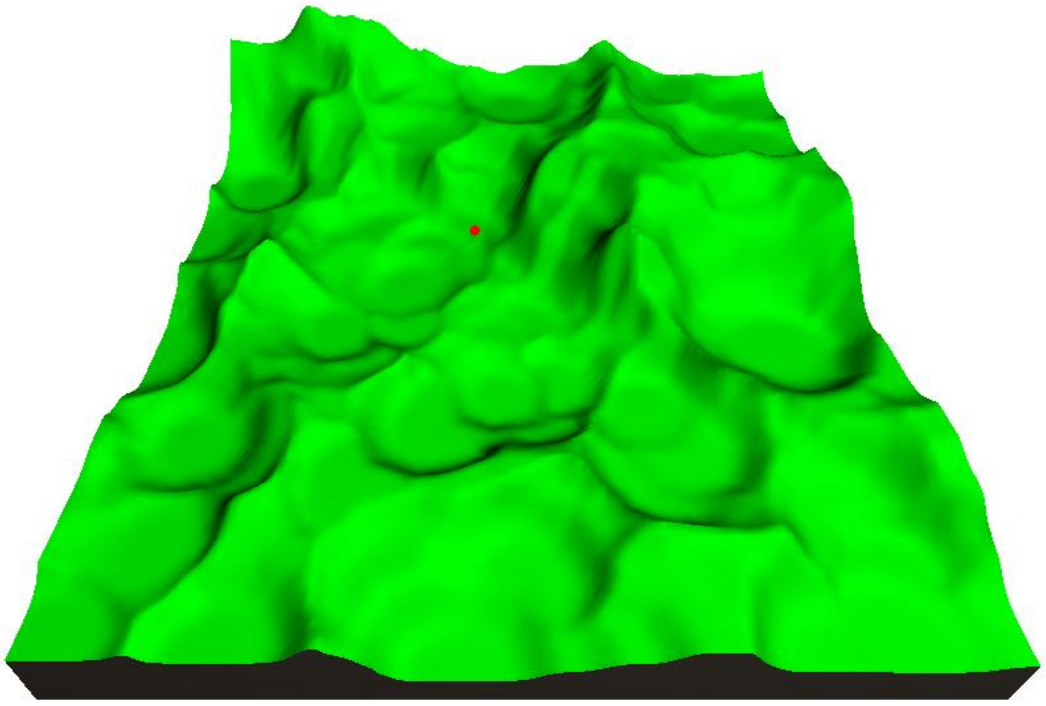

Figure 6 Craters

In figure 6, we can see a multiple application of erosion on a terrain created by fault algorithm.

Pathfinding

To demonstrate the algorithms that are looking for a path were chosen Dijkstra algorithm, A* in three modifications and breadth-first search. All these methods use a priority queue to store nodes while going through terrain. Nodes are ordered according to the rating function. The higher the value is, the further the nodes are inserted from the beginning of the queue. At the beginning, the queue always contains only the start node. Than nodes from his neighbourhood are added according to priority. First node in the queue is

removed from it and his neighbours are explored. If these are not field's border nodes, then number of neighbours is always eight. To consider the fact that the diagonal transition is longer than the horizontal and vertical transitions, the diagonal values of difficulty are multiplied by $\sqrt{2}$. The edge evaluating procedure is similar to the procedure of colorful graph creation. Difference is that now even transition over flat surface is not zero. See equation (3).

$$y = \frac{1}{-(|b_y - a_y| + 1)} + 1 + 0.01 \tag{3}$$

Here b_y is the height of the node and a_y is the height of one of his neighbors. Value of 0.01 will guarantee that even a crossover over flat surface will not have a zero value of difficulty.

A* uses the approximate direction in which the target should be. Program shows three possible variants. The first of them uses the Manhattan metrics. The second is Euclidean metric that uses real value of edges and the third is Euclidean metric that uses edges evaluated by 1. The use of the A* results in decrease of explored nodes. The price for this reduction is loss of possibility to find only optimal path. This path can be the shortest one, but it is not ensured. If we want to compare the Euclidean and Manhattan metrics, then we need to say that Euclidean uses more demanding mathematical operations, such as the division. This results in its increased time complexity.

Function used by A* to insert a node into the right place consists of two values: the node´s shortest distance from the start, that is found by previous steps of the algorithm and the value calculated by one of three previously mentioned options. The latter value may be quite inaccurate and represents only an estimate.

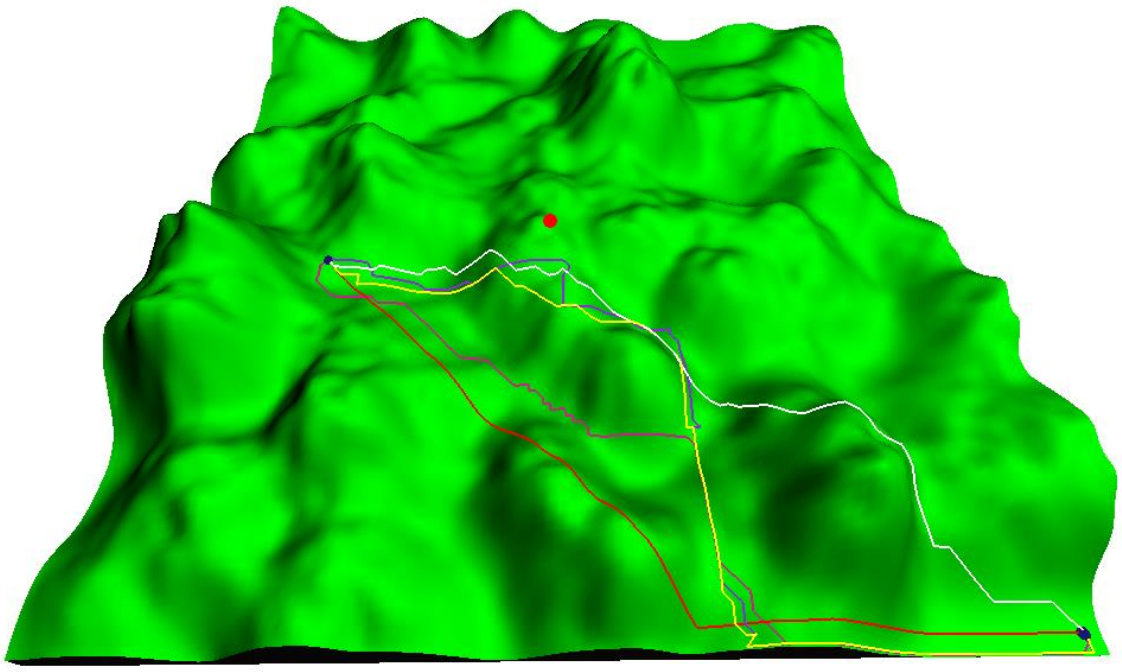

Figure 7 Found paths

Comparison of pathfinding algorithms

Pathfinding was executed twenty times on randomly generated terrains. The starting position was in the upper left corner and position of finish was in the bottom right corner.

Dijkstra algorithm always found the shortest path but with larger amount of explored nodes than A*. Due to same location of start and finish and the also fact, that breadth-first search doesn´t use value of edges, it had always same number of explored nodes and same number of nodes of path.

Terms from the two following tables are defined in previous text.

Table 1 Pathfinding algorithms

Algorithm	Average number of explored nodes	Average difficulty of the path	Average number of nodes of path
Dijkstra algorithm	15 914.85	33.59	214.45
A* with Manhattan metric	578.85	67.71	242.60
A* with Euclidean metric	3 171.90	49.71	227.35
A* with Euclidean metric, where value of edges is 1	634.70	64.67	134.00
Breadth-first search	127 510.00	67.67	127.00

