Charles University in Prague

Faculty of Arts

Department of Information Science and Librarianship

Dissertation thesis

Mgr. Michaela Buchtová

Information behavior and learning in the context of new media: Digital games and simulations as complex systems for information representation.

Informační chování a učení v kontextu nových médií: Digitální hry a simulace jako komplexní systémy pro reprezentaci informací.

Prague 2014 Supervisor: Mgr. Vít Šisler, Ph.D

Acknowledgements

This dissertation would never exist without my two colleagues and supervisors Vít Šisler and Cyril Brom who believed in me, supported me in my research work and taught me a lot about science methodology. Thank you!

As well I would like to thank the whole team of the research "*Learning Effects of Educational Simulations*" who made the experiment possible. Thanks also to Monika Hampacherová, Tereza Selmbacherová, Ehren Borg for helpful discussions, and Catherine Milne, Ruth Small, Marylin P. Arnone, Colleen Macklin, Scott Nicholson, Jeff Ramos for great consultations. And once again I thank to Vít Šisler, the advisor of the dissertation, for his patient help, amazing support and 24/7 consultations.

I must also thank Vincent and Yacine for interrupting my work with unforgettably beautiful moments. For helpful discussions and advice I thank my brother Martin, and of course for everything else my mother Iva and my father Pavel.

Prohlášení:

Prohlašuji, že jsem tuto disertační práci vypracoval(a) samostatně a výhradně s použitím citovaných pramenů, literatury a dalších odborných zdrojů.

V Praze, dne 9. April 2014

……..

Michaela Buchtová

Keywords:

Information behavior, Mental models, Motivation for information behavior, Educational simulations, Digital Game-Based Learning (DGBL)

Klíčová slova:

Informační chování, Mentální modely, Motivace k informačnímu chování, Vzdělávací simulace, Učení pomocí digitálních her

Abstract

This dissertation considers digital games and simulations as complex systems of information representation and explores their specific aspects influencing the process of knowledge acquisition. It focuses on process of mental model creation, information behavior and situational emotional and cognitive engagement. The methodological approach is grounded in variety of disciplines including information science, educational science, new media studies and computer science. The main method used is educational experiment. The use of digital game-based and non-digital game-based educational intervention is compared to similar program based on traditional schooling methods and classic lectures. The experiment outcomes are divided into four large segments exploring influence of digital games on process of mental models creation, motivation for future information behavior, situational emotional experience and social interaction.

Abstrakt

Tato dizertační práce studuje digitální hry a simulace jako komplexní systémy pro reprezentaci informací a zkoumá jejich specifické aspekty ovlivňující proces získávání znalostí. Zaměřuje se na proces tvorby mentálních modelů, informační chování a situační emoční a kognitivní zapojení. Metodologický přístup je založen na různých oborech, včetně informační vědy, pedagogiky, mediálních a kognitivních věd. Základní použitou metodou je edukační experiment, který porovnává efekty digitální edukační hry, nedigitální edukační hry a klasické pedagogické intervence založené zejména na klasických přednáškách. Experimentální výsledky jsou rozděleny do čtyř částí zabývajících se vlivem digitálních her na proces tvorby mentálních modelů, motivaci k informačnímu chování, situační emocionální prožitek a sociální interakce.

Table of contents

1 Introduction

> *"We aren't in an information age we are in an entertainment age."*
> Tony Robbins

The dissertation analyzes the influence of new media, specifically digital games and simulations, on knowledge acquisition and information behavior. This work approaches digital games and simulations as dynamic systems of information representation that are in comparison to other media able to provide some additional representational aspects. In particular they can attribute sound and visual characteristics to specific details, portray inter-relations of its subsystems and simulate its behavior in various situations. For this reason they might facilitate understanding of complex data in such information systems. The core interest of the work lies in specification of information behavior and in describing the specific aspects of knowledge acquisition as motivation, engagement and creation of mental models within the use of digital simulation.

The theoretical background of research presented by the dissertation is based on information science with applied cognitive and educational science. All the conclusions are based on experimental research that compares interaction with three different kinds of systems for information representation: classic frontal lecture, digital game, and non-digital game. As the research instrument is used educational game *Europe 2045*, the other two treatments derive from its content. The research sample consists of 330 individuals, mostly Czech high school students, the typical users of the game. We studied knowledge acquisition, information behavior and motivation for information behavior through series of research methods and tools.

Information behavior is a term developing over 60 years so many definitions were created. Nicholas Belkin (1980) described the whole process of information behavior as follows:

> *(…) the user realizes that there is an anomaly in (his/her) state of knowledge with respect to the problem faced. The person may address the anomaly by seeking information. After obtaining information, the person will evaluate again whether the*

> *anomaly still exists. If it does, and the person is still motivated to resolve it, more information may be sought.*

There are also important definitions considering information behavior as an inherited characteristic of human beings, e.g. Brenda Dervin (1992):

> *A sense-making metaphor describes humans as moving along through time and space until they reach a cognitive gap, where an information need is perceived. Such gaps must be bridged through the acquisition of new information before they can move forward again. The goal of a person's information seeking endeavors is to make sense of a current situation.*

Currently the most often used definition of information behavior is the one of Thomas D. Wilson (2000):

> *(…) the totality of human behavior in relation to sources and channels of information, including both active and passive information seeking, and information use. Thus, it includes face-to-face communication with others, as well as the passive reception of information.*

As the operational definition for this dissertation I chose the one of Donald O. Case from 2007. With its simplicity, it is capable of describing the vast complexity of human information behavior that the multidisciplinary context of new media presents:

> *Information behavior encompasses intentional information seeking as well as unintentional information encounters.*

The information boom of the 21st century changes the ways how information is typically represented and reached by its final users. Much has already been said about the "information age" and the changes it has brought to bear on our work, education, family and personal lives. But surely manners of information consumption have changed and new media with its fluid consistency has become the main source of information.

In 2006, NBC News, one of the most important news channels of its time, faced a crisis. Its most successful programs started to lose their audience and from demographical point of view NBC was aging - more and more rapidly losing its audience of young viewers. Those viewers were using Internet in many Web 1.0 ways (information gathering), and it became their primary source of information. Even though in 2007 among 18- to 29-year-olds there was still a gap

between Internet (34%) and TV (68%) as a main source of news, this gap would close entirely in 2010 with Internet providing 65% of information to young viewers (Klopfer & Haas, 2012).

But as the information space and channels change the information behavior changes as well. Eric Schmidt, the CEO of Google, said at the Techonomy conference in 2010:

> *There was 5 exabytes of information created between the dawn of civilization through 2003 but that much information is now created every 2 days, and the pace is increasing.*

Nowadays, information channels supply us with more information than we need, and thus information science plays an important role, specifically its aspects which study information behavior and information representation. Subsequently the right question here is: how is this new information space exploited? Koh and Dresang (2010) studied youth information behavior and how it was changed by the development of the digital environment. Today, youth are the first generation born directly into the digital age and so they are considered to be a good predictor of some trends in this area. Within their research, they observed that children used various formats of information, such as texts, images, and sounds, from multiple media sources (digital and print). But most all of them reported that they preferred to see visual and graphic information in books and on the Internet. A prevalent characteristic was multitasking -- working on multiple questions at the same time or using multiple media simultaneously. Students exhibited nonlinear and nonsequential information seeking, such as returning to a source previously searched, working on questions in a sequence other than 1 through 10, and gathering information from a resource in ways other than a step-by-step, one way only progression. Students developed self-defined and controlled paths. They made decisions on searches independent of the teacher and searched in ways other than those shown by the teacher (Koh & Dresang, 2010). As the teacher becomes a coach in the learning process, the information specialist as well changes his/her role in relation to the coach, showing us how to orientate ourselves in the information space. Research on digital games shows that games might be an efficient tool in this process.

Within their school-life today youth use digital media in many ways – they "googlize" data for their essays, they "skype" and chat about their homeworks, with their smartphones they take pictures of school tests and share them on the social sites. Even though it can seem as cheating, it is an important form of information behavior and knowledge acquisition. Youth using new media often learn from their peers, not teachers or adults (Ito, 2010). Even though their media and information literacy might be high, most of their information behavior is interest-driven (Ito, 2010), therefore teachers and parents might reconsider their role and focus more on engaging and motivating youth to take "the right" learning direction.

The problem of motivation in information seeking and knowledge acquisition became acute when mass and mainstream media started to use very sophisticated methods to lure more viewers. Visual and emotionally forceful content became a necessary condition even for daily news. As a result, it became more and more difficult to draw the attention and interest of young people with typical educational content, such as historical facts (Ito, 2010). Consequently, the challenge of today's educators is to seek new ways to mediate educational content so that students will feel inspired, engaged and motivated. In the language of information science, we need to seek new forms of information representation.

A remarkable fact from the information science point of view is that the question of representation of information becomes more important than manners of information behavior. During a given day we encounter more information than we are able to process – from television news, newspapers and the internet, advertisements, flyers, face-to-face communication, mail communication, social networking sites, etc. Our attention gets distracted frequently by information-poor content and it becomes more and more difficult to focus our minds upon the study of intellectually demanding and/or time-consuming subjects or documents.

The questions posed above lie somewhere on the borders of educational and information science. With rapidly changing information channels on one side and technologies infiltrating

educational environments on the other side, it is apparent that both fields need to focus on similar issues. But the problematic is described by different terms in those fields: knowledge acquisition vs. learning, information representation vs. teaching and learning tools, etc. Information science needs to pull together with education science and systematically seek new tools to represent data and information to their final users in more engaging ways -- even though the knowledge acquisition would not necessarily be the direct outcome. The key is in fostering motivation for future information seeking and learning behaviors, and in establishing a pattern of self-motivated knowledge seeking behavior in students.

1.1 New media challenges for mental models construction

"To know the world one must construct it."
Cesare Pavese

According to some theories, knowledge is constructed, not received. Rather than being static, knowledge is enacted in the service of doing (Squire, 2005, Mayer, 2001, Whitehead, 1929). There are many types of learning environments which embed new media as a tool for increasing the effectiveness of learning or of students' engagement. Information there is represented not only through text, but is multimodal and based on multimedia. On-line learning environments, digital simulations and games or mixed reality programs create space for new modes of information behavior, and have the potential to enhance learning.

Digital games and simulations offer new ways of representing complex models and themes while portraying several aspects difficult to describe by classic forms of informational representation. Games create a new environment for perceiving new kinds of information and experiences:

> *Thus students for example do not learn about big thinkers but play their role and choose between their views; like Plato and Aristotle, Anselm or Aquinas, Kant or Mill. Therefore students can feel the excitement of entering controversies and refuting opponents, as the thinkers in their life time (Bain, 2004).*

Compared to other media, games have their unique qualities and weaknesses in information representation as well. Games are able to represent information in new forms: they can depict spatial information (through game space and spatial relation of different objects), visualize relations of different objects (dimensions, interconnections, spatial relations), distinguish objects and categories of objects by assigning specific attributes to them (audio-visual representation, interaction behavior), simulate system behavior (game rules, interaction responses, instant feedback), and control emotions (narration, immersive elements, audio-visual design and representation). Experimental studies (Whitebread, 2009) suggest that the experience of "play" is particularly effective in preparing children for effortful, problem-solving, or creative tasks which require a high level of metacognitive and self-regulatory skills.

In contrast to classic teaching approaches based on knowledge transmission, in game-based learning a learner is considered to be a responsible actor in the whole process of knowledge acquisition. As Kay (1972), a pioneer of handheld devices for learning, proclaims:

> *Child is a verb rather than a noun, an actor rather than an object, he is not a scaled-up pigeon or rat, he is trying to acquire a model of his surrounding environment in order to deal with it, his theories are practical notions of how to get from idea A to idea B rather than consistent branches of formal logic, etc*. (Kay, 1972)

Independent students (not an object of the teaching process) do not need passively distributed information or knowledge; they need to go through the process of constructing it themselves (Bain, 2004). Game-based learning offers an active approach to constructing knowledge through problem-based situations, which opposes traditional teaching methods where knowledge is believed to be transmitted from teacher to student.

To better understand a knowledge construction, we can use a theory of mental models developed and popularized by Philip Johnson-Laird and Ruth Byrne. All human beings create cognitive representations of their environment, while many of the models in peoples' minds are high-grade simulations – working models of reality (Johnson-Laird, 1986). Their structure is mostly similar to the structure of a thing or concept in reality but their models are simpler, because their aim is "only" to offer an accurate prediction. All information from our

environment is used in more or less conscious creation of mental models - essential tools allowing us to navigate through everyday life. Our mental models are responsible for the way we interact with objects around us and respond to situations we encounter. But their complexity and level of concordance with reality depends on the form and quality of knowledge acquisition and information behavior. The process of knowledge construction demands a huge effort from students, they need a strong motivation which grounds forces and emotions into valuable activities.

Surely educational games will not change the educational system or the typical channels of information representatio but in this framework they may become a convenient tool for knowledge acquisition and engagement facilitation.

1.2 Educational games and playful activities as valuable challenges for knowledge acquisition and information behavior

> *"Do not, then, my friend, keep children to their studies by compulsion but by play. That will also better enable you to discern the natural capacities of each."*
> Plato (Republic, VII.)

Research of educational games has developed radically during the last ten years, with many universities adopting game studies as accredited study programs. Furthermore, in 2009 in New York City Quest to Learn was started, the first elementary school with a curriculum based on games (Salen et al., 2011). Based on some studies, computer games are able to simulate tasks involving the same cognitive processes required for task performance in the real world (Tobias, Fletcher, Dai, & Wind, 2011) and can provide immediate feedback that might induce a correction of misunderstood information or mental model re-construction (Moreno & Mayer, 2005; Cameron & Dwyer, 2005). Despite all those supportive facts, decades-long research of game-based learning still has not revealed clear answers to questions such as: which game

elements support learning? (Wouters et al., 2013); and how efficient is the game-based learning in comparison with other teaching techniques? (Papastergious, 2009, Ke, 2008). Some studies (Hays, 2005) indicate that educational computer games positively affect math and science learning outcomes, and academic achievements in general. Also, the acquired knowledge and skills have a long-lasting effect (Sitzmann, 2011, Wouters, 2011). However, other reports (Adams et al., 2012) argue that there is not any significant proof that game-based learning affects learning positively as compared to traditional instruction or multimedia presentations. Nevertheless, most of the authors concur with regards to positive emotional and motivational responses in students interacting with games incorporated into educational programs (Ryan & Deci, 2000, Brom et al., 2010, Salen et al., 2011, Habgood & Ainsworth, 2011).