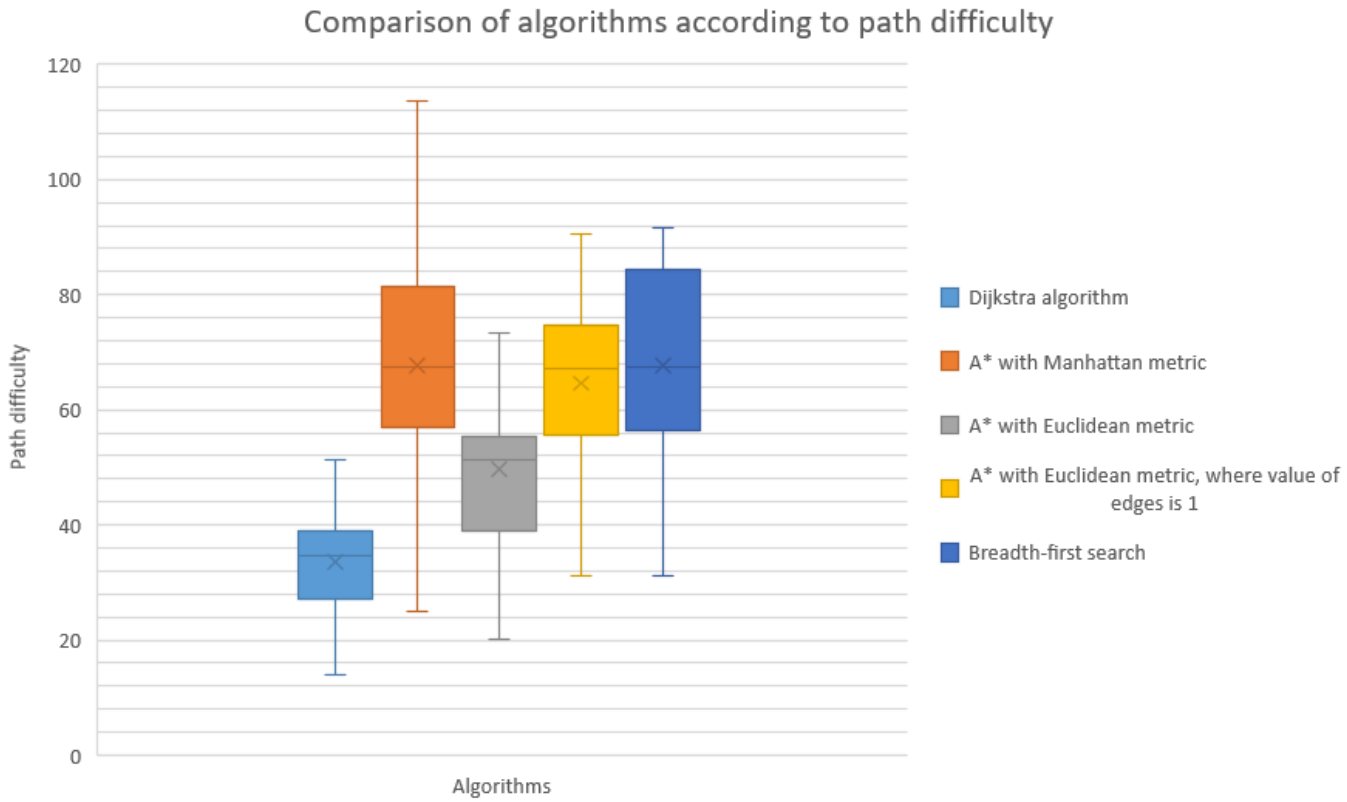

Figure 8 Pathfinding algorithms according to path difficulty

Comparison of method for terrain generating

Raw terrain generated by methods presented in the application is quite unrealistic. In the case of the fault algorithm, there are visible places where there was radical increase on the one side and decrease on the other side. This isn´t usual in real world due to erosion and other influences. Therefore, it is necessary to reduce visibility of these visual artefacts by some modifications. Also, the output of hill algorithm looks artificially. Only the value noise doesn´t have such visible visual artefacts.

According to us, the hill algorithm is best suited for editing, because it can handle the greatest amount of editing before its shapes goes flat. This flattening occurs in terrain generated by fault algorithm and value noise much earlier, because these terrains doesn´t have so big differences between heights of vertexes.

After applying modifications provided by the application, terrain becomes more realistic than before. Also, visual artefacts are removed. Suitable application of modifications can, according to us, leads to shapes that really resemble hills, mountains, craters and so on.

Algorithms can be compared according to overall difficulty of terrain. We can obtain this value as sum of all edge values that occur in terrain represented as a graph. Each of algorithms has been launched twenty-one times. Result are demonstrated in following tables.

Table 2 Terrain generating algorithms

Algorithm	Average terrain difficulty
Value noise	28118.30
Hill algorithm	28932.99
Fault algorithm	24749.41

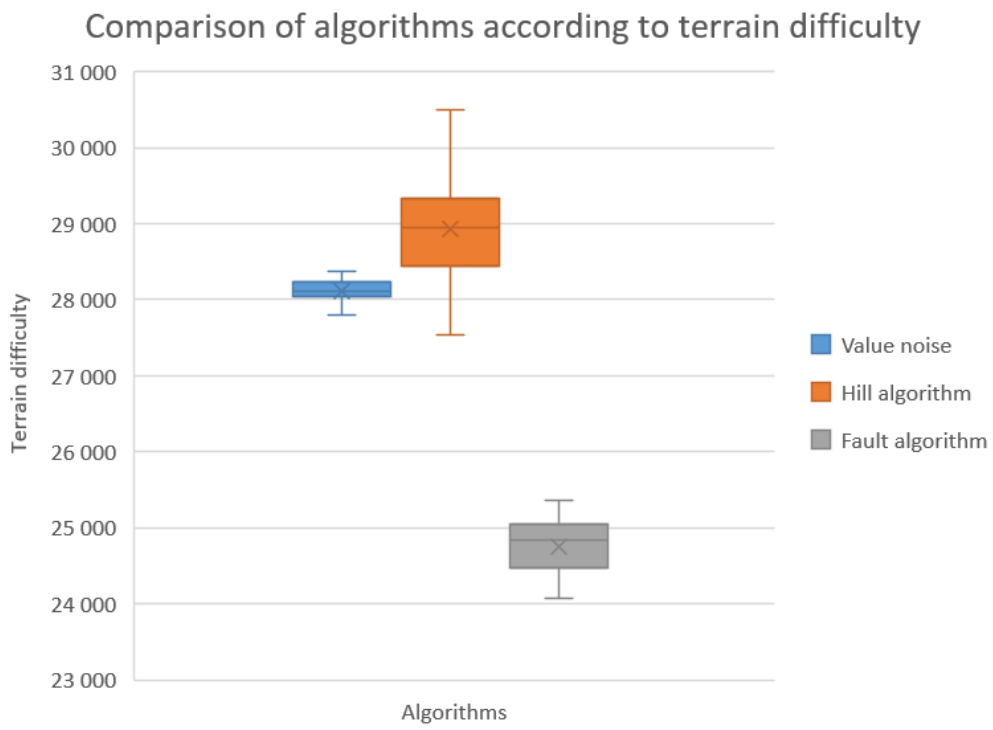

Figure 9 Terrain generating algorithms according to terrain difficulty

CONCLUSION

This paper deals with terrain generation and pathfinding in maps for educational purpose. To give students insight into this topic, application was created. This application shows some of mentioned methods for terrain generating, these are value noise, fault algorithm and hill algorithm. It is possible to edit raw terrains by smoothing, dilatation and 2 types of erosion. Pathfinding between 2 nodes is shown by Dijkstra algorithm, breadth–first search and A* with use of Euclidean and Manhattan metric. User can see the text output, that illustratively compares found paths per mentioned criteria. Moreover, the application contains graphical representation of edges between nodes of the graph, in which the path is searched for. These

edges have colour that depends on their difficulty. It is possible to hoover camera over terrain. Implemented algorithms for terrain generation and pathfinding have been compared among to chosen evaluating criteria.

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TEACHER ATTITUDES TOWARD GAME-BASED LEARNING IN HISTORY EDUCATION

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ABSTRACT

Game-based learning (GBL) is an emerging field reaching new contexts. Research has reported about students' rich use of digital games and the learning potential of GBL in traditional school subjects. Digital games have been tested as educational tools in various subjects in Swedish schools during the last decade, in areas such as teaching and learning of history and foreign languages. However, there is a lack of detailed research on attitudes toward the use of GBL in history education.

Main aim of the study was to examine and discuss attitudes toward an increased use of digital games in formal history education. Earlier studies have analysed students' opinions and preferences, but this study has a focus on the teacher perspective and on which design factors are important if digital games should be an alternative for self-learning in history education. The research approach has been qualitative cross-sectional study where secondary school teachers have answered questionnaires with open-ended questions on their view of didactics and the use of GBL in formal education. All selected respondents are registered as professional secondary school history teachers. Furthermore, teachers have described their own gaming habits and their game design preferences.

Findings show that a majority of the informants have good knowledge about digital games with historical setting and also a positive attitude toward an increased use of GBL. Secondary school teachers also have a tradition of using various media in their teaching and learning activities and there are neither any regulations against an increased use of digital games. An important aspect of history education, where digital games might not the first choice, is in the description of the main changes and influence of a historical époque. Authors' recommendation is to use games that can enable tangential learning where the gaming sessions could be seen as appetisers for further and deeper learning.

KEYWORDS

Game-based learning, GBL, History education, Digital games, Tangential learning 1

INTRODUCTION

Besides being a hyped and emerging research Game-based learning (GBL) has also been widely discussed in the educational sector in the 21st century. There are several studies indicating that GBL is not only a motivating educational idea, but also a didactic concept that carefully implemented could be an alternative with better outcomes than with traditional methods (Malone & Lepper 1987; Gee 2003; Prensky 2001).