In 1972, Alan Kay created a digital learning tool, in his words "a personal, portable information manipulator", called Dynabook. He proposes that handheld computers with complex educational software embedding playful and simulation activities are one of the most efficient environments for learning whether for children or adults:

> *A safe environment, where the child can assume almost any role without social or physical hurt is important part of the day. (…) Finally, an environment which is immediately responsive to the child's activities and allows him to gain a model of himself is tremendously important.* (Kay, 1972)

His Dynabook model was never created but became an inspiration for Negroponte's project One Laptop per Child. In fact, Dynabook is an object of discussion about technologies for learning to this day. In a very recent interview, Alan Kay pointed out that in terms of education it is not a technology that is important but the content – program and proposed activities (Greelish, 2013). In his opinion there is still not a product which would be capable of using all the possibilities of personal computers and handhelds for learning. Dynabook activities were playful and problem-solving based. Users could create their own programs, share them with their peers and learn from their own or shared experience (Kay, 1972). In Dynabook,

information is conveyed through playful activities which are searched, gathered, reconstructed and modeled into new forms.

Play seems to be nature's mean for knowledge and skills acquisition. It embraces exploratory behavior, observation, curious questioning, and failure, which is also considered to be a crucial part of the learning process. A safe environment, without danger of a painful failure, and that offers instant feedback to one's actions is one of the most important characteristics of an effective educational gaming environment.

Many definitions of "game" have been espoused, but surely there is no 'best one' which clearly stands out. However, by gathering the historically strongest ones we can track core aspects of the games:

Roger Caillois (1961) sees game as:

> *(...) an activity which is essentially: free (voluntary), separate (in time and space), uncertain, unproductive, governed by rules, make-believe.*

Bernard Suits (1978) accents the rules in game:

> *To play a game is to engage in activity directed towards bringing about a specific state of affairs, using only means permitted by rules, where the rules prohibit more efficient in favor of less efficient means, and where such rules are accepted just because they make possible such activity.*

Chris Crawford (1981) focuses on aspects of shared reality created within game play:

> *I perceive four common factors: representation (a closed formal system that subjectively represents a subset of reality), interaction, conflict, and safety (the results of a game are always less harsh than the situations the game models).*

Katie Salen and Erik Zimmerman (2003) simplify the definition to the core principles:

> *A game is a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome.*

And Jesper Juul (2003) defines game as:

> *(...) a rule-based formal system with a variable and quantifiable outcome, where different outcomes are assigned different values, the player exerts effort in order to influence the*

outcome, the player feels attached to the outcome, and the consequences of the activity are optional and negotiable.

To summarize and bring up a working definition for the purpose of this study, games are complex systems representing subsets of reality, they are rule-based and player invests effort to get a specified outcome that is valued as positive (to win) or as negative (to lose).

As mentioned above, the complex environment of games create engaging moments that can stimulate knowledge acquisition (Squire, 2005) and engagement with a given topic (Egenfeldt-Nielsen, 2005); but there is still much discussion about the efficiency of such activities as compared to traditional teaching methods (Adams et al., 2012). From a general point of view, we should focus on gaming experience in a long-term perspective. Time spent playing may be both pleasurable and valuable, but the learning effects do not need to be obvious as measured by school-like knowledge tests. They become apparent while the game's virtual experience is later evoked in a real-life context (Hammer & Black, 2009).

This dissertation brings some new insights based on experimental research, comparing game-like activities happening in a virtual environment with analogous activities executed in real live conditions and with a frontal teaching approach. Information behavior and knowledge acquisition are studied using various tools, while emotional and cognitive engagement are considered to be important variables in the exploration of both concepts and motivation for future information seeking actions. Methodology and experimental design are described in the first part of the dissertation, and the following chapters offer an analysis of experimental data and conclusions.

2 Goals of the dissertation

The main quest of current information science research in the field of digital games and simulations as information representation systems is to explore game elements and evaluate their benefits and limitations for knowledge acquisition. Correspondingly the main goals of this dissertation are to explore the possible influences of game-based activities on the process of knowledge acquisition (on cognitive, individual and social level) and information behavior. In particular we seek for:

(1) Game elements enhancing knowledge gain, and mental model (re)construction (inner knowledge representation).
(2) Inner affective experiences of game-like learning in comparison with traditional pedagogical methods.
(3) Impact on group information behavior (information sharing, communication manners and frames) that a game can have.
(4) Influence of game-like and non-game-like learning experience on information behavior and motivation for future learning.

The methodological approach is grounded in variety of disciplines including information science, educational science, new media studies and computer science. The main method used within the dissertation research is educational experiment. Educational programs using educational games or simulations are compared to similar programs based on traditional schooling methods and classic lectures.

2.1 Hypotheses overview

This dissertation outlines set of four subsequent issues and explores following hypothesis:

#1 Educational games help in efficient building of complex mental models;

- Hypothesis: *"The concept maps will be more complex and retentive within the experimental group."*

- Methods of validation: content analysis of concept maps created by students (self-reported visual representation of their knowledge); post-test and 1 month delayed post-test.

#2 Educational games foster curiosity and learning motivation, which if aroused within game-play have a stronger and longer-lasting impact on information behavior as compared to traditional lecturing;

- Hypothesis: *"The experimental group will within one month following the educational intervention show a higher engagement in information behavior."*

- Methods of validation: questionnaires, post-test and 1 month delayed post-test

#3 Educational games arouse positive emotions linked to a particular learning theme, those emotions stimulate situational cognitive engagement;

- Hypothesis: *"The experimental group will in learning situations show more positive affects which support learning and situational cognitive engagement."*

- Methods of validation: emotional graphs and PANAS test (Positive Affect and Negative Affect Scale, Watson et al., 1988); post-test.

#4 Educational games and simulations played collectively in one physical space, e.g. classroom, might stimulate creation of motivating and engaging 'learning frame';

- Hypothesis: *"Verbal and non-verbal behavior showing positive engagement and willingness to develop learning situation will be present in (inter)actions of game participants."*

- Methods of validation: class observations and conversation analysis of audio records.

3 Methodology

The dissertation details the results of a long-term experimental study conducted during September 2012 – May 2013 with students from high schools in the Czech Republic. The study was part of a larger study investigating the learning effects of digital games[1] using a so-called media-comparison approach (Mayer & Johnson, 2010). The main part measured knowledge outcomes by various pen-and-paper tests (detailed description in Brom et al. 2014); the second part focused on several factors influencing knowledge acquisition (emotional experiencing, motivation for future learning, social interaction), and its results are described on the following pages. This part of the study was rather qualitative, while the main part was strictly quantitative. Within the qualitative part we have used some new research tools to closely portray aspects of knowledge acquisition; its development and applicability are discussed below as well.

To evaluate the educational influence of the game-based learning approach, we developed a design for a controlled experiment with one experimental and two control groups, where three different teaching approaches were employed: (1) a digital game, (2) a classic lecture and (3) a non-digital game (details in Chapter 3.2). The experimental data are discussed below, for the evaluation of statistical significancy $p<.05$ level is used.

3.1 Research instrument: Europe 2045

As the research instrument we used educational simulation *Europe 2045*. The game attempts to teach students three kinds of knowledge; to improve their high-level skills; to increase their ability to discuss, negotiate, work in teams, and make group decisions. The second goal is to familiarize students with facts, such as geographies of European countries, EU institutions and policies, typologies of political inclinations, etc. The third goal is that students acquire mental

[1] „Learning Effects of Educational Simulations (LEES)“ project number P407/12/P152 supported by Czech Grant Science Foundation (GA ČR).

models of large-scale processes and socio-political notions such as a model of "energy dependence" or "liberalism".

Europe 2045 was released in 2008 and the evaluation study (Brom et al., 2010) suggested that it was successfully integrated into the formal schooling system (e.g., out of 188 students involved in the study, 37% rated the game as excellent and 41% as good; only 6% of all responses were negative). Till today the game was implemented in dozens of Czech high schools and played by more than 4,000 students. *Europe 2045* was modified for the purposes of the experimental research; the original version was described in Šisler et al. (2008). All the features described below are of the modified version (Europe 2045 Exp.).

Europe 2045 Exp. is an educational team-based serious game for 8 players. The games' aim is to improve students' high-level skills (to increase their ability to discuss, work in teams, etc.); to teach facts about the EU institutions and policies; and to help build mental models of large-scale processes and sociopolitical notions such as a model of "energy dependence" or "liberalism". *Europe 2045 Exp.* combines the principles of two game genres: multi-player on-line videogames and social role-playing games. It is supposed to be played in a group led by a teacher; one part of the game is played in multi-user virtual environment (on PC) and second part in a classroom, where role-playing game activities take place. A teacher is always present and takes on the role of a discussion moderator.

In the beginning, each user chooses a project to play for (Social Europe – Social Democracy, Liberal Europe - Liberalism, Conservative Europe - Conservatism, etc.). A project is a vision of how the EU should look in the future, and therefore players need to achieve structural changes to bring the EU closer to their project goal (e.g., the Environmentalism project supports environmental protection and investment into alternative energy resources, while the Conservatism project strives to preserve traditional values). The winner of the game is the player who was able to push through or refuse as many policy changes as possible in order to re-create Europe according to the vision of the project he/she was playing for.

*Europe 2045 Exp.*features three layers of game-play: the economic layer, the diplomatic layer and the story-telling layer. In the economic layer, each student assumes a role of a European state leader and in virtual environment defines the domestic policy as tax levels and environmental protection (see Fig. 1).

Figure 1: Europe 2045 Exp. GUI, a domestic policy

In the diplomatic layer, the player has an opportunity to present drafts for policy changes to the EU (for issues such as common immigration policy, stem-cell research and/or agricultural quotas). Discussions about these changes take place in the classroom, and can be conceived as a simulation of official EU negotiations within institutions, such as the European Parliament, the Council of Europe, and the Foreign Affairs Council. Players submit their final votes via the game interface.

Players can also support their votes by creating informal pacts with other state leaders, and for this purpose they can also use the in-game discussion forum. The game features both collaborative and competitive aspects at the same time. So the final appearance of Europe at the end of each game session is the result of intense negotiations and voting within the group.

In the story-telling layer, players face an introductory simulated scenario (a tanker accident off the coast of Norway), and must react to the events, their consequences, and, in cooperation with fellow players, seek appropriate solutions. The intro scenario serves to teach the players a dynamic discussion model. The game story is also created within the game by the players' actions; all the changes in the state policy cause consequent events, e.g. strikes, protests etc. All the changes influence their state budget, environment, infrastructure development, the general satisfaction of their citizens, and other values -- reflected in their local news, available in online newspapers customized for each state (see Fig. 2). So students can see the effects of their changes in a realistic context.

Figure 2: Europe 2045 Exp. GUI, on-line newspapers

The initial state of the game is based on real-world data from the year 2011. The game is played in rounds with each round representing one year (one game consists of five rounds).

Players also utilize an on-line encyclopedia as a theoretical and supporting source of information (see Fig. 3) another helpful tool for success in a game.

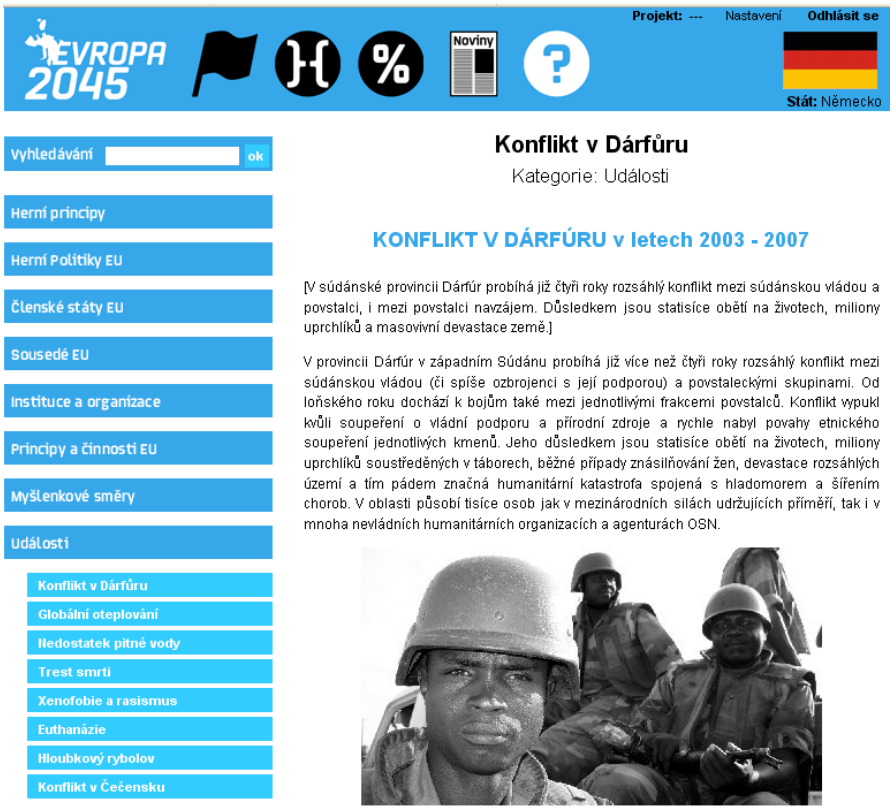


Figure 3: Europe 2045 Exp. GUI, encyclopedia

Europe 2045 Exp. was played during one-day workshop lasting about four hours. The experiment utilized a form of one-day workshop.

In one round, the players typically started by reading in-game news, afterwards the teacher summarized the outcome of the previous round. Then the players prepared themselves for the presentation of drafts for policy changes; here they did not interact with PCs but read printed texts from the in-game encyclopedia. Later, they moved away from the computers and presented their drafts for policy changes to their fellow players. The teacher moderated the presentations, while the other players were able to ask supplementary questions and/or oppose the student's agenda. After the presentations, students began negotiating for or against support of the proposed policy changes. The negotiation process had an allotted time frame

and was not moderated by the teacher. In fact, the teacher encouraged students to stand up, make small clusters, secretly negotiate outside of the classroom, etc. and otherwise take active roles in the negotiations. Small groups of students often informally engaged in "collaboration agreements", which usually lasted more than one round, and under which the students mutually supported each other's proposals. The round ended with voting.

3.2 Experimental design

The experimental design was built on the results of two preliminary studies: (1) the qualitative evaluation conducted within implementation of *Europe 2045* at first Czech high schools (N = 188; age 16 – 18) (Brom et al., 2010), and (2) the pilot study focusing on learning effects of serious games using *Europe 2045* as a research instrument; the quasi-experimental study compared various cognitive and affective variables (N = 74; age 16 – 18) (Šisler et al., 2012). Within both studies, the qualitative and quantitative research tools were evaluated, as well as the design of the educational workshops for the three research groups.

Within our present study we used three different media that were later compared to each other: (1) *Europe 2045 Exp.,* an educational digital game (experimental digital game group); (2) a classical frontal teaching approach (control classic lecture group); and (3) a non-computer game copying *Europe 2045 Exp.* played in the classroom (control non-digital game group). All students were told that the educational workshop was a part of a research project studying new approaches to teaching; words as game or classic lecture were avoided. The measures were collected as well one month later within the 1-month delayed test session.

The timetable and all workshop activities were strictly defined (see Fig. 5) for the experimental and both control groups, so we could assure the comparability of research variables: the same amount of time dedicated to learning activities, frontal teaching sessions, pauses, similar vocabulary and communication style etc. To avoid environmental issues that

might threaten the reliability of the pilot study, we chose a laboratory design – that is, the experiment did not take place at students' proper schools but in the classrooms of Charles University, and the teachers were hired specifically for the experiment. To minimize possible bias caused by specific teacher personalities, we worked with a group of six teachers, all males younger than 35 years of age, with similar clothing style, short hair and similar speech and teaching styles. These teachers rotated through different classrooms and taught in all three types of research groups (one experimental and two control groups). Each teacher had an assistant, who administered the questionnaires and helped with technical issues. Also present in the classroom was one independent research observer, who coded students' verbal and non-verbal behavior during the presentations and discussions.

The experimental design was created in collaboration by Cyril Brom (Faculty of Mathematics and Physics, Charles University in Prague), Vít Šisler (Faculty of Arts, Charles University in Prague), Michaela Buchtová (Faculty of Arts, Charles University in Prague), Ivo Šebek (Faculty of Arts, Charles University in Prague) and Tereza Selmbacherová (Faculty of Arts, Charles University in Prague). This dissertation describes the outcomes of the qualitative part of the experiment, which focused on information behavior and processing, emotional experiencing, motivation, and behavior patterns. The quantitative part measured knowledge acquisition and emotional engagement through standardized tests and biofeedback (some details about the experimental design in Brom, 2012). Qualitative design was mostly developed by Michaela Buchtová, i.e. the author of this dissertation, while quantitative was developed by Cyril Brom, who led the experiment (a more detailed description in Brom et al., 2014).

3.2.1 Digital game treatment (experimental digital game group)

Exactly eight students took part in this treatment. Within the game, the students played six rounds, which included breaks; the entire treatment took about five hours. In the very beginning, the players were familiarized with how to control the game and with the process of presenting drafts of policy changes and negotiations. They were told how the game score was computed, and how they could compete against each other and/or collaborate to win.

Each student had three minutes to read a short description of eight European projects-visions: More Europe (Euro-optimism), Less Europe (Euro-skepticism), Fortress Europe, Green Europe (Environmentalism), Open Europe, Social Europe (Social democracy), Liberal Europe (Liberalism), and Conservative Europe (Conservatism). Next, they chose three preferred projects to play for, and the teacher gave instructions on creating a concept map (for details see Chapter 4.3); afterwards they were asked to draw a concept map of one project which was chosen from those three by the teachers' assistant (the first preferences could not always be respected, as the game could not contain two similar projects).

Each project in the game has an assigned state; to visually identify their roles, players got a flag badge and a small flag stand on their table. During the first eight minutes, they read a more detailed project description, which also served as a preparation for a one-minute presentation of the project's main vision in front of the other players (an hourglass was used for timing).

The next rounds of the game had similar design: four players selected by a computer were to propose a draft for a policy change (for details see Chapter 3.1); they had eight minutes to study additional materials relating to the game (mainly the on-line encyclopedia), and the rest of the players could control their state (i.e., play the economic layer), or read materials about policies associated with their own projects or about policies proposed by the other four players (utilizing the on-line encyclopedia). Afterwards players were invited to turn away from computer screens, and each student assigned to propose a policy change had exactly 1.5 minutes to introduce the policy and present its benefits, after the open discussion

moderated by the teacher began (2-3 minutes). When all four proposals were presented, there were five minutes of overall negotiation, where the teacher challenged students to leave their places and discuss ideas with other players individually.

In the end, students voted separately on their computers. The teacher presented the results at the beginning of the next round, as well as the current game ranking of the players. Within the workshop there were three short breaks, plus a 30-minute long lunch break before the last round and one short break after the end of the game (see Fig. 5).

3.2.2 Classic lecture treatment (control classic lecture group)

Six to ten students took part in this group; the exact same schedule was also employed, while the same content was mediated to the students by non-game-based learning techniques.

In the very beginning, the teacher gave a frontal lecture about the EU and then students took part in a short pen-and-paper activity about the legal system in European countries. The activities took about 60 minutes; the content of both activities was not related to the aim of the experimental research. Afterwards, each student had three minutes to read a short description of eight European projects-visions. Contrary to the experimental game group, these students did not choose their projects and they did not represent their states (did not receive flag badges/stands etc.).

In the experimental game group, each student had three minutes to read a short description of eight European projects-visions (More Europe, Less Europe, Fortress Europe, Green Europe, Open Europe, Social Europe, Liberal Europe, Conservative Europe). They were then asked to mark three projects that seemed interesting to them, then the teacher gave instructions on creating a concept map (for details see Chapter 4.3) and afterwards – apart from their choices – they were each assigned one project (parallel to the experimental game group) and instructed to "study a project" rather than "to play" a project role (the play and free choice of a role is an essential part of role-play games). Similarly to the experimental game group, they

drew a concept map of their project, got eight minutes to read a more detailed project description and make a one minute presentation of the project's main vision in front of the other players (an hourglass was used for timing as well).

The program consisted of repetitive blocks partly copying the game rounds. Students were assigned a policy to study and to present; they had eight minutes to study it and 1.5 minutes to introduce the policy and present its beneficial aspects. After each presentation, the teacher invited other students to express their opinions regarding whether the policy should be put into force in the EU or not, when considering the context of "their" project. They could express positive as well as negative opinions and ask questions. The discussion was moderated by the teacher and took a maximum of three minutes.

Students did not vote about the policy drafts and did not interact with a European state model, so the whole workshop of the classic lecture control group turned out to be shorter. The introduction of the game was replaced by an unrelated 40-minute-long frontal lecture on the EU thematic and by a 20-minute-long, pen-and-paper mini-rebus about EU law. There was also an unrelated short film about an EU topic at the very end of the workshop (around 20 minutes) and two short breaks in the middle were added (see Fig. 5).

3.2.3 Non-digital game treatment (control non-digital game group)

Six to eight students took part in the non-digital game treatment. It copied the activities of the experimental game group but computers were avoided. Participants played roles of EU state representatives and led face-to-face discussions while simulating the process of the EU negotiations.

The voting system was simulated directly in the classroom using a voting urn, and the in-game textual materials (encyclopedia texts) were printed out and distributed to the players. The schedule and the content were exactly the same as in the experimental game group (see Chapter 3.2.1.) except that the players did not have the opportunity to control their state (the

economic layer). This time spent by the experimental game group (approximately 15 minutes) was replaced by an extra break and a longer voting process (the votes had to be counted manually in the non-digital game treatment) (see Fig. 4).

Figure 4: on the left: voting interface in *Europe 2045 Exp.* (experimental digital game group); on the right: a teacher standing next to the voting urn in the control non-digital game group, the most recent proposals are written on the board behind him (top), as well as the player's latest ranking (bottom).

EXPERIMENTAL DIGITAL GAME GROUP	CONTROL CLASSIC LECTURE GROUP	CONTROL NON-DIGITAL GAME GROUP
Students coming to classroom, preliminary knowledge test (5 min)	Students coming to classroom, preliminary knowledge test (5 min)	Students coming to classroom, preliminary knowledge test (5 min)
Introduction and introductory presentation about EU (20 min)	Introduction and introductory presentation about EU (20 min)	Introduction and introductory presentation about EU (20 min)
Participants divided into groups (5 min)	Participants divided into groups (5 min)	Participants divided into groups (5 min)
Introduction into group activities (5 min)	Introduction into group activities (5 min)	Introduction into group activities (5 min)
Reading short description of eight European projects-visions; personal choice (4 min)	Pen and paper group activity, EU law (30 min)	Reading short description of eight European projects-visions; personal choice (4 min)
Explanation of game rules (5 min)	Pause (5 min)	Explanation of game rules (5 min)
Concept map creation (6 min)	Reading short description of eight European projects-visions; personal choice (4 min)	Concept map creation (6 min)
Teacher assignes EU projects and drafts of policy to students, time to study them (12 min)	Concept map creation (6 min)	Teacher assignes EU projects and drafts of policy to students, time to study them (12 min)
Students presenting their projects (1 min each)	Teacher assignes EU projects and drafts of policy to students, time to study them (12 min)	Students presenting their projects (1 min each)
Pause (10 min)	Students presenting their projects (1 min each)	Pause (10 min)
Explanation of point system (8 min)	Pause (10 min)	Explanation of point system (8 min)
Teacher presents delegate of Estonia with his exemplary draft of policy (5 min)	Frontal lecture, EU basics (50 min)	Teacher presents delegate of Estonia with his exemplary draft of policy (5 min)
1st game round: Students' preparation for their presentation, reading the documents (8 min) Studets' presentations of drafts of policy (1.30 min each) and discussions (2 min each) Backstage negotiations (5 min) Voting and counting the result (7 min) Interaction with virtual environment (5 min)	Pause (10min) Teacher presents exemplary draft of policy (5 min) Students' preparation for their presentation, reading the documents (8 min) Studets' presentations of drafts of policy (1.30 min each) and discussions (2 min each) Discussion about drafts of policy and their relation to the European projects-visions (5 min) Pause (10 min) Teacher assignes drafts of policy to students, time to study them (8 min) Studets' presentations of drafts of policy (1.30 min each) and discussions (2 min each) Discussion about drafts of policy and their relation to the European projects-visions (5 min) Psychological tests session (PANAS, flow) (5 min) Short film with EU thematic (15 min)	1st game round: Students' preparation for their presentation, reading the documents (8 min) Studets' presentations of drafts of policy (1.30 min each) and discussions (2 min each) Backstage negotiations (5 min) Voting and counting the result (12 min)
Pause (5 min)		Pause (5 min)
2nd game round		2nd game round
Pause (5 min)		Pause (5 min)
3rd game round		3rd game round
Psychological tests session (PANAS, flow) (5 min		Psychological tests session (PANAS, flow) (5 min
Lunch pause (20 min)		Lunch pause (20 min)
4th game round		4th game round
Pause (5 min)		Pause (5 min)
Winner announcment (2 min)	Lunch pause (20 min)	Winner announcment (2 min)
Test session (60 min)	Test session (60 min)	Test session (60 min)

Figure 5: Experimental and control groups' timelines

3.3 Participants

Within the experiment we organized 14 workshop days (six hours), always for one high school class, and for another two workshop days we recruited college students (mainly students of computer science or psychology), who participated for course credits or a payment of 400 CZK. The high-schoolers took part in the educational workshop as a part of their normal classwork, they did not receive any additional payment.

282 high school students took part (males = 126, females = 156; mean age M = 16.5, SD = 0.9) and one workshop day was organized for younger high school students (N = 17, males = 10, females = 7; mean age M = 13, SD = 1). The college students formed groups for two workshops (N = 31, males = 21, females = 10; mean age M = 23.5, SD = 0.5).

Each group consisted of 15-26 participants, the high school students always arrived as a regular class group with their teacher. So in the high school groups, participants knew each other well and in the college groups, some of them did and some did not know each other. All participants got a number to keep their data anonymous and able to compare them with the data from 1-month delayed testing session.

After the short introduction in the beginning of the workshop day, participants were asked to fill out a pre-questionnaire assessing their knowledge of European Union affairs. Based on the scores of those questionnaires, they were divided into two or three subgroups, each getting different experimental treatment (see Chapters 3.2.1 – 3.2.3). In the case of 19 or less participants in a group, only two subgroups for the experiment were created (the experimental game group and one of the control groups), and in the case of 20 and more participants all three treatments (the experimental game group, the control classic lecture, and the control non-digital game group) were applied.

Distribution of the students into the subgroups was not random. In order to have a comparable sample in each subgroup, pairs (in the case of two groups) or trios (in the case of three groups) of persons with similar scores from the pre-questionnaire were created, and then assigned to

the experimental conditions randomly. Thus each subgroup had the same proportion of students from each level of knowledge and gender.

3.4 Timetable and testing

After the knowledge pre-questionnaire, the participants received an introductory lecture about the EU that took about 20 minutes. During this time, the tests were evaluated and at the end of the lecture participants were divided into the subgroups (see Chapter 3.3). Teachers from our research team gathered participants into their groups and walked them into separated classrooms (till the end of a workshop day participants from different subgroups did not meet each other). From approximately 9:00 a.m. till 1:30 p.m. participants learned about the same content through different educational treatments (for more details see Chapter 3.2), with a few short pauses and one 30-minute long break for lunch.

When the educational part was finished, participants got a 5-minute long pause and then the testing session started. This session took about 45-60 minutes and consisted of nine written tests, one group problem-solving activity, and a very short oral interview in groups of 2-3 students. The tests examined students' knowledge (5 questionnaires), their mental models (concept map, more details in Chapter 4.3), emotional profile (Social Interaction Anxiety Scale, SIAS), emotional experiencing (emotional graph; more details in Chapter 6.2), and self-evaluation in the area of knowledge of EU affairs. The short interview in groups of two or three students served as a general oral examination of what students remembered from the workshop (in the thematic of the EU affairs). The examination was led by teachers' assistants.

One month later, the participants filled in subsequent knowledge tests and a few inventories. Students were not informed in advance. The one month-delayed testing period lasted 90 minutes.

4 (Digital) games and simulations and its' effect on development of mental models

Hypothesis no. 1: *The concept maps will be more complex and retentive within the experimental group.*

4.1 Mental models: overview

Theory of mental models rises from philosophy, early psychology and contemporary cognitive science. Philosopher Charles S. Peirce mentioned its very first concept when he described deduction as:

> *(…) that mode of reasoning which examines the state of things asserted in the premisses, forms a diagram of that state of things, perceives in the parts of that diagram relations not explicitly mentioned in the premisses, satisfies itself by mental experiments upon the diagram that these relations would always subsist, or at least would do so in a certain proportion of cases, and concludes their necessary, or probable, truth.* (In Hartshorne & Weiss, 1931)

The work of developmental psychologist Jean Piaget might also be considered as one of the first sources of inspiration. He presented two crucial concepts of learning and adaptation process, assimilation and accommodation (Piaget, 1932). With assimilation, we attempt to fit new information into existing slots or categories, while accommodation is rather a result of a contradiction or confusion and involves the process whereby we modify our existing model of the world and try to implement new information that does not fit into an existing slot or category. Thus the example of assimilation can be a mental representation, or schema of a certain group of people, a racist schema that is supported by the whole reference group of a person; everything around him/her just adds more and more information to that schema that makes sense (mostly we only notice information that fits our schema and confirms it). Later the person gets to college and actually meets people from that group and realizes that

the schema regarding the group requires a radical reorganization (accommodation). The new schema is completely different, not just supplemented by new information.