A frequently identified problem with educational games is, according to Breuer & Bente (2009), that they mainly are designed for learning and not for entertainment. This can be a barrier to students' engagement

as well as learning when the gameplay is not challenging enough. To enable GBL in educational contexts games need to be more than educational tools. Prensky (2001) points out that it is a waste of money to invest in learning games that lack entertaining values. Well-designed games should mix learning content with exciting gameplay to achieve joyful learning.

GBL is a relatively young concept if compared to traditional learning material and with the interesting novelty of engaging interactivity (Breuer & Bente, 2009). Digital games with their new features and mechanisms also have new research concepts, and one of them is tangential learning. In games designed for tangential learning the primary objective is not to actively educate the player, but rather to create an interest for game themes and game environments. With the long-term effect of students seeking information by themselves and learning about facts and phenomena related to game themes and learning objectives (Floyd & Portnow 2008).

Another, older and more analysed concept is intrinsic motivation, which in GBL often is based on ideas from Mark Lepper and Thomas Malone (1987). Intrinsic motivation could be exemplified as gaming for gaming's sake and also learning for learning's sake, like someone reading a book for joy and self-fulfilment without expecting any external rewards or credits. Intrinsically motivated students tend to be more aware of complexities and unexpected possibilities than others (Kapp, 2012). Furthermore, intrinsically motivated students seem to spend more time and effort learning a topic and also with a tendency to use the acquired knowledge in the future (Malone, 1981). Important factors in a game to stimulate intrinsic motivation on the personal internal level are challenge, curiosity, control and fantasy (Malone & Lepper 1987).

According to Prensky (2001) a general problem in contemporary education is that learning content as well as instructional design are too boring. The suggested idea is to increase the use of digital games in most educational contexts to engage learners. This could be applied in many courses and subjects, but there are few areas with so many existing quality games as History. Two eras with a wide variety of popular games are the Roman Empire and World War II.

An example of a game that would be interesting for History education is the strategy game Rome: Total War where the player can chose among roles such as politician, officer or city planner (Creative Assembly 2004). Another game analysed in this study is Call of Duty, where the game can be played through the eyes of a British or a Soviet World War II soldier (Infinity Ward 2003). Historical environments have been used in the game industry as a way to create game worlds that often are more convincing and engaging than fictive ones, with an immersive atmosphere that is appreciated among gamers (Floyd & Portnow 2014).

Problem

Contemporary studies show that digital gaming is a wide-spread and engaging passion in general (Juul, 2010), and for the younger generation in Sweden in particular (Swedish Media Council, 2016). It can be seen as a problem that this new medium is not more used and integrated in subjects where useful games are available. In the field of History education there exist several appropriate genre alternatives for several historical eras. Games might be used to modernise the existing instructional design, where are the barriers?

There exist some studies that have investigated the students' view of GBL in Swedish educational settings Larsson-Auna (2012), but here are less studies on the teacher perspective. This study had a focus on Swedish secondary school teachers' view of using games in History education.

Aim of the study

The aim of the study was to examine and discuss Swedish secondary school teachers' attitudes toward an increased use of digital games in formal History education.

2 EXTENDED BACKGROUND

Digital games can be defined as an interactive medium played on computers, game consoles or mobile phones with some kind of screen (Dictionary.com, 2017). According to James Paul Gee (2003) games have

a strong learning potential since the aim is to find solutions to problems where the player finds pleasure in the challenge of overcoming obstacles in the game. Breuer & Bente (2009) have divided games broadly into two categories: serious games and commercial games. A serious game is a game that primarily is designed for learning outcomes while a commercial game basically is developed to entertain. In an extended definition serious games should involve learning activities resulting in knowledge and skills that are of use in real world settings (Zyda, 2005).

Depending on the interpretation of the term serious game, it can be seen either as an oxymoron or as a tautology. An oxymoron in the aspect that a game is associated with entertainment, the opposite of seriousness, or a tautology since play and games always have had an evolutionary role to help humans to survive, and for that reason fundamentally serious (Breuer & Bente, 2009).

Game-based learning

The use of games in educational contexts is an old tradition where mathematical and strategical concepts have been illustrated and practised for thousands of years with the use of board games like Chess and Kalaha. Discussions on pedagogical aspects of playing games for more general learning started in the 1970s based on ideas by Jean Piaget (1973) and Lev Vygotsky (1978). Contributions which also might be seen as a continuation of the older discussions on the general human need of play that was started by the Dutch cultural theorist Johan Huizinga (1938), with ideas about mankind as Homo Ludens or in English Playing Humans.

In the 1980s the birth of digital games started a renaissance for GBL when Thomas Malone (1981) did an analysis of why computer games are so obviously engaging and motivating. Malone's findings had three key components: challenge, curiosity and fantasy. Another early pioneer in the 1980s studying how games stimulate learning and motivation was Mark Lepper. Later Lepper and Malone compared and combined their findings in the creation of the Taxonomy of Intrinsic Motivation. The found components of intrinsic motivation were divided into the levels of internal motivation and the level of interpersonal motivation (Malone & Lepper, 1987).

Research on GBL has been a fast emerging and hyped field in the 21st century with a creation of different subfields. GBL is today an integrated part of various educational concepts and there are at least four branches:

1. GBL by playing commercial of-the-shelf (COTS) games
2. GBL by playing tailor-made educational games
3. GBL to support social inclusion of disadvantaged groups
4. GBL based on game construction

This study has a focus on Branch 1 since the field of History has a rich variety of well-designed COTS games for many historical eras. However, Branch 4 and the idea of game construction might be an idea for History education also and not only for Computer science. As an example Huizenga et. al. (2009) have described in a Dutch study how students' active involvement in the construction of games seem to have a great potential. With the same idea in Netherlands as in other parts of the world with GBL stimulating flow and motivation (Admiraal et. al. 2011).

Tangential learning

GBL must not necessarily have to teach course topics directly. In a video recorded by Floyd and Portnow (2008) the concept of tangential learning is suggested as an alternative or complementary to facilitate learning. The basic idea of the term is that a game introduces a theme, a technique or a concept to inspire and motivate learners to further self-studies (Portnow, 2008). Instead of direct teaching and learning activities games should engage and stimulate learning by putting related content in an attractive and engaging game context. Squire, DeVane & Durga (2008) explored the potential of tangential learning in a

study where lower secondary school students played the well-known and popular game Civilization III during a year. Civilization is a game on history with a relatively high degree of realism where players can follow a civilization from its beginning to present time (Squire, 2005). Participants in the study could be described as low and average performing students with low commitment to traditional teaching activities in History classes. By playing Civilization III they got motivated to seek information outside the actual gaming and during the year they improved their formal subject grades (Squire, DeVane & Durga, 2008). In Mozelius, Fagerström and Söderquist (2016) weak positive correlation was reported between knowledge acquisition and tangential learning.

3 METHOD

The overall research strategy has been a qualitative cross-sectional study where data has been gathered from a subset of Swedish secondary school teachers during May – June 2016. The strength of the strategy is the possibility to give a detailed image of a phenomenon at a specific point of time (Denscombe, 2014). On the other hand, an identified problem with cross-sectional studies is that they are snapshots where the inquiry may provide differing results if the time-frame had been different (Levin, 2006). Cross sectional studies are useful at identifying associations that later can be followed-up and more thoroughly studied (Mann, 2003).

The majority of cross-sectional studies with a quantitative design have used questionnaires or structured interviews to collect data, while the qualitative studies have a tendency to use semi-structured interviews (Bryman, 2006). Given the goals and logic of the qualitative approach, purposive sampling is often the employed strategy to get a detailed understanding of a selected groups' experiences. Aligned to the research goals, a purposive sampling strategy should select individuals or groups that provide a rich specialised insight into the research questions (Devers, & Frankel, 2000).

This study has been carried out as a small scale survey with the focus on open ended questions with longer more in-depth answers. Around 30 teachers have answered a qualitative questionnaire with questions not only on their view on existing games but also on their own gaming habits and which games that are suitable to involve in teaching and learning activities. There were also questions on learning material in general and how various media might be combined with traditional teaching sessions. To assess the quality of the answers some questions were related to detect inconsistency.

Data analysis

Collected data was analysed in a thematic analyse to identify, analyse and report thematic patterns grouped as categories (Braun & Clarke 2006). In the initial phase thematic patterns can be found and listed according to their frequency in the data set (Ryan & Bernard 2003). Patterns and themes can be identified either deductively/ theory driven or inductively/data driven (Braun & Clarke 2006). This analysis was carried out inductively and one reason was that there are few earlier studies or theory on the teacher view of GBL. Finally, found thematic patterns were grouped in seven categories which all are presented and discussed in Chapter 4 Findings and discussions.

Research ethics

No names or personal details about the informants have been published and all the information in the analysed questionnaires have been kept as anonymous as possible. The study has been conducted as recommended by the Swedish Science Council (Hermerén, 2011).