The first notion of the term "mental model" comes from psychologist Kenneth Craik who hypothesized that people reason by carrying out experiments on internal models of physical situations, where the model is a structural, behavioral, or functional analog to a real-world phenomenon (Craik, 1943). Since the early 1980's, a "mental models framework" has developed in a large segment of cognitive science.

The most influential account of mental modeling is that of Johnson-Laird who refers to mental model specifically as a model:

> *(…) that has same structure as the situation that it represents. Like an architect's model, or a molecular biologist's model, the parts of the model and their structural relations correspond to those of what it represents. Like these physical models, a mental model is also partial because it represents only certain aspects of the situation. There is accordingly many-to-one mapping from possibilities in the world to their mental model.* (Johnson-Laird, 2005)

Based on recent theoretical research, we can define mental models as intrinsic representations of objects, ideas, or processes which individuals generate during cognitive functioning (Buckley & Boulter, 2000; Wang, 2007). The models contain presuppositions about the systems, and causal rules and relations between its subsystems. People use these models to reason, describe, explain, predict phenomena, and/or generate expressed models in various formats (e.g., verbal description, diagrams, simulations, or concrete models) to communicate their ideas to others or to solve problems (Buckley & Boulter, 2000; Greca & Moreira, 2000). Mental models are stored in long-term memory (Coll & Treagust, 2003) and are retrieved and mobilized immediately to deal with encountered problems (Vosniadou & Brewer, 1994), but according to Schwartz and Black (1996) people manipulate mental models only when they need to generalize rules or when their present rule fails. Otherwise, they tend to immediately apply a practical rule to make direct predictions and skip the effortful processes of mental simulation. The accommodation of the model is often huge and people mostly construct

completely new models (Johnson-Laird, 1983; Glynn & Duit, 1995). This part of the mental models theory is researched by so-called conceptual change theories (Chi, 1992, Chi et al., 1994; She, 2004; Vosniadou, 2003; Vosniadou & Ioannides, 1998).

The process of mental simulation means that the models can be manipulated mentally, or "run in the mind's eye," to make predictions about the outcomes of causal states in the world (Vosniadou & Brewer, 1994). To be runnable, the construction of mental models includes two stages. The first phase is to envision the physical phenomenon as a system; it entails the creation of images of the components involved in the phenomenon, and identification of the causal relationships between the components. The second phase is to execute this physical system to obtain the intended output, for example a prediction. In this phase, people start with specifying the states of the components and then determine how the state of one specific component may change the states of other components on the basis of the causal relationships between them. Accordingly, multiple representations, such as mental images and production rules (if...then), appear crucial to manipulate a mental model for generating predictions and explanations of a physical system. Therefore learning and specific training can enhance a person's capabilities to create and work with mental models (Chiou, 2009).

Mental models first originate from an individual's constant interactions with related physical phenomena and systems (Norman, 1983; Chiou, 2009), which is considered to be a basic adaptive function of all living organisms. But humans, thanks to their linguistic abilities, are able to create the models as well from a mere description (Nersessian, 2002).

One of the major functions of mental models is to help people generate predictions and explanations (Norman, 1983). On the other hand, mental models have a lot in common with beliefs; they are constraints which emerge out of the structure of previously acquired knowledge, and which influence acquisition of new knowledge (Vosniadou & Brewer, 1994). Mental models are incomplete and unstable; people tend to forget the details of the system if those details have not been used for some period (Norman, 1983).

4.2 Digital games and theory of mental models

A number of experiments investigated mental processes of literature readers and confirmed the hypothesis that readers spontaneously construct mental models to represent and reason about the situations depicted by the text (Dijk & Kintsch, 1983; Franklin & Tversky, 1990; Johnson-Laird, 1983; Zwann & Radvansky, 1998). Mostly readers imagined situations by "being on place as an observer" (Nersessian, 2008). It is still a question what kind of experience can be created by game and what differences into mental modeling process and outcome it brings.

Mayer et al. (1984) proposed that coherent mental models are created while efficient cognitive aids are available, for example a student reading a scientific text containing specific description of cause-and-effect system might develop more coherent mental model than a student reading a text without those aids linking nodes of the specific system. The second student will rather create a "memory list" and will be difficult for him/her to comprehend the system functioning.

Digital games considered as a medium for representation of information offer novel ways to represent complex models and themes, they create a new environment for perceiving new kinds of information and experiences. Games are able to represent information in many aspects: they can depict spatial information (through game space, spatial relation of different objects), visualize relations of different objects (dimensions, interconnections, spatial relations), differ objects and categories of objects by assigning specific attributes to them (audio-visual representation, interaction behavior), simulate system behavior (game rules, interaction responses, instant feedback), and control emotions (narration, immersive elements, audio-visual design and representation).

Similar to mental models, game mechanics are related to each other through causal relationships, spatial information connecting entities, and costs of alternative outcomes in given relationships. To master the in-game challenges, a gamer must create a mental model of

the intrinsic obstacles in the game world that is similar or identical to the true computer game model (Boyan, 2011).

Games constantly test the players' prior mental models and embody the process of cognitive disequilibrium and resolution; they foil expectations (create cognitive disequilibrium) without exceeding the capacity of the player to succeed. Interacting with a game requires a constant cycle of hypothesis formulation, testing, and revision (Van Eck, 2006). This is possible with a high level of sustainability because of a digital game's unremitting and immediate feedback. A continuous cycle of cognitive disequilibrium and resolution allows processes of assimilation and/or accommodation within a player's mental models. Surely the efficiency and outcomes of such processes will depend on many variables such engagement, mental capacity, flexibility of mental models' structure etc.

Traditional classic lectures influence the creation and conceptual change of mental models through theoretical description, explanation, questioning and discussion. Games immerse its users directly into the problematic and let him/her to test the mental models in (inter)action. The above mentioned example of accommodating new mental model of a minority group through a personal experience with that group can serve as a springboard to the first hypothesis overlaying this chapter: would such an accommodation of the person's mental model be possible thanks only to a theoretical description within a lecture?

4.2 Concept maps: overview

To study a structural change in participants' knowledge and uncover the process of their mental model creation, we need to use more sensitive and comprehensive assessment tool than standardized written tests. Direct qualitative questioning or think-aloud protocols (Nersessian, 2002) were impossible to use because of time restrictions and the number of research subjects in our experiment; participants came as a big group and it would be inappropriate to separate only chosen individuals. Mayer as well (1984) proposes written

questioning focusing on (near or far) knowledge transfer and "runnability" of mental models, i.e. "*On the moon, objects generally weigh one sixth of their weight on earth. Describe the density of an object on earth and when it is on the moon.*" This dissertation rather focuses on evaluation of content and architecture of the mental models, i.e. the first phase of mental models creation (for more details see Chapter 4.1). For this reason as a primary tool of mental models evaluation we used content analysis of concept maps created by research participants.

In educational qualitative research we can often find so-called "concept mapping," a technique to visualize the organization and relationships between various concepts, thoughts and/or theories. Concept mapping was first described by Stewart, Van Kirk, and Rowell (1979) and developed by Novak and Gowin (1984) as an efficient learning technique within knowledge constructivist paradigm. Nowadays, concept mapping is often also used in the assessment of learning processes (Besterfield-Sacre et al., 2004; Poole and Davis, 2006) and is one of the respected techniques for assessing students' mental models of complex concepts. Instead of written answers in standardized test, they graphically represent their knowledge and understanding in schematic hierarchical models of ideas or concepts linked through branches of sub-concepts, or interrelationships (i.e., crosslinks).

Although concept maps are well accepted as a viable assessment tool in qualitative educational research, there is not a general agreement on a scoring technique (Besterfield-Sacre, 2004). A number of researchers have attempted to develop accurate methods for assessing concept maps. The most classic one was developed by Mintzes et al. (2001) who evaluated concept maps through the inner connections between its sub-concepts; i.e. evaluated the validity of the connections and determinated their super/subordinate nature. Another approach proposed Bayram (1995), he focused more on the whole structure of a map; he proposed a point system based on the map's hierarchical levels, correct propositions and branches. One point was given for each hierarchical level, each relationship between concepts established by a correct connection. Ruiz-Primo et al. (2001) combined Novak's and Bayran's approaches and related

each map to a criterion (expert) map. The other part of the score was based on diversification and development of hierarchy.

4.3 Methods of the hypothesis verification

In the hypothesis no. 1 we postulated more complex and retentive mental models within the groups of students exposed to educational game (experimental game group or control non-digital game group) rather than within the group exposed to classic lecture.

Students' mental models were measured by concept maps that students drew both, right after the learning session (maps #1) and one month later (maps #2). Two evaluation methods were used: (1) Ruiz-Primo et al. (2001) approach – the comparison of students' concept maps with expert maps and (2) content analysis of concept maps. The content analysis served as a pilot study of possibilities and limits of such method for mental models evaluation, its results are summed by this dissertation. The comparison of maps with expert maps will be published later on by Cyril Brom et al. All the following statements about expert map comparison are based on preliminary results and for this reason no exact numeric data is cited.

In the following analysis data from the experimental digital game group and both control groups are compared to each other. For evaluation were chosen only participants who attended educational workshop and one month delayed testing session (so we could compare both maps #1 and #2), afterwards we also compared those to the group of "naive" students, the students who did not take part of educational workshop but took part of the 1-month delayed test session (generally the students who were sick the day of the workshop).

Concept maps from 340 subjects were evaluated; 91 from the experimental digital game group, 111 from the control classic lecture group, 80 from the control non-digital game group and 58 from the "naive" students.

In the very beginning of the educational workshop students were asked to read a 3-4 sentence summary of eight political projects (a specific political direction, e.g. liberal, conservative, environmental, multicultural, etc.), chose three projects that interest them and afterwards the students got assigned one project (for details see Chapters 3.2.1 – 3.2.3). For their concept map the students got an empty form with an ellipse in the middle (see Attachment 1) and following instruction: "*Into the empty ellipse write the name of the political direction, you were reading about today. To the surrounding area write the key concepts related to this direction.*"

Before the map creation the teacher presented the following instructions: "For my mental map I chose the anarchism. Actually, just recently I saw a documentary about anarchism, so I know a lot about it... What am I thinking of now?" …*writes 'Anarchism' into the ellipse*. "On which side of the political spectrum?" …w*rites 'radical left' and connects it directly to 'Anarchism'.* "As it is in the left side of political spectrum, it tries to enforce…" …w*rites 'social justice' and connects it directly to 'radical left'.* "Everyone has probably heard of…" …w*rites 'Sex Pistols' and connects it directly to 'Anarchism'.* "I think its origin is…" …w*rites 'France' and connects it directly to 'Anarchism'.* "I might as well mention that it determines itself against…" …w*rites 'political power' and connects it directly to 'Anarchism'.* "So mainly…" …w*rites 'state' and connects it directly to 'political power'.* "Generally speaking, it refuses a social stratification…" …w*rites 'hierarchy' and connects it directly to 'state'. "* Since Anarchism is radical, it wants some big, radical change..." …w*rites 'revolution' and connects it directly to 'radical left'.* "Which will lead to liberation…" …w*rites 'freedom' and connects it directly to 'revolution'.* "And the last line: freedom can be understood as liberation from that hierarchy, which is fighting against, so I will connect it…" *…connects 'hierarchy' and 'freedom'.*

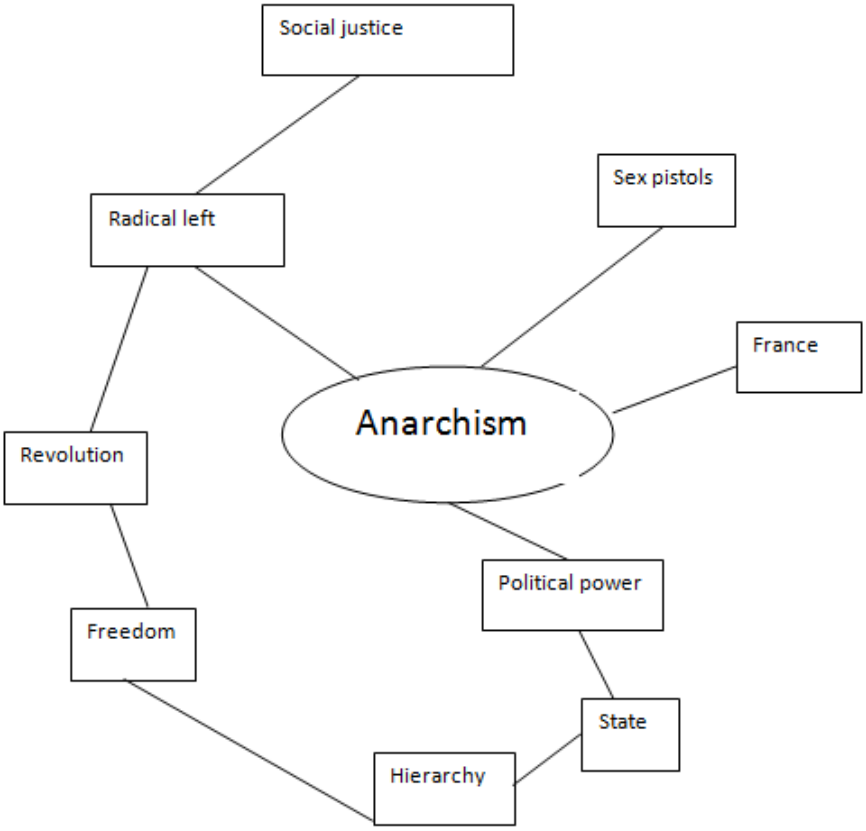


Figure 6: Concept map drawn by teacher as an instructional example

In total, students drew three concept maps: in the beginning of the educational workshop (maps #0); right after the learning session (maps #1); and one month later (maps #2). Maps #0 were not analyzed, they served only as a training tool to assure the same level of understanding the concept maps between all students

To evaluate students' concept maps we first used the method of comparison with an expert map (Ruiz-Primo et al., 2001). Two evaluators created a "perfect" map containing all possible connections and right answers for each political project. Afterwards they independently evaluated all students' map by comparing them to the expert map. Therefore each map got two percentage scores representing its accordance with the "perfect" one. After a statistical test of the evaluators' accordance (Pearson product-moment correlation coefficient), the average value from those two results was considered for the further analysis. The preliminary results

show between group differences. The results will be published in an academic paper in 2014 (Brom et al., 2014). The problem we encountered was that the differences in percentage do not reveal much about qualitative change of students' knowledge. Our purpose was as well to observe the changes in students' mental models not only to numerically assess their knowledge.

Therefore in the next steps we analyzed all mental maps by method of content analysis and followed changes in their concept maps through time – by comparison of maps created after educational workshop (map #1) and maps created 1 month after (map #2).

Classic quantitative measures of content analysis were applied: keyword frequencies and spatial measurements of a map (branching, subcategorizing). The evaluator analyzed each entry word in map #1 and followed its development in map #2. The base value for the content analysis was a "sub-concept", a fragment of a concept map related to one specific theme (so it can contain more than one entry). E.g. in the exemplary concept map described above (see Fig, 6) eight entries would be counted: (1.) political power + state; (2.) hierarchy; (3.) France; (4.) Sex Pistols; (5.) freedom; (6.) revolution; (7.) radical left; (8.) social justice.

We utilized two categories for evaluation of sub-concepts in maps #1:

1) relevant,
2) irrelevant.

And six categories for the sub-concepts in maps #2:

1) disappeared (present in maps #1 and not in maps #2);
2) stayed in unchanged form;
3) stayed in "up-graded" form (the sub-concept in map #2 was in more apposite position or more appropriate and/or developed phrase than in map #1);
4) stayed in "down-graded" form (less apposite position or less appropriate and/or developed phrase than in map #1);

5) new (for the entries that were present in maps #2 and not present in maps #1);
6) irrelevant (as above).

As up-graded sub-concepts we considered the entries or group of entries that developed or/and concretized the entries from map #1. For example hierarchy branching into middle class, upper class etc. would be considered as an up-graded sub-concept. The down-graded sub-concepts lack a rich branching or are more general than their correspondent in the map #1.

The concept maps often contained some irrelevant entries that were unrelated to the basic theme of the concept map, such as a wrong answer or error by the other words. In the case of our example the entry "social aid for elders" would be considered as an irrelevant sub-concept. Indeed the comparison between individual maps #1 and maps #2 was crucial for the analysis.

Additional qualitative analysis was also used to explain differences in greater detail, i.e. the character of the content was evaluated and trends in the maps' content were described.

4.4 Outcomes

Within the expert map comparison method maps #1 showed only slight differences while comparing the three groups to each other. The average percentual value of accordance with the expert map was quite similar for the three groups. But there was a remarkable shift while comparing those maps (maps #1) with the maps #2. All the groups turned for the worse but the experimental digital game group and the control non-digital game group only slightly, and the control classic lecture group more considerably. Such an outcome can advert to lower retention of mental models within classic lecture intervention; the game groups sustained their concept maps closer to the quality of the maps created right after the educational workshop.

What expert maps comparison lacks is a qualitative approach explaining a deeper meaning of percentual differences. To see the qualitative value in the development of students' concept maps we employed a method of content analysis (for more details see Chapter 4.3).

4.4.1 Concept maps content analysis

Counting the amount of entries, concept maps created right after the educational intervention (maps #1) in all three groups contained approximately the same number of entries; on average 9.9 (SD = 3.5) in the experimental digital game group, 9.7 (SD = 4.1) in the control classic lecture group and 10.5 (SD = 4.2) in the control non-digital game group. There was a non-significant difference between groups, $F(2, 281) = .853$, $p = .427$. On the contrary the "naive" group created significantly smaller concept maps, they contained in average 5.6 entries (SD = 4), $F(3, 339) = 20.077$, $p < .001$.

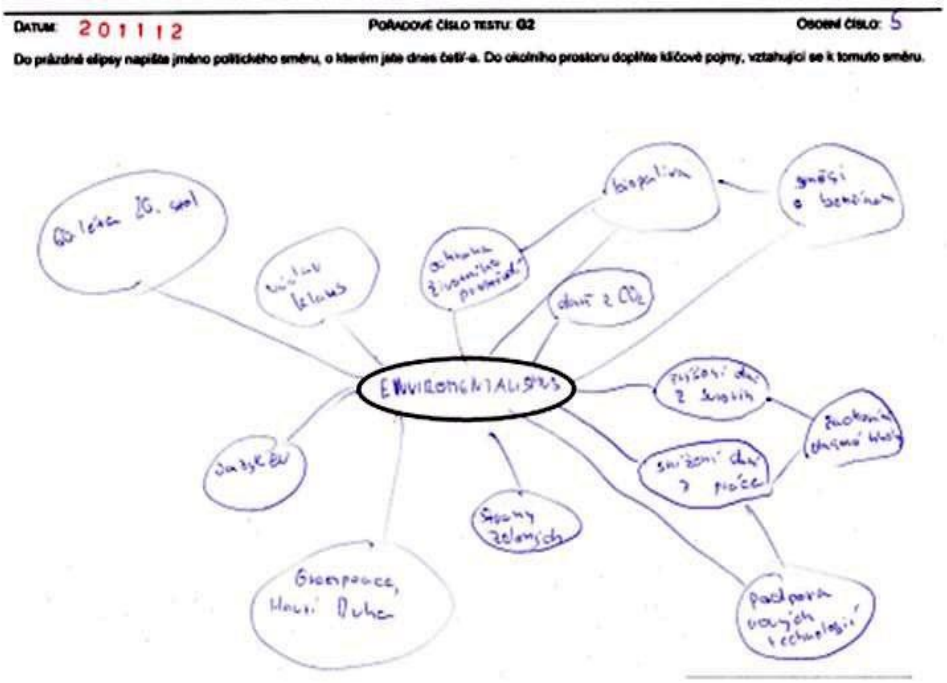


Figure 7: An example of "typical" map #1

The 1-month delayed concept maps (maps #2) were smaller than the previous ones, with less entries and branching: experimental digital game group lost in average two and half entries; the average number of entries was 8.4 (SD = 3.6), the control classic lecture group one and half entry (M = 7.4; SD = 4.2) and the control non-digital game group two entries (M = 8.6; SD = 3.8). There was a non-significant difference between the three groups, $F(2, 281) = 2.457$, $p = .086$.

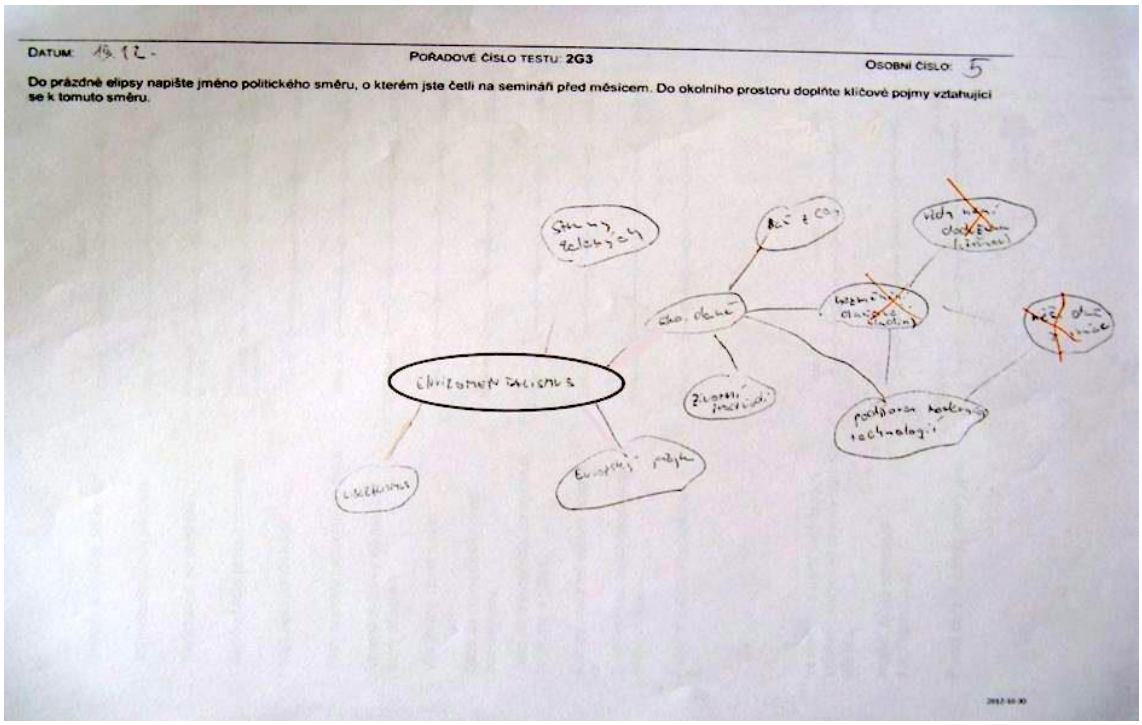
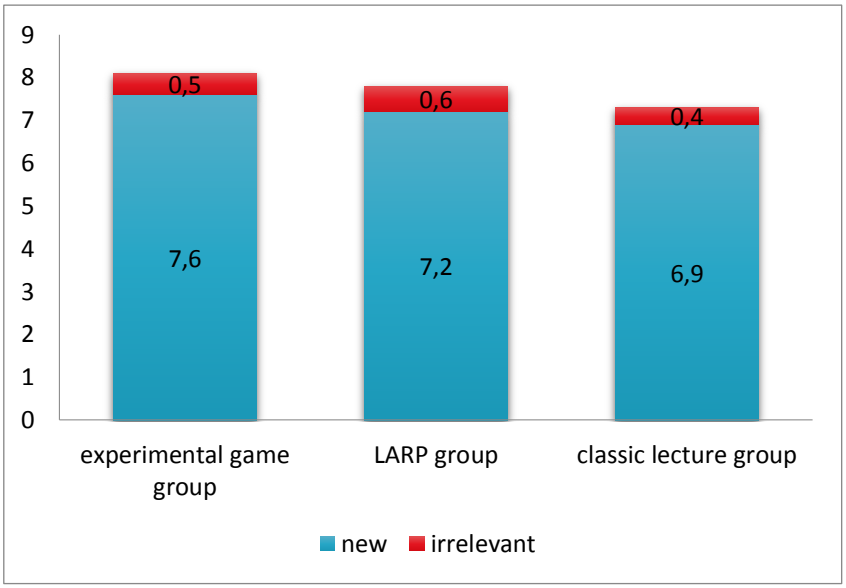


Figure 8: An example of "typical" map #2

From the sub-concepts point of view the average maps #1 differed between groups, the amount of relevant and irrelevant sub-concepts was approximately similar (see Graph 1).



Graph 1: Maps #1, sub-concepts proportional comparison

The average concept map in the experimental digital game group contained 8.1 sub-concepts (SD = 1), the control non-digital game group 7.8 (SD = 2.1) and the control classic lecture group 7.3 (SD = 2). There was a not significant difference between the three groups, $F(2, 281) = 2.138$, $p = .120$. The "naive' group had significantly smaller concept maps with 3.2 (SD = 1.6) sub-concepts; $F(3, 339) = 41.447$, $p < .001$.

The graphs depicting averages do not show some qualitative differences as for example that number of irrelevant sub-concepts seems similar beyond the groups but in fact bigger amount of students from the experimental game group performed mental models with 1.3 irrelevant sub-concept while on the other hand less students from the control non-digital game group inserted into their mental models in average two irrelevant sub-concepts (in greater detail described in Chapter 4.4.2).

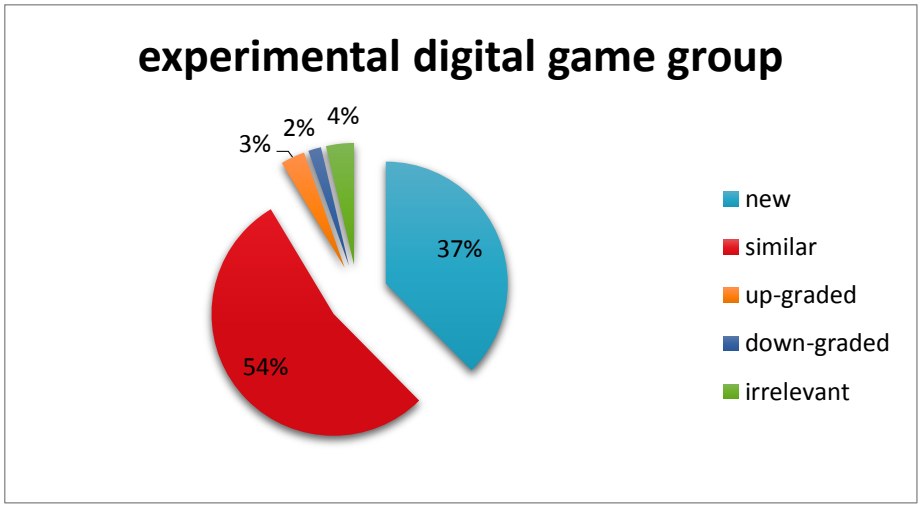
According to the analysis comparing the individual concept maps with the "perfect" expert maps, maps #1 did not differ significantly. By contrary this analysis showed a drop down of the classic lecture group one month later (maps #2).

The additional qualitative content analysis that focused on content description, revealed that the maps #1 in all groups contained a larger amount of factual detailed information (e.g. dates of important historical events, names of European institutions and representatives etc.); 42 in total in the experimental game group, the average for one participant 0.46 (SD = 0.7), 91 in the control classic lecture group (M = 0.81, SD = 0.8), and 39 in the control non-digital game group (M = 0.48, SD = 0.7). Amount of such entries dropped to more than its half in maps #2: 17 in total in the experimental game group (M = 0.19, SD = 0.4), 39 in the control classic lecture group (M = 0.42, SD = 0.6), and 14 in the control non-digital game group (M = 0.16, SD = 0.4). Those factual details were mentioned in frontal lectures but obviously did not endure in mental models long-term. The sub-concepts showed better sustainability in cases that were more general, as (in our example) hierarchy, freedom, revolution etc.

Maps #2 lost in comparison with maps #1 approximately 1.6 sub-concepts: the experimental digital game group had on average 6.5 sub-concepts (SD = 1.5), the control non-digital game group 6.1 sub-concepts (SD = 1.6) and the control classic lecture group 5.5 sub-concepts (SD = 1.6). The control classic lecture group presented the smallest mental models, there was a significant difference between groups, $F(2, 281) = 3.233$, $p = .041$.

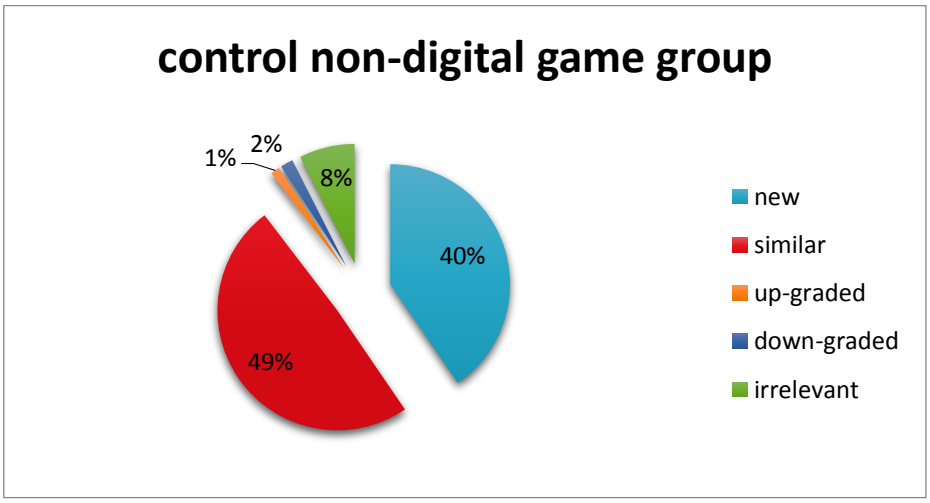
The expert maps comparison showed decline in the control classic lecture group maps #2. Therefore the question for the qualitative analysis is; what is the durable and persisting content in mental models and how exactly is the content changing?