4. FINDINGS AND DISCUSSIONS

Found patterns in the analysed data were grouped into the following seven categories: Attitudes toward GBL, Media types and teaching resources, Historical accuracy, Insight into historical events, Teachers' gaming preferences, Game design and Potential problems. Answers were in general surprisingly detailed and with a depth that motivates to go through the categories one by one with separate discussions. To

distinct between the various respondents they are referred to as Respondent 1, Respondent 2 ... following the order in which their questionnaires were submitted.

Attitudes toward GBL

The first obvious finding is that the general attitude toward GBL and other alternative teaching media was very positive amongst the respondents. Just a few respondents brought up drawbacks with an increased use of digital games. Several answers were relatively short, affirmative and resembling the one from Respondent 8: "Sounds like a concept worth trying", but sometimes with the minor reservation: "Great, but it can be a problem if not all students play the game. But the same goes for most learning content and homework" (Respondent 13). Some teachers also brought up the interesting idea of GBL as part of a 'flipped classroom' setup and with the same reservation: "Good, but as with all types of flipped classrooms there is a risk that students don't do their homework" (Respondent 16).

Another question with association to flipped classrooms was the one about the idea of students playing games and that the following teaching activities should be adapted to discuss themes in the played games. The same pattern here with some short affirmative answers like "Yes, this could have advantages" (Respondent 16) but also with doubts like "I could certainly work, but it would need thorough planning and preparation" (Respondent 22) or, "Yes, but it's depending on the game quality and it could be an alternative for students' with reading disabilities. But not only gaming there must be reading and writing involved as well" (Respondent 29).

Accept from questioning secondary school students' self-discipline several respondents pointed out the potential for more motivated students. From the teacher perspective Respondent 19 brought up that "It would increase the teachers' workload when different students are in different stages of a game". There was also a question on what the teachers see as the most interesting part of their job, where Respondent 15 wrote: " ... to break the box and challenge the traditional teaching tradition".

Finally, the question on the concept of tangential learning got mainly positive response even if most teachers were not aware of the term, "don't know that concept" (Respondent 20) and "Certainly, and in particular if it could include several historical eras during a course" (Respondent 16). However, the answer from Respondent 6 was "I'm sceptic, they (students) are probably interested of other aspects of gaming".

Media types and teaching resources

Almost all respondents mentioned that they use various media types in their teaching sessions and some answers are "IT, visits outside school and films" (Respondent 23) and "I try to use videos, documentaries as well as recorded lectures" (Respondent 17). Furthermore, Respondent 11 wrote that "Films to grab students attention and sometimes as learning content as well. Documentaries as an introduction but also analyses of music and games".

Film/video was the most common answer to the question on complementary media and that they in particular are using documentaries. Digital games have much in common with film and videos but with the extension of a higher interactivity. According to some well-known GBL researchers the higher interactivity in games is the reason to why they should replace or complement film/video (Prensky, 2001; Gee, 2003). Furthermore, Papastergiou (2009) claims that games have a potential to replace most traditional educational media since it seems to be a more engaging way to acquire knowledge.

No respondent questioned the added value of interaction and the objection was rather the limited time frame, "It's so much that should be highlighted in such a short time, my estimation is 70% for historical eras, 20% for source criticism and 10% for the use of History" (Respondent 5). In another answer Respondent 28 described the limited time frame as "We are short of time, every part such as The Enlightment, Discoveries, Revolutions, Industrialism and Imperialism get one week each". Another time shortage is that teachers have hard to find when they should play and analyse suitable games, "In a situation where teachers could play through a game planning for follow-ups and assignments based on the actual

game this would work fine, but that is not how it looks today" (Respondent 24). A third time aspect is that the total playtime of games often exceed the time frame of teaching and learning sessions.

Suggestions from the respondents is to provide recommendations for various games and how they might be adapted to curricula. Finally, a teaching resource related issue is the cost of games, where Respondent 15 asks for "Availability and free of charge". Today, costs for games is not included in the budget for teaching resources.

Historical accuracy

In the answers to the question "How important is it that course material have a high degree of historical accuracy", several respondents thought it could be an advantage if games contained anachronisms to get discussions. But also with conditions like "It depends on the purpose, to teach historical époques and change processes facts have to be correct, but considering source criticism and use of History it would be interesting to analyse how History has been interpreted and used as a power tool" (Respondent 7). A similar answer from Respondent 17 was that "It could be excellent to discuss use of History based on actual anachronisms".

Several respondents answered that anachronisms could open up a debate on how History is applied in the contemporary society. On the other hand many respondents highlighted the importance of historical accuracy if games should be a complementary or replacement for other media types and Respondent 15 posited that "As soon as the historical accuracy fails teachers won't use the game". Furthermore, Respondent 3 wrote that "I find it decisive that the game has accurate details. For that reasons subject matter experts with knowledge both in History and Didactics should be part of a selection and recommendation process. And this, could of course, be better done by a team of domain experts".

There seem to exist two standpoints, one teacher group where historical accuracy is highly prioritised, and another that finds anachronisms as an interesting base for discussions. However, other media types are far from flawless and reasonable would be to set the standards for games as high as for other media types, and that some biased or inaccurate teaching resources could be used in debates on critical thinking or illustrating the use of History.

Insight into historical events

Many teachers answer to the question on what should be the most important to prioritise in History education with "the understanding of the connection between today and earlier eras". Why does the contemporary societies look like they do and which social, cultural and technological events have contributed. Respondent 12 and Respondent 18 described how they found it meaningful "Everytime that a student understood the alignment between the present and the past" and joyful "when students see the link between elder times and today".

There are also some suggestions on how this might be supported by GBL "To get in touch with ideas, persons and to dramatise changing processes" (Respondent 5). With the same idea Respondent 13 thought that "It (games) can be used to increase the understanding of an event, a process or phenomena (such as revolutions, democracy, dictatorship)". Finally, Respondent 17 wrote that "Games with choices and options are interesting from the teacher perspective, games where you 'experience' an era. Action games might be of use as well, but with the risk of a focus shift".

Teachers' gaming preferences

Half the respondent group wrote in their answers that they do not play games or have stopped playing. "Not now, but I did in the 1980s" (Respondent 29). "Not anymore, but earlier a bit of Total War long time ago Call of Duty" (Respondent 6). Other teachers mentioned that they had problems to find their way in the gaming jungle and a suggestion could be, as discussed under 4.2, to create a recommendation list with the help of domain experts.

In the gaming half Total War and Call of Duty were mentioned and so were several Role playing games (RTGs) "I play o lot of RPGs, adventures (and often with historical themes like Assassins creed) and simulations" (Respondent 8). "RPGs mainly" (Respondent 15) and among the more hardcore gamers "A lot of games, Red orchestra, Rising storm, Arma 2 & 3, the Total War series, Europa universalis are all favourites for a History geek like me" (Respondent 21). To summarise the majority of the preferred games could be classified as RPGs or strategy games, but there were also several occurrences of first person shooter games.

Game design

If the respondents' answers about appropriate game design should be summarised in two short, distinct answers it would be "Self-instructing" (Respondent 16), "Easy to learn, a convincing backstory and not too time consuming" (Respondent 22). Most respondents have an emphasis on high usability both for teachers and students. There are of course answers that highlights the importance of quality content, but the main focus is on that games should be easy to use and not too time-consuming which might make some of the bestselling AAA games to be a doubtful choice. Despite their engaging gameplay and detailed historical references they are often complex, time consuming and sometimes difficult to install. "As an example I think that Civilization is to too time consuming" (Respondent 9).

The second focus is on games potential for engagement, "Simple, good structure and engaging" (Respondent 5) and "They should be engaging, make students think and solve problems. And to present historical events in a touching way." (Respondent 15). Third focus is historical accuracy and sometimes with the same arguments as described under 4.3 but also "As correct as possible, in combination with action and entertainment and if possible with theoretical parts on Swedish History" (Respondent 21). Some teachers tend to have a worst scenario with GBL based on games with lots of inaccuracy and confusing details.

To summarise, games should be design for usability, shorter gaming sessions and be engaging with convincing backstories without anachronisms or incorrect details.

Potential problems

Several problems were brought up in answers to the questions about games in teaching activities and the question about games as homework in flipped classroom setups. Common problems for both are technical problems and access to proprietary software: "Does everyone have access to the games, and how about hardware?" (Respondent 2) and "The main worry is technical problems" (Respondent 13). Another potential problem for both environments is the cost for purchasing games.

In the classroom setting the main issue is the time span, as discussed earlier under 4.6, "Max 40 minutes for gaming sessions, since lectures are 60 min and software installation, introduction and explanations take time" (Respondent 1) and "The game mustn't be too long to fit in to lessons" (Respondent 4).

Regarding the long game span in many of the most popular games the flipped classroom alternative seems tempting, but "Flipped classroom will certainly work in some schools but for me it's only about 10% of the students that do their homework, which would make the follow-up lesson pointless" (Respondent 11). There are also several answers questioning if all students have Internet access at home and the required hardware for AAA games.

CONCLUSION

Swedish secondary school teachers´ attitudes toward game-based learning in History education can be summarised as:

- Teachers are mainly positive and optimistic toward GBL
- Traditional media types could be complemented with selected games of high quality
- There exist two different standpoints toward historical accuracy in games

• Teachers have a perceived lack of time in their daily work which might be an obstacle for GBL

• It is important that games, as all types of learning resources, can give insight in historical events and processes and point out connections between the past and the present

• Games must not be too expensive, since costs for games is not included in the budget for teaching resources. Neither should they be difficult to install or use

• Games for use in classroom settings should be possible to play in 40 min sessions

• Time consuming games are better used as homework in flipped classroom settings

• Teachers need support for technical problems and recommendations for game selection

Authors' recommendation for classroom settings is to use games that can be played in short gaming sessions having a potential to stimulate tangential learning. Games should be as historically accurate as possible and easy to install and use. The concept of a 'flipped classroom gaming' looks promising where students in longer gaming sessions with quality game content might have excellent learning outcomes if Internet access and hardware issues are handled. Finally, as pointed out by Holly Nielsen: *"Games don't need academic validation to sell, but academia needs to engage with games in order to modernise its approach to public history"* (The Guardian, 25/04/2017).

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VARIANT TEXTS ACCORDING TO TYPES OF SENSORY PERCEPTION

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ABSTRACT

The paper deals with a problematic of creating variant texts according to a sensory perception. An idea of transcribing text is based on a theory of adaptive learning, which is thoroughly studied at the Department of Information and Communication Technologies. Researchers in this work combined the adaptive approach together with thinking styles introduced by Libor Činka and created four variants of texts of the chosen topics. Then those texts undergone the verification by the students from high school and university, who read them and evaluated them as well as they answered to a prepared set of testing questions. All received data was compared against the replies from the learning style questionnaires VARK and questionnaire by Šimíčková. The paper discovered some differences between the results of VARK and Šimíčková questionnaire, which proved to be slightly more reliable compared to both the results of test questions and the students' own opinion. There were also differences between sensory variants of texts. As expected, the kinesthetic variant proved to be the less effective compared to the rest. It seems that university students accepted the rewritten texts better than high school students too.

KEYWORDS

Variant texts, types of sensory perception, learning style, adaptive instruction.

1 INTRODUCTION

The theory of adaptive learning is being developed at Department of Information and Communication Technologies for last several years. The Barborka4 system was created for the realization of experiments of adaptive teaching. In the beginning of the adaptive education the students start with a questionnaire that measures their learning styles and other characteristics that affect their learning. The aim is to achieve more efficient learning of students and deeper understanding and remembering of information during the education process. (Kostolányová, 2012)

The background of the student population in any university is very diverse. This includes varied socio-economic background, wide ranging ages of students, varied cultural background, prior educational experiences, levels of competency and preparedness, and preferred learning strategies. (Meehan-Andrew, 2009) Effective teaching in such a set up can be difficult and challenging. Teaching is a process of knowledge presentation while learning is often multifactorial and depends on the mindset of each student. (Drago, Wagner, 2004)

Neil Fleming in his landmark article 'I'm different; not dumb: Modes of presentation (V.A.R.K.) in the tertiary classroom' says that people learn in different ways using variety of strategies to convert the educational message into their long term memories. (Prithishkumar, 2014) There is no single best way to

teach, but teachers can diversify their teaching styles to cater to the learning styles of each distinctive student. (Becker, 2007) Awareness of learning styles will help educators identify and solve learning problems among students. (Baykan, 2007)

An interesting stimulus for the research was the idea of Libor Činka, who argues that the preferred way of thinking (which can also be understood as a preferred learning style and can be determined on a basis of a questionnaire) in a speech reflected by the frequent occurrence of words associated with the thinking of either visual or auditory, or kinesthetic. You can meet the people who think quite strong in one sense only rarely. A situation where you have to be very attentive in order to identify the preferred way of the speaker's thinking is more common. It is because the language of the speaker contains not always clear identification of the words in his preferred way of thinking.

To test this idea, the four different texts were selected and these texts had no connection to the students' field of study. These texts were subsequently rewritten using the words which Činka has assigned a preferred way of thinking. The questionnaires that are used to detect learning style were also include in the research.

Basic research questions were:

- Can you formulate the text itself according to the learning styles?
- In which way?
- Will this modified text be more understandable and enjoyable for the readers?
- Will the reader with the preferred visual style of thinking be able to remember more due to rewritten and revised text?
- Will the text be easier to read for him? Will it be better understandable?

To fulfill these questions, the choice of proper text was made. Then the texts were rewritten to all sense variants and the time-consuming data collecting started including filling in the questionnaires and testing the texts by students who were reading them. The evaluation of this research brought interesting results.

2 SENSORY ANALYSIS

A group of properties called Sensory Perception describes which form of information students are most comfortable with. The sensory perception in the system Barborka4 is determined by a questionnaire, whose authors are Fleming and Mills (Fleming, 1992), and is also determined by other testing questions from Žáčková (1999) later on modified by Šimíčková. Both questionnaires try to capture to what extent the students' senses are represented by the different types of sensory perception; verbal, visual, auditory and kinesthetic. Based upon the type of sensory perception the study material is adapted. A positive impact on the rate of learning during the use of adaptive teaching has been confirmed in several dissertations.

Both questionnaires VARK (Murphy, 2014), Šimíčková will be used in order to discover how they both differ in the way of identifying of preferred learning style and to determine how much their data will be similar.

In this research the students completed both questionnaires. After that they were familiarized with the characteristics of each type of sensory perception. Then they should try to determine to which extent they think they have the dominant types of sensory perception. In the conclusion, the results from VARK, Šimíčková and students' opinion will be compared.

3 THE TYPES OF SENSORY PERCEPTION IN THE TEXT - THE LANGUAGE OF THE SENSES

According to Činka (2012), a type of sensory perception in speech is reflected by the frequent occurrence of words associated with the thinking of either visual or auditory, or kinesthetic. Only rarely you can meet people who think strongly in one way. More common is a situation where you have to be very attentive to the preferred type of sensory perception. It cannot be identified, because speaker's language is not always clear in the first hearing and identification of a preferred way of thinking may be misinterpreted.

Visual types frequently used sayings:

- "I do not see any sense."
- "It is clear what you want to show us."
- "Let me show you my vision."
- "I do not see the sense."
- "Let me clarify this idea."

For visual types are important the tables, graphs, sketches.

Auditory types rather hear say:

- "I think it was absolutely consistent."
- "Do I hear you well?"
- "Tell me more."
- "Sounds great!"
- "Let's discuss."

Auditory people respond best to the instructions and information expressed verbally considering written messages or instructions to be less important.

Kinesthetic types express more feelings and emotions:

- "I do not know why it is exciting."
- "I understand how you feel."
- "You hit the nail on the head."
- "You need to fight with that."
- "I'm in a terrible stress."

Based on the above characteristics Činka created a table of words that represent different types of sensory perception, i.e. the language of senses. Red words represent a visual, auditory a blue, green a kinesthetic and black a neutral (see Fig. 1, in Czech).

vidět	myslet	oznámit	znát	odkrýt	obtížný	pamatovat	drsný
aspekt	rozhodnout	volat	vliv	oko	aktivní	vědět	pochopit
iluze	ječet	soudit	klepy	okruh	nutit	nesouhlasím	pevný
grafický	hovořit	hodnotit	klapnout	vymezit	narazit	panický	rozeznávat
ilustrovat	hluk	harmonie	konstatovat	obraz	mnout	napadnout	uznávat
malovat	hlasitý	formulovat	naladit	krátkozraký	emocionální	řídit	navštěvovat
odhalit	jevit se	meditovat	jasný	načrtnout	chladný	chopit se	proces
slyšet	image	vědomý	blýsknout se	dotazovat	citlivý	držet	učit
akcent	nápadný	dívat se	pestrý	doslech	brousit	povolit	dráždit
alarmovat	věřit	barvy	vyzkoušet	výmluvný	bolavý	motivovat	dotknout se
bouřlivý	řešit	horizont	připravit	diskutovat	bezcitný	rozumět	dojatý

Figure 2 Words of sensory perception (Činka, 2012, in Czech)

4 DESIGN OF THE RESEARCH

We decided to test the theory of words of sensory perception in practice. We conducted a selection of four texts of different topics that we rewrote using words of sensory perception. The four variants were created (verbal, auditory, kinesthetic, auditory) for each text. Then we let the students read them. A student read four texts that were thematically and sensory variant different that every student has worked with four variants and four themes. After reading them each student completed a questionnaire with knowledge questions from the text and further questions regarding how he read the text and how he understood it. Each respondent also completed in the time span of about one month the questionnaires to determine the learning style VARK and Šimíčková version. The validity and reliability of VARK questionnaire was determined in earlier research (Leite, 2010, Fitkov-Norris, 2015, Thepsatitporn, 2016). After completing all these questionnaires, the processing and evaluation questionnaires followed.