The average map #2 of a student from the experimental digital game group consisted of 54% repeating sub-concepts, 3% up-graded sub-concepts, 2% from down-graded sub-concepts, 37% of sub-concepts were new and 4% irrelevant (see Graph 2).



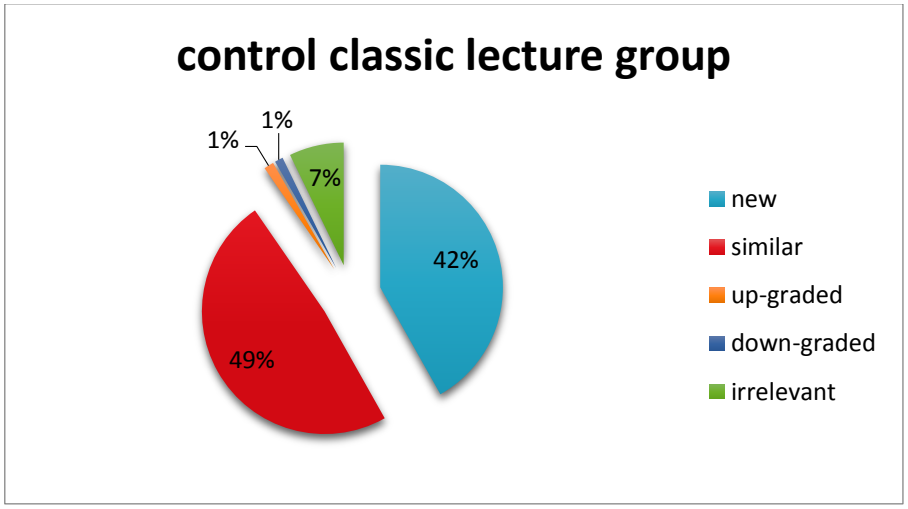
Graph 2: Experimental digital game group, maps #2, sub-concepts

The control non-digital game group kept the similar sub-concepts from 50%, up-graded 1%, down-graded 2% and added new sub-concepts from 40%. Irrelevant sub-concepts were present from 7 % (see Graph 3).



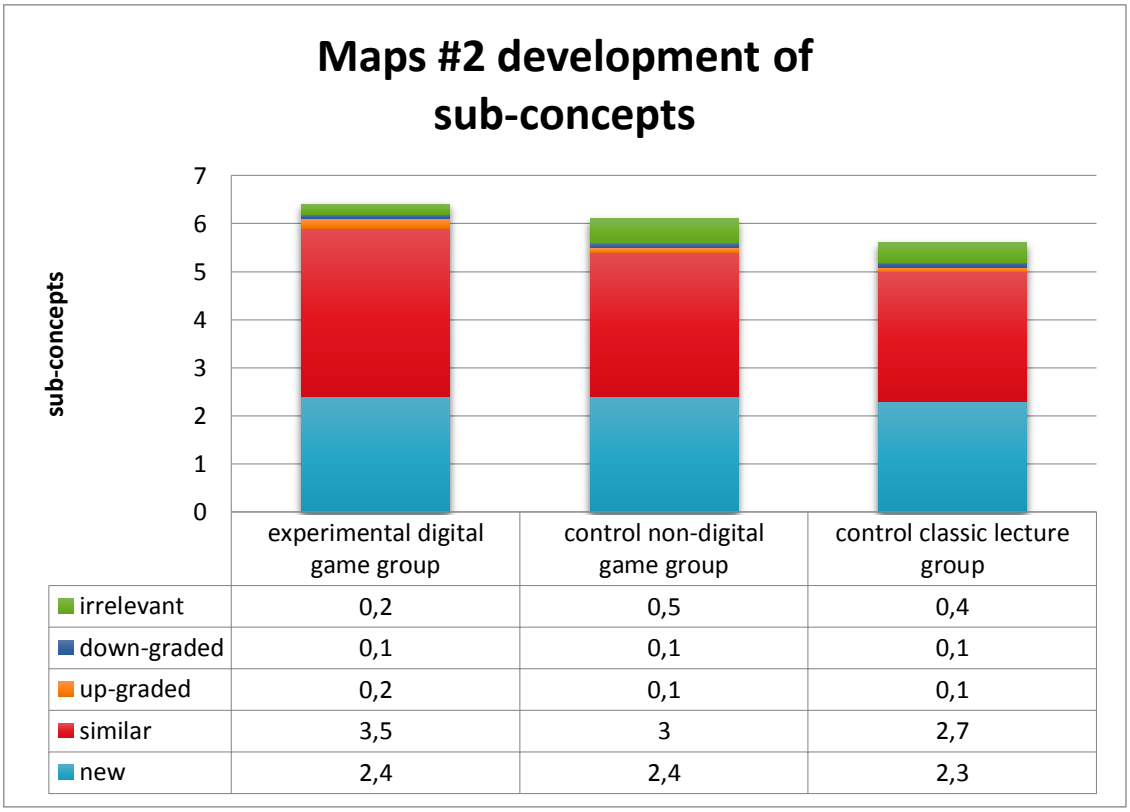
Graph 3: Control non-digital game group, maps #2, development of sub-concepts

The average map #2 in the control classic lecture group repeated similar sub-concepts in 49%, up-graded and down-graded from 1%. The new sub-concepts took 42% of the maps and irrelevant 7% (see Graph 4).



Graph 4: Control classic lecture group, maps #2, development of sub-concepts

If we take into consideration the final size of the maps #2 (sub-concepts: the experimental digital game group = 6.5, the control non-digital game group = 6.1, the control classic lecture group = 5.5), we can see the proportional differences in more detail (see Graph 5).

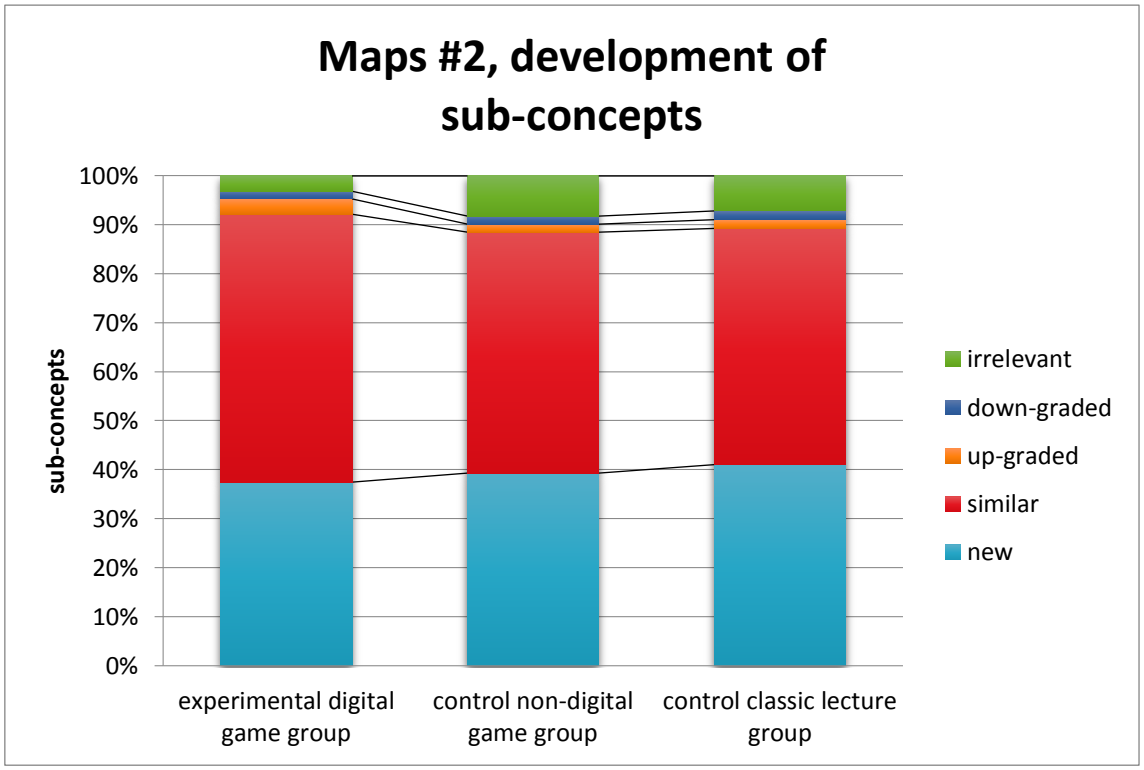


	experimental digital game group	control non-digital game group	control classic lecture group
irrelevant	0,2	0,5	0,4
down-graded	0,1	0,1	0,1
up-graded	0,2	0,1	0,1
similar	3,5	3	2,7
new	2,4	2,4	2,3

Graph 5: Maps #2, development of sub-concepts

An average concept map had 0.2 of irrelevant sub-concepts in the experimental game group, 0.5 in the control non-digital game group and 0.4 in the control classic lecture group that is a non-significant difference, $F(2, 281) = 1.934$, $p = .140$. All three groups added similar number of new sub-concepts, 2.3 – 2.4 ($F(2, 281) = .185$, $p = .830$) and "down-graded" their sub-concepts in the similar number of cases, 0.1 ($F(2, 281) = .530$, $p = .589$). The significant difference appeared between the game groups and the control classic lecture group while counting the repeating (from maps #1) sub-concepts, the participants of both game groups intervention did use/remember smaller amount of sub-concepts from maps #1; students from the control classic lecture group used in average 2.9 of sub-concepts used as well in map #1, the experimental digital game group 3.8 and the control non-digital game group 3.2; the significant difference appeared $F(2, 281) = 5.795$, $p = .003$. Up-graded

sub-concepts were significantly more frequent in the experimental digital game group; $F(2, 281) = 3.588$, $p = .029$.



Graph 6: Maps #2, development of sub-concepts in 100% graphs

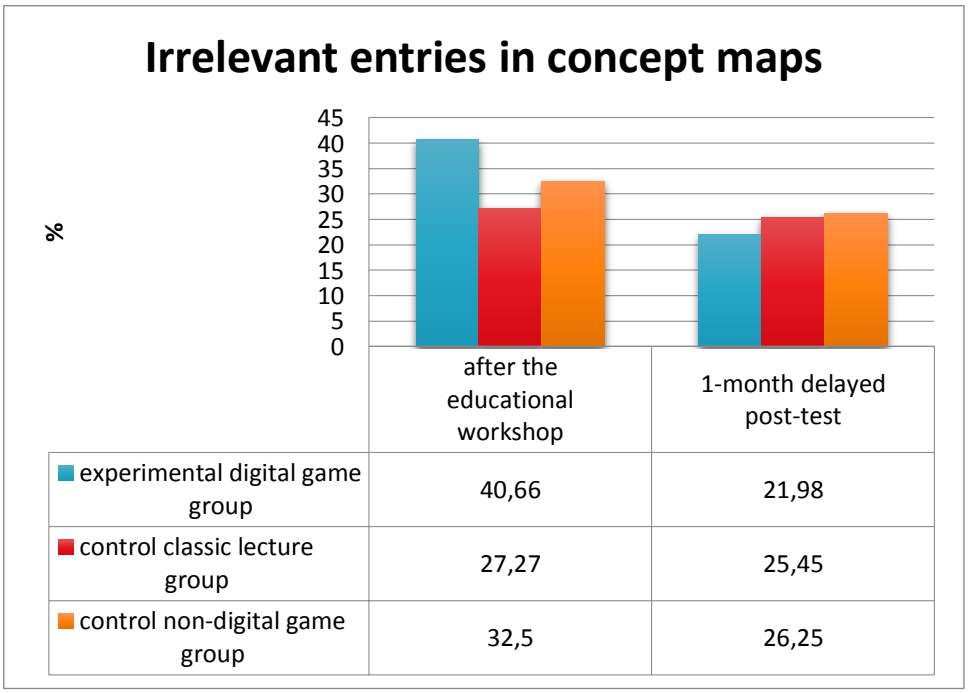
The experimental digital game group had the least number and proportion of irrelevant and new sub-concepts. But those students worked more with the sub-concepts already present in map #1 (see "similar", "up- and down-graded" in Graphs 2-5). It seems that the quality of sub-concepts in mental models does not tend to change much over time, the amount of up-graded or down-graded ones was quite low and approximately similar beyond groups (with a slightly higher proportion within the experimental digital game group).

4.4.2 Irrelevant fragments of concept maps

The concept maps often contained some irrelevant entries, words, or short phrases unrelated to the basic theme of a concept map, a wrong answer or error by the other words. Compared to

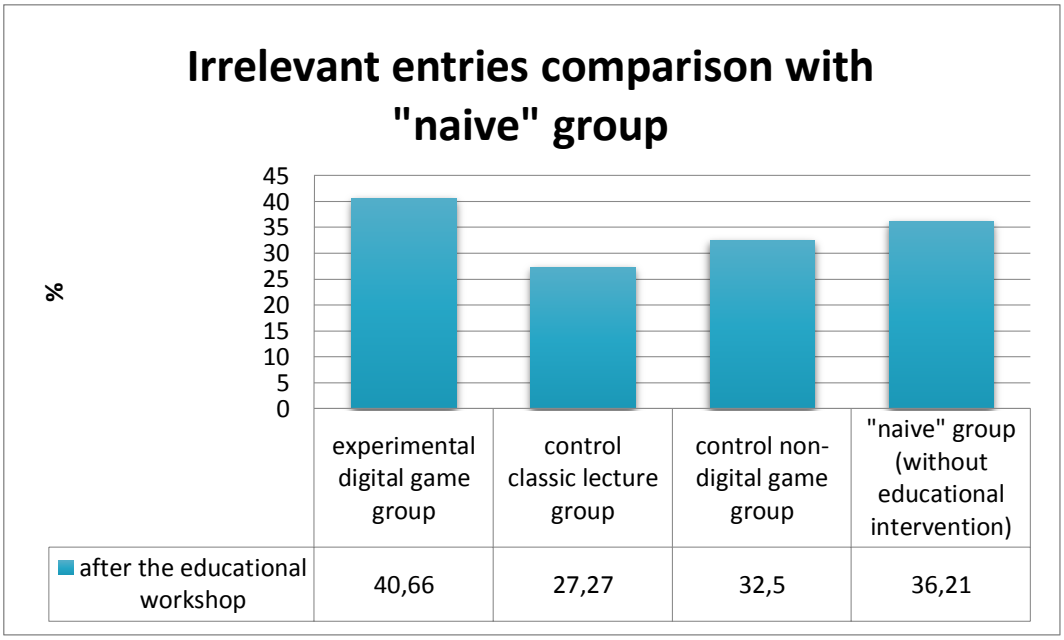
the control classic lecture group students from both game groups had a higher number of irrelevant sub-concepts in content maps created after the educational workshop (maps #1): 41% of concept maps from the experimental digital game group contained one or more irrelevant sub-concepts compared with 33% from the control non-digital game group. Therefore the experimental digital game group had about a 5% higher amount of irrelevant sub-concepts than the "naive" students who erred 36% of the time (see Graph 7). On the other side, the control classic lecture group had only 27% of students who made mistakes in their concept maps. The number of irrelevant sub-concepts in such maps was on average 1.32 (SD = 0.8) for the experimental digital game group, 2 irrelevant sub-concepts (SD = 1.2) for the control non-digital game group, and 1.30 (SD = 0.7) for the control classic lecture group. The "naive" group had in average 3.17 (SD = 2) irrelevant sub-concepts.