The research group

The research sample consisted of 35 respondents. The 14 students were from high school and 21 university students of Information and communication technology in education.

Selection and processing of variant texts

The chosen texts had no connection to the field of study of all students. The topics were not covered neither on high school nor university. Table. 1 describes the content of selected texts.

Table 1 Text topics

Topic No. 1 Blood Groups	Text deals with the discovery of different blood groups, their history and influence on catering for different types of blood groups.
Topic No. 2 Lord of Lightning	Very short biography of Nicola Tesla's life and inventions.
Topic No. 3 Pond in the Garden	Describes the process of building a pond in the garden. By digging a trench through the film location, making the pond after placing a pump and filter.
Topic No. 4 Golden Ratio	The construction of the golden section in mathematics and its practical use in practice.

Respondents completed the two electronic questionnaires for the purpose of learning (codename RVAK, ŠIMI2) and read four texts on different subject and sensory perception. At the end, they filled in a questionnaire to read text.

Each topic was written on one side of an A4 sheet that it did not take a lot of time for reading the texts. The texts were rewritten using the words that according Činka represented some kind of sensory perception. Činka speaks about three types of variants of words - auditory, visual, and kinesthetic. The original text was considered a verbal variant. Here is an example of the following rewritten text of the "Lord of Lightning." Colored words are transposed ones (the translation from the Czech):

Verbal variant - the original text:

"Nikola Tesla, who at the peak of his career earned the nickname the Lord of Lightning, was born during the storm. It happened on the night of 9 to 10 July 1856 in the Serbian village of Smiljan. Even as a child he had a great imagination and an excellent memory. Gradually, he learned six languages, he studied mathematics and physics at the Universities of Graz in Austria, and Prague and Budapest and during the work in the telegraph company he began to deal with the principle of alternating current. "

Visual variant – the rewritten text:

"Nikola Tesla, who at the peak of his career was marked as the Lord of Lightning, was born symbolically during the storm. It happened on the night of 9 to 10 July 1856 in the Serbian village of Smiljan. Even as a child he was distinguished by a great imagination and an excellent memory. Gradually, he learned colorful set of six languages, he studied mathematics and physics at the Universities of Graz in Austria, and Prague and Budapest and during the work in the telegraph company he began to clarify the principle of alternating current. "

Auditory variant – the rewritten text:

"Nikola Tesla, who at the peak of his career was called the Lord of Lightning, was born during the storm. It happened on the night of 9 to 10 July 1856 in the Serbian village of Smiljan. Even as a child he had a great imagination and an excellent memory. Gradually, he learned six languages, he studied mathematics and physics at the Universities of Graz in Austria, and Prague and Budapest and during the work in the telegraph company he began to deal with the principle of alternating current. "

Kinesthetic variant – the rewritten text:

"Nikola Tesla, who at the peak of his career earned the nickname the Lord of Lightning, was born during the storm. It happened on the night of 9 to 10 July 1856 in the Serbian village of Smiljan. Even as a child he had a great imagination and an excellent memory. Gradually, he learned six languages, he studied mathematics and physics at the Universities of Graz in Austria, and Prague and Budapest and during the work in the telegraph company he focused on the principle of alternating current. "

In this way, all the texts were transcribed in all selected topics.

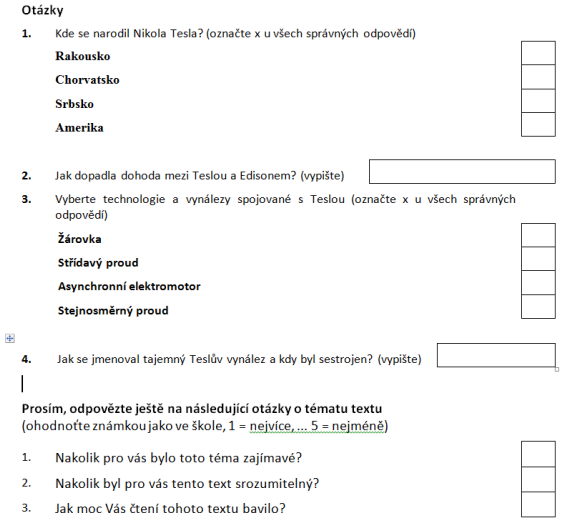
5 QUESTIONNAIRE DESIGN

For each topic, a questionnaire was created which tested the level of acquired knowledge. Furthermore, the questionnaire contained three questions on the interest, attraction and clarity of the text. These three questions were the same in all texts:

- How much interesting this topic was?

- How much clear the text was?
- How much have you enjoyed reading this text?

See a questionnaire bellow (in Czech).



Otázky

1. Kde se narodil Nikola Tesla? (označte x u všech správných odpovědí)
   - **Rakousko** ☐
   - **Chorvatsko** ☐
   - **Srbsko** ☐
   - **Amerika** ☐
2. Jak dopadla dohoda mezi Teslou a Edisonem? (vypište) ☐
3. Vyberte technologie a vynálezy spojované s Teslou (označte x u všech správných odpovědí)
   - **Žárovka** ☐
   - **Střídavý proud** ☐
   - **Asynchronní elektromotor** ☐
   - **Stejnosměrný proud** ☐
4. Jak se jmenoval tajemný Teslův vynález a kdy byl sestrojen? (vypište) ☐

Prosím, odpovězte ještě na následující otázky o tématu textu
(ohodnoťte známkou jako ve škole, 1 = nejvíce, … 5 = nejméně)

1. Nakolik pro vás bylo toto téma zajímavé? ☐
2. Nakolik byl pro vás tento text srozumitelný? ☐
3. Jak moc Vás čtení tohoto textu bavilo? ☐

Figure 2 Questionnaire for text variant (in Czech)

6 QUESTIONNAIRES ON LEARNING STYLES

Each respondent questionnaires also filled in a questionnaire to determine the learning style in addition to variant texts. There were two questionnaires filled out by respondents given at least two weeks' gap. Questions from both questionnaires are used in the system Barborka4 to identify the learning style of students:

- VARK - a questionnaire composed of 16 questions, used worldwide to determine the learning style. Each question offers the possibility of dealing with a particular situation in one of four styles (visual, auditory, verbal, kinesthetic). The respondent may choose more than one answer to a question. This questionnaire is also used for purposes of online education (Zapalska, 2006).
- Questionnaire from Šimíčková - contains 40 questions. Always 10 questions testing the specific learning style. The questions are worded notification sentence and respondent should determine how often to described life situation (often, sometimes, rarely).

After the questionnaire that respondents completed a set of another questions was added to determine what learning style are according to them after they have been displayed characteristics of different styles.

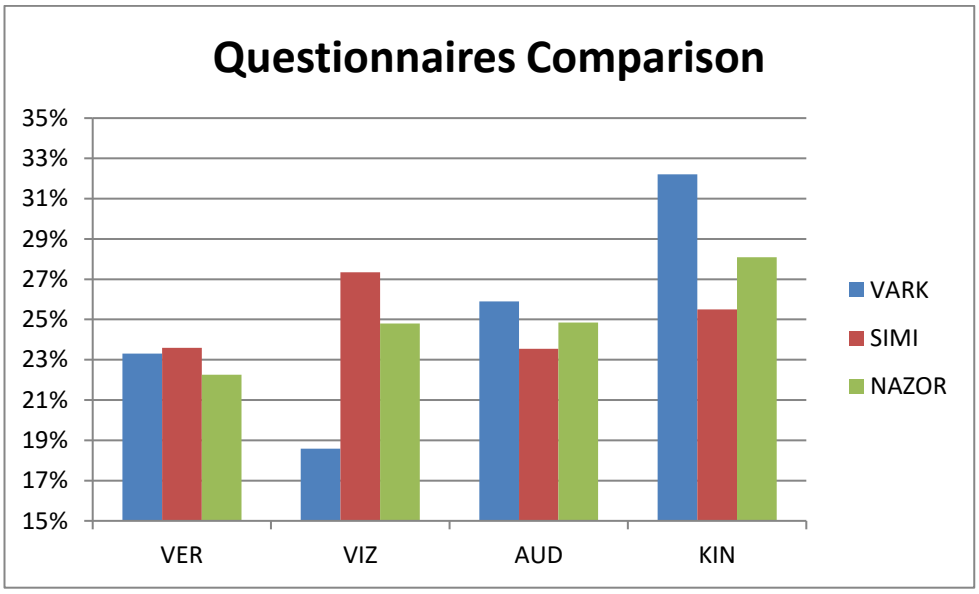
Process of reading texts and completing the questionnaires

Two months before the reading of variant texts the respondents filled in both questionnaires. Between both questionnaires there was at least two weeks' delay. After that the students came to read the four variant texts. Each of students read four different topics in four different variants, but four in total (the students had the different texts in different variants chosen randomly, but it was made sure that each of them had different sensory variant and not repeating topic). The reading all four texts took an hour in average.

Then the all data was gathered into the spreadsheet and evaluated.

7 RESULTS – THE LEARNING STYLES

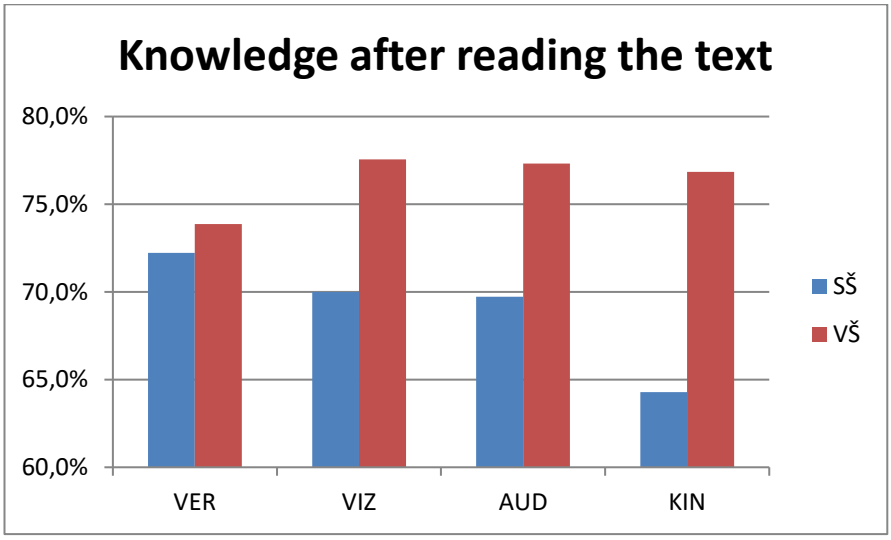
The graph no. 1 shows the comparison of results of two questionnaires on learning styles (VARK, Šimíčková) and opinions (NAZOR) of respondents. For comparison, the questionnaire was calculated as the percentage of identified style of each respondent. The graph shows the average proportion of learning styles of all respondents. There is a significant variation evident between visual and kinesthetic style in VARK questionnaire. Šimíčková version more corresponds to the views of respondents.



Graph 3 Questionnaires Comparison

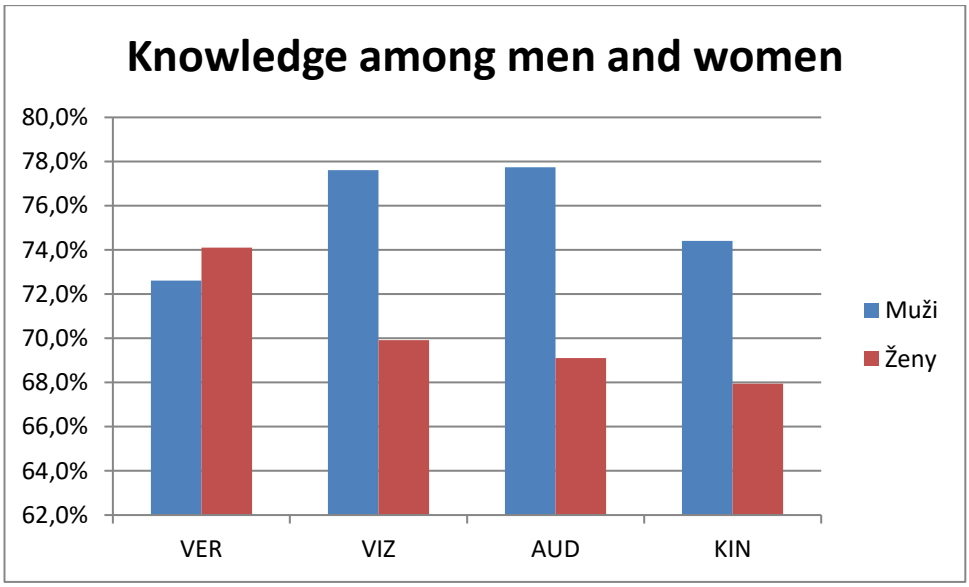
8 RESULTS - KNOWLEDGE AFTER READING THE TEXT

The degree of knowledge gained from the read texts was calculated as the percentage of correct answers. The graph no. 2 shows that high school students (SŠ) have a lower success rate for all variants of the text. The smallest success has kinesthetic variant texts. It is possible to argue that the modification of the original text in sensory variant did not suit to high school students, but university students (VŠ) have proven some increase of knowledge in the rewritten texts variations.



Graph 2 Knowledge after reading the text

The graph no. 3 shows the difference of knowledge among men (Muži, blue) and women (Ženy, red). Women seem to be better at verbal texts variations. Knowledge of men are higher in visual, auditory and kinesthetic variant texts.



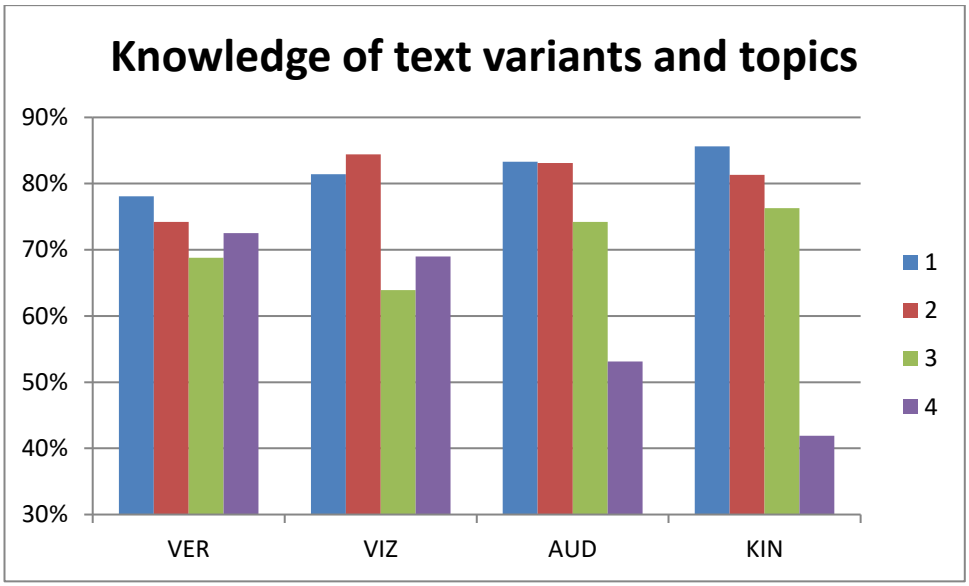
Graph 3 Knowledge among men and women

The table no. 2 shows the overall average students' knowledge according to variants and topics. There is not much difference in knowledge for each variant text. It seems that the modified texts do not significantly improve the percentage of acquired knowledge. On the other hand, the topic seems to be the factor changing the received knowledge.

Table 2 Knowledge in Variants and Topics

Knowledge – Variants		Knowledge – Topics	
Verbal	73 %	Topic No. 1 Blood Groups	82 %
Visual	75 %	Topic No. 2 Lord of Lightning	81 %
Auditory	73 %	Topic No. 3 Pond in the Garden	71 %
Kinesthetic	71 %	Topic No. 4 Golden Ratio	59 %

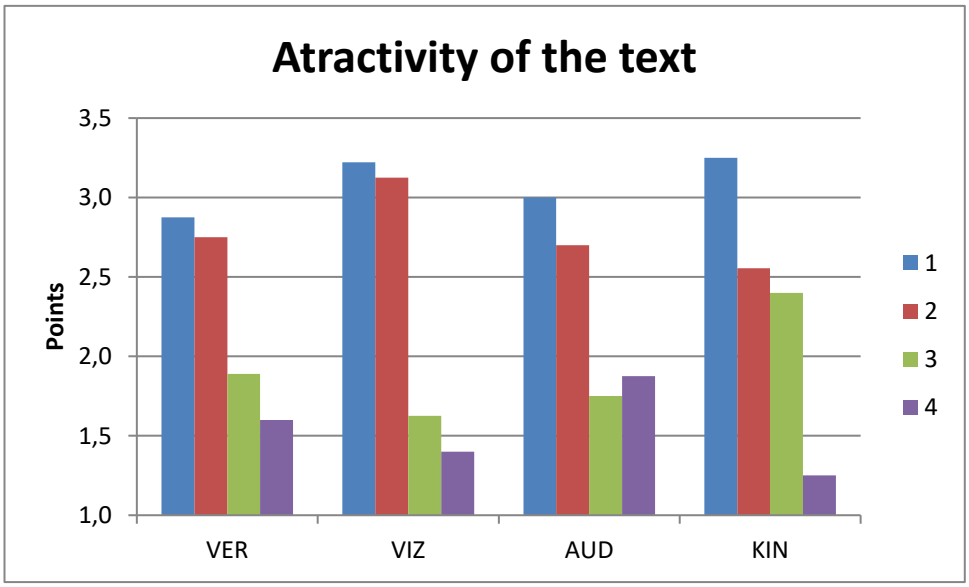
Graph no. 3 displays the percentage of correct answers in a knowledge test by topics and texts variations. The most balanced versions are the original texts – verbal variant. There were higher results in knowledge of the rewritten texts at the topics 1 and 2. A significant negative impact had the auditory and kinesthetic variant of topic 4, which significantly decreased percentage of students who correctly answered the test questions.