In the 1-month delayed test session both game groups showed improvements:



	after the educational workshop	1-month delayed post-test
experimental digital game group	40,66	21,98
control classic lecture group	27,27	25,45
control non-digital game group	32,5	26,25

Graph 7: Irrelevant sub-concepts in concept maps (% of students)



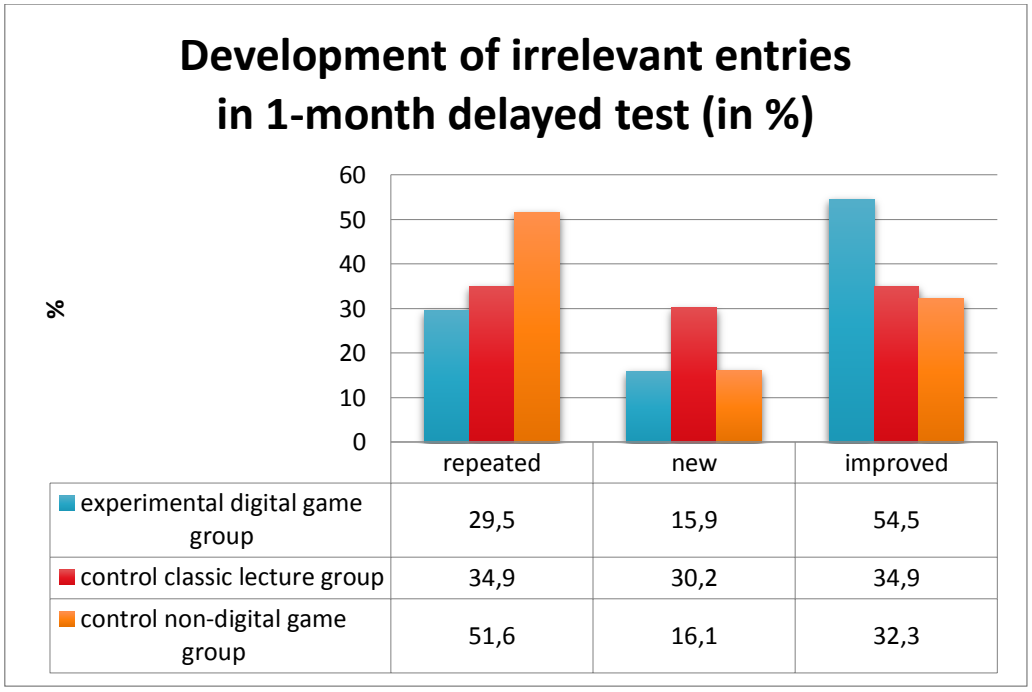
Graph 8: The irrelevant entries - comparison with the "naive"group

While comparing maps #1 with maps #2 the experimental digital game group showed18% of improvement, the control non-digital game group improved by only 6%, and the control classic lecture group improved by less than 2%, generally sustained in the same approximate level of errors (see Graph 7). The number of mistaken sub-concepts in maps #2 with some irrelevant entries was as follows: the experimental digital game group in average 1.1 (SD = 0.3); the control classic lecture group 1.7 (SD = 1.2); the control non-digital game group 1.7 (SD = 0.8).

While analyzing the development of irrelevant parts in individual students' mental models we can observe some group differences as well. The development of irrelevant sub-concepts was evaluated by comparing of all concept maps containing some irrelevant sub-concept with its corresponding map (after the workshop or 1-month delayed). Three categories were employed:

1) repeated (irrelevant sub-concept/s in both concept maps);
2) new (irrelevant sub-concept/s only in 1-month delayed map);
3) improved (irrelevant sub-concept/s only in after-workshop map).

The classic lecture group had similar proportion of all three categories in their concept maps (see Graph 9); approximately one third of the students' mental models improved (35%), stayed on the same level (35%), and changed for the worse (30%). By contrast the experimental digital game groups improved their concept maps in 55%, stayed on the same level in 30% of cases and in 16% of cases the concept maps contained new irrelevant sub-concepts. The control non-digital game group showed a different trend: the concept maps improved in 32% of cases, stayed on the same level in 52% of cases and got worse in 16% of cases.



	repeated	new	improved
experimental digital game group	29,5	15,9	54,5
control classic lecture group	34,9	30,2	34,9
control non-digital game group	51,6	16,1	32,3

Graph 9: Development of irrelevant sub-concepts (% of students)

Regarding the irrelevant fragments of mental models developed after the educational intervention, we found that game groups showed more mistaken concepts in the first maps but in following one month improved those concepts: more than half of the students from experimental digital game group (54%) corrected the mistaken concepts (over 30% in the other two groups) and less students from both game groups developed new inaccurate concepts (see Graph 9).

4.4.3 Method of mental models evaluation through concept maps content analysis: discussion

The content analysis of concept maps served as a pilot study of possibilities and limits of such method for mental models evaluation. To ensure the students' ability to create concept maps we have let them to create a preliminary concept map in the very beginning of the educational workshop. For a future research we propose to utilize a different thematic for an exercise concept map and comprehend the preliminary concept map to the content analysis. Such data could bring important results portraying the mental model creation based on subjects' preliminary knowledge.

The final content analysis consisted of quantitative analysis, following a numeric development of entries gathered into thematic sub-concepts (exactly "stayed in unchanged form", "stayed in 'up-graded' form", "stayed in 'down-graded' form", "disappeared", "new", "irrelevant"); and a qualitative approach, analyzing the character of such sub-concepts. For future research we propose the similar method but, as Mayer (2009) proposes, with two independent evaluators with deep knowledge from the given area, outcomes of their evaluation should be analyzed and compared together to ensure the biggest possible reliability.

4.5 Conclusion

The development of students' mental models was observed through concept maps created by the participants right after the educational intervention (maps #1) and one month later (maps #2). Also added to the analysis were the maps of the students who took part in the 1 month-delayed testing session but not in the educational workshop, they were called the "naive" group and took the role of a baseline for our analysis.

In total concept maps from 340 subjects were evaluated; 91 from the experimental digital game group, 111 from the control classic lecture group, 80 from the control non-digital game group and 58 from the "naive" students. The base value for the content analysis was a "sub-

concept", a fragment of a concept map related to one specific theme (so it can contain more than one entry).

All the maps were analyzed by two methods: (1) the comparison with expert maps, a "perfect" map created by expert containing all possible right answers; and (2) content analysis of all entries/sub-concepts in the concept maps and their comparison within maps #1 and maps #2. This dissertation describes the results of the second analytical method, the expert map comparison is not yet completely finished, only rough data are known.

None of the analytical methods found great differences between groups in maps #1. Contrary the maps #2 in the expert map comparison had a worse score; the game groups only slightly and the classic lecture group bit more radically. The content analysis searched for the qualitative data to describe such change.

In one month, the maps #2 lost some entries or sub-concepts, mainly those containing detailed factual information (e.g. dates of important historical events, names of European institutions and representatives etc.). The difference between game groups' maps and those created by students from the classic lecture group in 1 month-delayed testing session could be summarized as follows:

1. The control classic lecture group maps #2 lost in comparison with their maps #1 slightly bigger, and significant, portion of sub-concepts than the game groups (final maps #2 from the control classic lecture group were the smallest ones and lost about half sub-concept more than maps #2 from game groups).
2. Moreover the students from the control classic lecture group implemented into their mental models a proportionally larger amount of new sub-concepts (in maps #2: 42% of new in the classic lecture group, 40% in the control non-digital game group and 37% in the experimental game group). For a comparison to the base line, the concept maps of the "naive" group were significantly smaller than those from students who took part of some educational intervention.

3. Within maps #2 the game groups worked in higher proportion with the sub-concepts (relevant or irrelevant) created throughout the educational session (they had significantly bigger amount of "repeated" sub-concepts).
4. The experimental digital game group had the biggest and significantly higher number of up-graded sub-concepts (the reason and exact process needs a future experimental verification).
5. The experimental digital game group had the smallest number and proportion of irrelevant entries; the experimental digital game group in average 0.2 (SD = 0.5, i.e. 4% of the average concept map); the control classic lecture group 0.4 (SD = 0.8, i.e. 7%); and the control non-digital game group 0.5 (SD = 0.9, i.e. 7%).

According to point 2 above the mental models created throughout the game-based educational session seem to be more sustainable. The students worked with a slightly bigger but significant ($F(2, 281) = 5.795$, $p = .003$) proportion of the sub-concepts gained there while the control classic lecture group reconstructed their mental models with new information that was more often irrelevant. Also the proportion of repeated sub-concepts points out the fact that the game groups worked more with the mental models created within the educational workshop and during the following month,

The number of irrelevant sub-concepts developed after the educational intervention (in maps #1) was proportionally very similar across the groups. In the detailed view, we can observe that less students in the control classic lecture group mistaken their concept maps (27% of cases, the experimental digital game group in 41% of cases and the control non-digital game group in 33% of cases). The number of irrelevant sub-concepts in such maps was on average 1.3 (SD = 0.8) for the experimental digital game group, 2 (SD = 1.2) for the control non-digital game group, and 1.3 (SD = 0.7) for the control classic lecture group; a non-significant difference $F(2, 281) = 1.059$, $p = .348$. After the one month (in maps #2) less students from game groups presented mental models with mistaken concepts, while the control classic lecture group stayed on the same level: the experimental digital game group 22% students

incorporated an irrelevant sub-concept, the average number of such sub-concept was 1.1 (SD = 0.3), in the control non-digital game group it was 26% of students with 1.7 (SD = 0.8) of irrelevant sub-concepts; and in the control classic lecture group 26% with 1.7 (SD = 1.2) of irrelevant sub-concepts. The amount of irrelevant sub-concepts in maps #2 showed a non-significant difference $F(2, 281) = 1.934$, $p = .146$.

To see the development of irrelevant entries in greater scale, we evaluated each map with mistaken sub-concept(s) individually: within one month more than half of the students from the experimental digital game group (54%) corrected the mistaken concepts (over 30% in the other two groups) and fewer students from both game groups developed new inaccurate concepts (around 16%, in the classic lecture group 30%).

Qualitative evaluation of the concept maps development showed a tendency for all students to forget specific factual details (dates, names and specific institutions); participants of all three educational interventions forgot within the following month half of such information. The control classic lecture group incorporated two times more of such information into their mental models (according to maps #1 and maps #2 as well), but the overall value of their mental models (according to maps #2) was, in comparison with the both game groups, qualitatively worse (smaller with new, rather than up-graded, sub-concepts).

In the hypothesis no. 1 we supposed more complex and retentive mental models within the groups of students exposed to the educational game (experimental digital game group or control non-digital game) rather than within the group exposed to the classic lecture. The content analysis of the concept maps created after the educational session (maps #1) and one month later (maps #2) revealed that mental models acquired within the game intervention (digital or non-digital) were more sustainable over time; those students worked with a larger amount of sub-concepts from maps #1; students from the control classic lecture group used on average 2.9 of sub-concepts in map #1, while the experimental digital game group used 3.8 and the control non-digital game group used 3.2; the significant difference was $F(2, 281) = 5.795$,

p = .003. Participants of the control classic lecture group did not develop the mental models acquired through educational intervention to such an extent as the game groups, but they implemented new sub-concepts (see the point 2 above or Chapter 4.4.1). Thus, it seems that games as complex systems of information representation allow for the creation of sustainable mental models that can be qualitatively developed through time. The traditional classic lecture influences the creation and conceptual change of mental models through theoretical description, explanation, questioning and discussion. Games immerse a learner directly into the problematic and let him/her test the mental models in (inter)action. This cause-and-effect system might develop more coherent and sustainable mental models than only verbal intervention.

The content analysis of concept maps seems to be a helpful tool in developing an understanding of mental model development. This quasi-experimental study shows preliminary outcomes and opens the field for future research. A deeper analysis of themes appearing in the concept maps of each group promises to provide further interesting data. For future research, we propose to compare three maps – one describing preliminary knowledge, the second describing knowledge after an educational intervention and third a knowledge (at least) one month later. Two independent correctors should evaluate the concept maps.

5 Motivation for information behavior

Hypothesis no. 2: *The experimental digital game group will within one month following the educational intervention show a higher engagement in information behavior.*

Self-directed information seeking behavior is defined as one of the crucial parts of the learning process and of mental model creation (Kulthau, 1993; Pitts, 1994). It allows time for information-gathering from multiple resources, and allows time for reflection, which promotes deep learning (Kulthau, 1993; Hartley, 1995). Additionally, information seeking behavior as a part of self-regulated learning is generally characterized by well-managed educational goal settings and sustaining motivation (Winne, 1995), which may stand opposed to teacher-directed learning in significant ways. Litman and Jimerson (2004) pinpoint positive emotional affects within learning as determinant factors in future information seeking behavior. Thus, the teaching method and the learning situation potentially play a decisive role in future information seeking behavior.

While designing the research, we focused on the identification of variables that can directly influence a motivation for future information seeking behavior. Recognition of concrete factors influencing this motivation can help us in constructing educational programs that are efficient in promoting learning and mental model creation, built on a solid informational base.

5.1 Promoting motivation for future information seeking behavior

In the context of formal education, opportunities for information seeking behavior are mostly limited; because of strong time restrictions, information seeking is generally organized, task-based and controlled by a teacher. In this context it is important to focus on motivating students for self-directed information seeking behavior in the future and to extend the

learning space to afterschool activities. Fostering curiosity and encouraging students to pursue personal interests in specific areas is one of the possible approaches.