Graph 4 Knowledge of text variants and topics

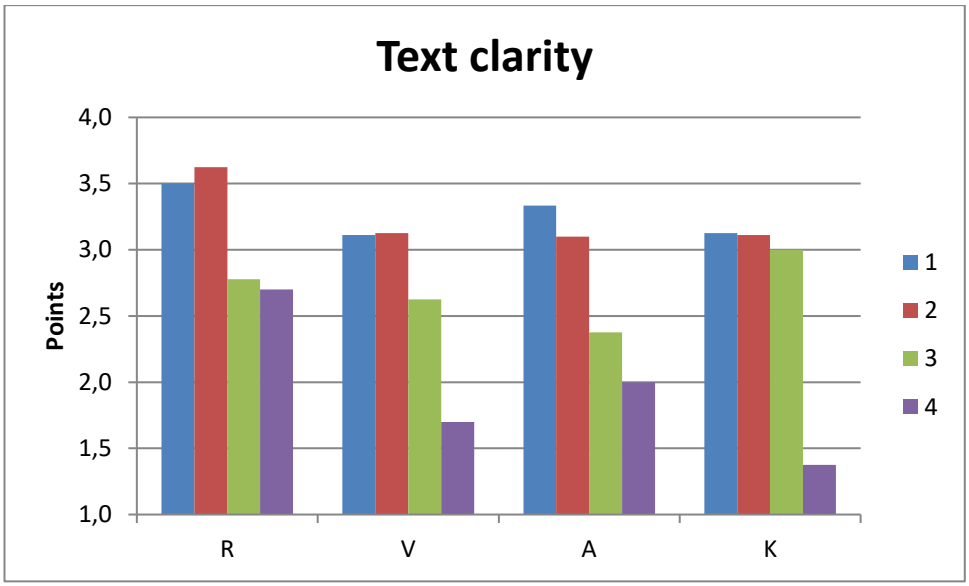
9 ANSWERS TO THE EVALUATION QUESTIONS

The graph no. 4 shows the average number of points to the question: " How much interesting this topic was?" 0 points means the least, 4 the most. The most appreciated text was the Blood groups in all variants where in all variants the attraction grew a little. The following was the topic 2 the Lord of lightning, which was the most interesting in the visual variant. The remaining two topics were less attractive, where the worst ended the topic 4 in kinesthetic variant. The topic 3 "Pond in the Garden" was the most interesting for students in the kinesthetic variant. These results correlated to some extent with the results in the graph no. 3 and the text interestingness could be the cause of success in the knowledge test questions.



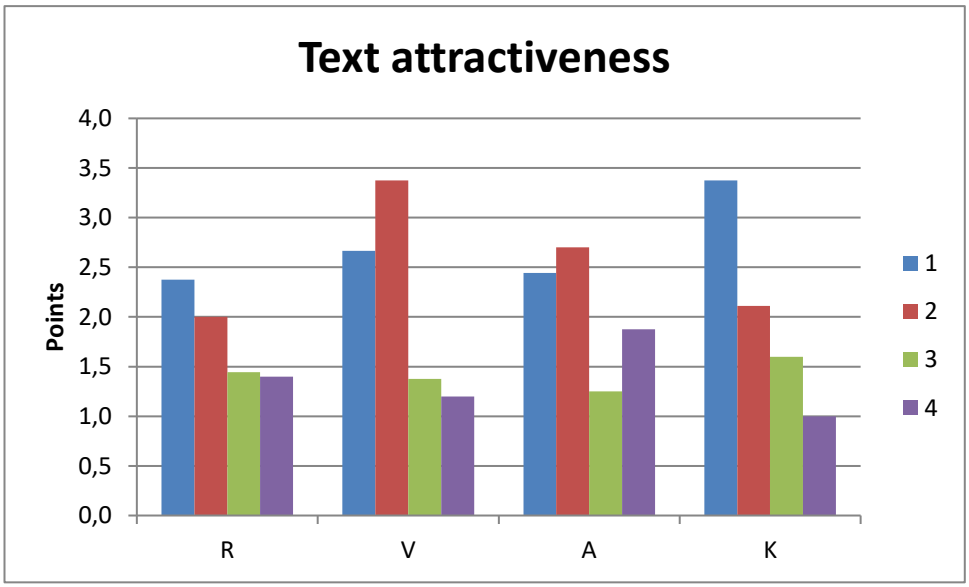
Graph 5 Attraction of the text

The graph no. 5 deals with the question: " How much clear the text was?" Here we see clearly that all the topics were clearest the most for the students in the original verbal variant with an exception of the kinesthetic topic 3, which the only seemed clearer than the original version.



Graph 6 Text clarity

The rest of results is represented by the question " How much have you enjoyed reading this text?" in the graph no. 6. There has been an increase in an attractiveness from its original version in the topics 1 and 2. The most students enjoyed reading topic 2 in the visual variant and topic 1 in the kinesthetic variant. It seems that swapping sensory words can lead to greater attractiveness of the text.



Graph 7 Text attractiveness

Percentage of the responses in variant texts due to the results of the VARK questionnaire

Now we compare how students have been successful in the knowledge test questions depending on what were the predominant learning style based on the VARK questionnaire. Table no. 3 is calculated the percentage of correct answers for those students who had the strongest learning style according to the test. The second column is the number of these students. The table does not represent all, since the four students were excluded who had two equally strong learning styles. Students with the identified dominant visual style of learning had the highest success rates in the verbal text and vice versa with the detected verbal style were more successful at visual text. For the auditory and kinesthetic styles were results equal. But it must

be said that there was a small sample of students and differences in the proportion of correct answers are not much statistically significant, therefore we cannot generalize conclusion based on this results.

Table 3 VARK and text variants

VARK questionnaire	The number of students	R	V	A	K
V	3	**90.0 %**	65.8 %	79.6 %	85.4 %
A	6	62.1 %	65.0 %	**70.2 %**	66.9 %
R	6	76.3 %	**81.7 %**	71.3 %	53.8 %
K	16	71.3 %	75.6 %	74.1 %	**76.1 %**

CONCLUSION

The paper describes the research, which was based on the idea of Libor Činka and his thoughts about the types of sensory perception in the text, because his division of sensory perception of the text is the same as learning styles, which is detected by the questionnaires VARK and questions by Šimíčková. We have redesigned according to the proposed procedures the four different texts in the three sensory variants (visual, auditory, kinesthetic) and the original one was labeled as verbal. The research involved 35 students from the high school and university.

Firstly, students completed the questionnaires on learning styles. The results of the analysis of the findings of the questionnaires pointed out to a contradiction in the results of the questionnaire VARK and the opinions of students with visual and kinesthetic learning style. Questions by Šimíčková agreed more to a students' view of their own learning style (see graph 1).

Another area of the research was the memorized knowledge of the texts acquired by reading them. A significant difference between secondary school and university has shown, where the university students had a greater degree of knowledge in the modified variants of texts (see graph 2). If we take into account the overall performance in the level of knowledge, according to the sensory texts variation, the rewritten texts seem to not affect the acquired knowledge of students and all variants have the proportion of correct answers over 70 %. The difference between the smallest and the largest proportion of correct answers is 4 %. But it is different about at the topics of texts, where appeared a significant impact on their level of knowledge according to what topic the students read. The difference between the best and the worst percentage of correct answers is 23 % (see graph 4). Based on these results we cannot confirm the correctness of Činka's ideas and the memorization rate is primarily affected by the theme of the text than what words are used in the text.

According to the evaluation questions (subjective feelings of students on the interest, clarity and attractiveness of the texts) confirms previous findings on the rate of acquired knowledge and based on that we know that the least interesting, understandable and boring text has the lowest successful rate. But some impact of variant texts still can be observed. If the rewritten (V, A, K) and original texts are compared the interestingness and attractiveness have increased in average. On the contrary the clarity of rewritten text variations has fallen.Acknowledgements

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