Information seeking behavior can be motivated and triggered by multiple factors such as simple information need (Kulthau, 1993) or more complicated mental states such as uncertainty or curiosity (Loewenstein, 1994). Uncertainty is an opportunity to widen our range of experiences and therefore our skills, competencies and space of control. Curiosity can be described as a situational affect and/or a part of personal characteristics, while Kashdan and Yuen (2007) assume the positive effect of curiosity on academic achievement and outcome. In a deeper analysis of curiosity, Arnone et al. (2011) focuses on personal, situational and contextual factors influencing curiosity. Among personal factors can be included motivation, self-regulation, self-efficacy, competence, developmental differences, and cognitive abilities. Contextual factors refer to something that helps to explain meaning, e.g., a school or museum environment; and situational factors are presented by material facilities in school or in other learning environments, unexpected interactions in the moment, connected questions and situational informational needs. Kashdan and Yuen (2007) in this framework presume that threatening and unsupportive environments can limit curiosity and exploratory behavior. Clearly, educational approach and environment play an important role in fostering information seeking behavior in students.

One of the specific kinds of self-directed information seeking behavior is also seeking and/or active profiting from opportunities for discussing a theme. Social interaction plays a huge role in creating personal opinion and attitudes as well as reasoning and ordering specific information within mental models (Zimmerman & Blom, 1983).

Recent research proposes that a multimedia environment can stimulate curiosity and learning motivation (Wouters et al., 2011; Arnone et al., 2011); digital games contain many features that are believed to enhance those characteristics. Games and play generally provide a safe environment where fear of failure is minimized and curious behavior becomes a key to

success. Game elements such as challenging tasks, narratives or perceptual changes might evoke curiosity and consequently motivate students to explore the game world and learn in an engaging way (Dickey, 2011). Digital games also provide students with instant feedback on their actions, which helps them to remain in a psychological state of flow (Csiksentmihalyi, 2008), wherein individuals become unaware of themselves, their physical environment and the passage of time. Their behavior is concentrated, goal-oriented, and associated with wider and deeper attention. All those qualities are also essential to curiosity. Indeed, even Kashdan and Roberts (2004) apply the model of flow to curiosity, employing the term "absorption" in that context.

5.2 Methods of the hypothesis verification

The hypothesis looks for long-term effects of educational approaches on stimulation of self-directed information seeking behavior. All three groups received same information by different methods (digital game-based, classic lecture and non-digital game-based) and afterwards were compared to each other. To verify a possible change in information seeking behavior we used a method of questioning and focused on expressed motivation for information seeking behavior in three different forms – following events on international political scene, seeking and/or active profiting from opportunities for discussing the theme and self-directed information seeking.

330 questionnaires were evaluated, 104 from the experimental digital game group, 130 from the control classic lecture group, 96 from the control non-digital game group (for more details about the sample see Chapter 3.3).

The following questions were used within three sets of questionnaires distributed before the educational session (pre-test, coded as 1 bellow), right after the educational session (post-test, coded as 2 bellow), and one month after the educational session (1-month delayed post-test,

coded as 3 bellow) (complete questionnaires in Attachments 2, 3, 4). The pre-test questionnaire contained 14 questions, the relevant question was the first one (1/1.); the post-test had 12 questions in total, the relevant one was ninth (2/9.); the 1-month delayed post-test contained 13 questions and the relevant ones were eight (3/8.), ninth (3/9.), eleventh (3/11.) and thirteenth (3/13.).

PRE-TEST:

1/1. Events on the international political scene: *(choose one answer, please)*

a. I do not follow at all

b. I follow approximately once a week

c. I follow twice or three times a week

d. I follow daily

POST-TEST:

2/9. Events on the international political scene: *(choose one answer, please)*

a. I am not interested to follow

b. maybe I will check sometimes

c. I would like to follow few times a week

d. I would like to follow daily

1-MONTH DELAYED POST-TEST:

3/8. During the last month did you follow events on the international political scene? *(choose one answer, please)*

a. I did not follow at all

b. I checked it sometimes

c. I followed it few times a week

d. I followed it daily

3/9. How often during the last month did you talk to someone on the topic of the EU, the process of political decision-making and international politics? *(choose one answer, please)*

a. never

b. once or twice

c. three or four times

d. more than four times

3/11. After the workshop did you search for some additional information about a subject taught during the workshop? *(choose one answer, please)*

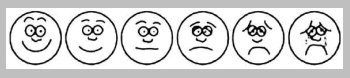
a. no

b. once or twice

c. three or four times

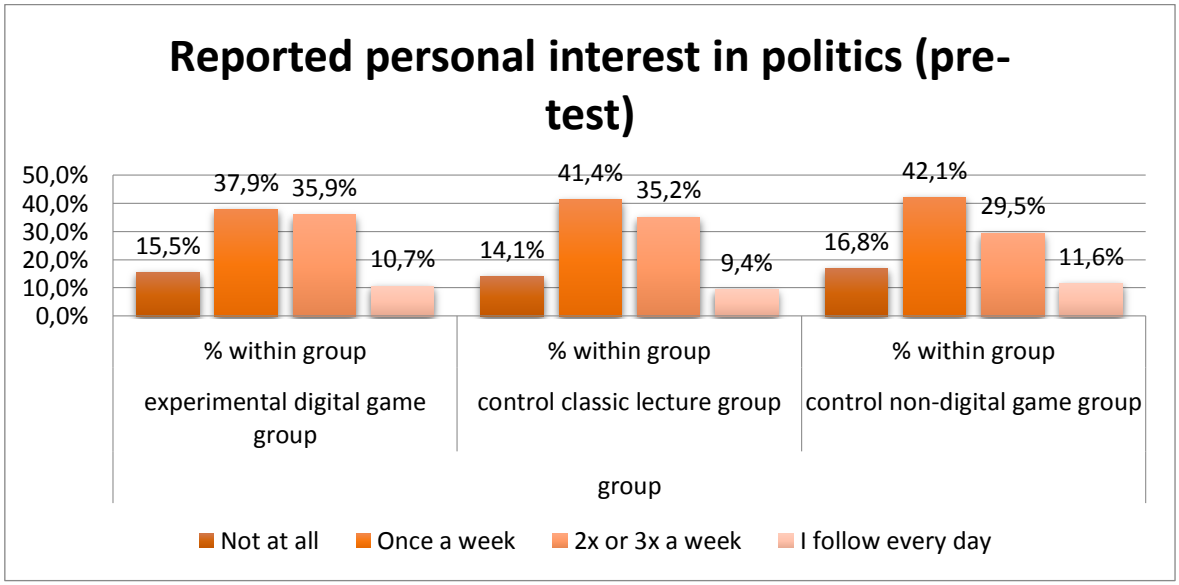
d. more than four times

3/13. Imagine that in the newspapers or on the internet you will come across the headline: "*The battle culminates in the EU budget. Nearly all threat by veto*." How much will you be interested in the article? *(choose one emoticon, please)*

I will surely read it  I will not read it

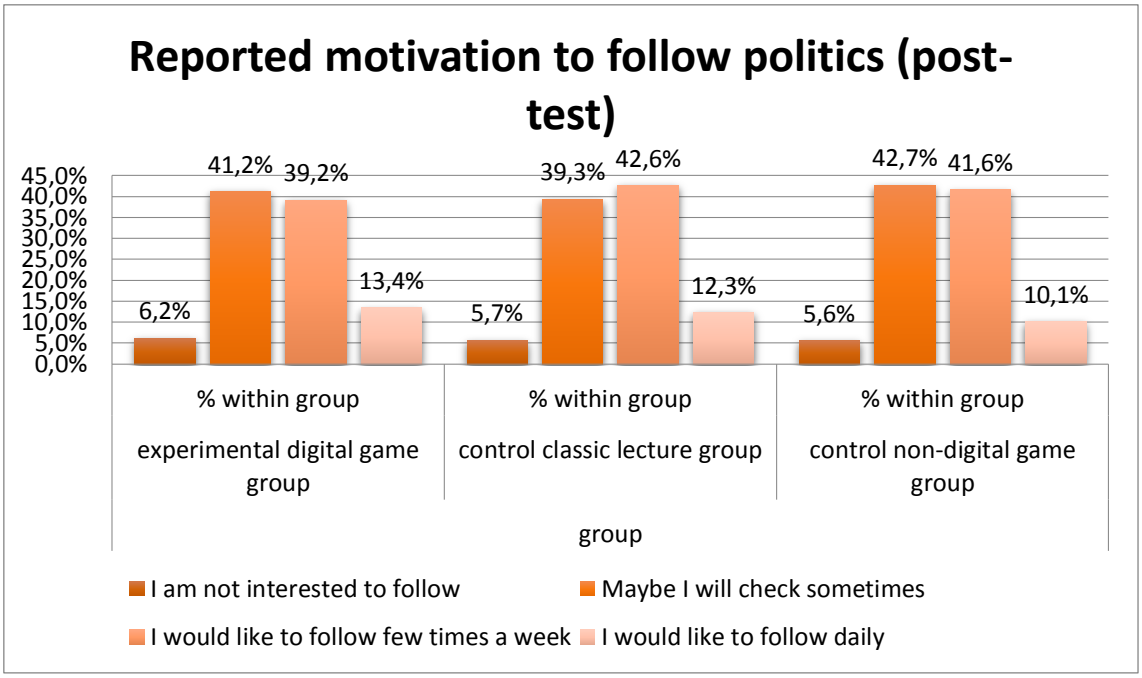
5.3 Outcomes

In the pre-test students showed mild interest in international politics; most of them (M = 73%, SD = 0.87) reported that they follow events on the international political scene once to three times a week, whereas the answer "once a week" was the most frequent answer (Mode).



Graph 10: pre-test questioning outcome; "Events on the international political scene: I follow…"

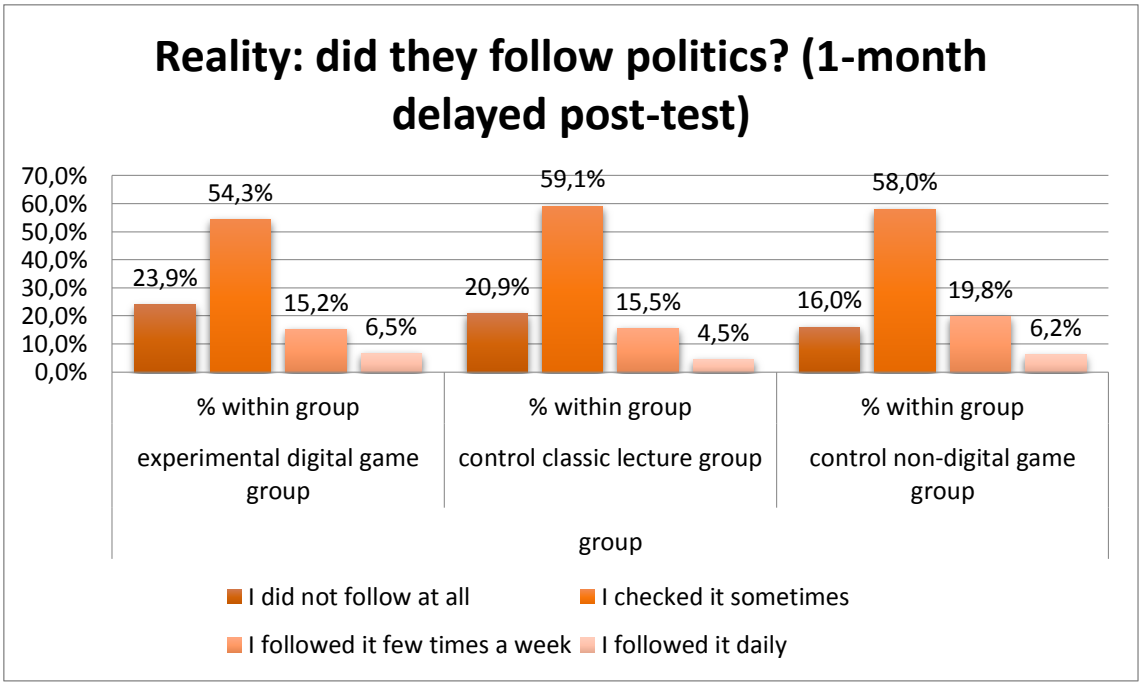
Right after the workshop, the motivation to follow events on the international political scene had a similar, though slight, increase in all groups. Around 40% of students from all groups were motivated to follow events on the international political scene a "few times a week" (Mode = answer number =3).



Graph 11: post-test outcome; "Events on the international political scene:"

In observed data there were no significant differences between groups $\chi^2(6, N = 308) = 0.77$, $p = .990$.

The one-month follow-up questioning revealed a bit different reality compared to the presented motivation after the educational intervention. 16 – 29 % of students from all three groups did not follow political events at all, 54 – 59 % checked sometimes, 15 – 20 % followed few times a week and 4 – 6 % followed it daily.



Graph 12: 1-month delayed questioning outcome; "During the last month, events on the international political scene:"

In observed data there were no significant differences between groups $\chi^2(6, N = 283) = 2.6$, $p = .860$.

Neither seeking for additional information or opportunities to discuss the theme with others did not show any group differences (for more details see Table 1 bellow) so the hypothesis no. 2 cannot be accepted – it has not been supported by our data. Data in the following table were coded from the questionnaires as following (codes on the right):

1/1. Events on the international political scene:

a.	I do not follow at all	1
b.	I follow approximately once a week	2
c.	I follow twice or three times a week	3
d.	I follow daily	4

2/9. Events on the international political scene:

a. I am not interested to follow 1

b. maybe I will check sometimes 2

c. I would like to follow few times a week 3

d. I would like to follow daily 4

3/8. During the last month did you follow events on the international political scene?

a. I did not follow at all 1

b. I checked it sometimes 2

c. I followed it few times a week 3

d. I followed it daily 4

3/9. How often during the last month did you talk to someone on the topic of the EU, the process of political decision-making and international politics?

a. never 1

b. once or twice 2

c. three or four times 3

d. more than four times 4

3/11. After the workshop did you search for some additional information about a subject taught during the workshop?

a. no 1

b. once or twice 2

c. three or four times 3

d. more than four times 4

3/13. Imagine that in the newspapers or on the internet you will come across the headline: "*The battle culminates in the EU budget. Nearly all threat by veto*." How much will you be interested in the article?

(I will surely read it) 1 2 3 4 5 6 (I will not read it)

			During the last month did you follow events on the international political scene?	How often during the last month did you talk to someone on the topic of the EU, the process of political decision-making and international politics?	After the workshop did you search for some additional information about a subject taught during the workshop?
experimental digital game group	N	Valid	92	86	84
		Missing[2]	12	18	20
	Mean		2,04	1,92	1,33
	Std. Deviation		,81	,88	,47
	Median		2,00	2,00	1,00
control classic lecture group	N	Valid	110	103	104
		Missing[1]	20	27	26
	Mean		2,04	1,95	1,34
	Std. Deviation		,741	,821	,633
	Median		2,00	2,00	1,00
control non-digital game group	N	Valid	81	80	80
		Missing[1]	15	16	16
	Mean		2,16	1,96	1,26
	Std. Deviation		,77	,86	,50
	Median		2,00	2,00	1,00

Table 1: 1-month delayed questioning outcome

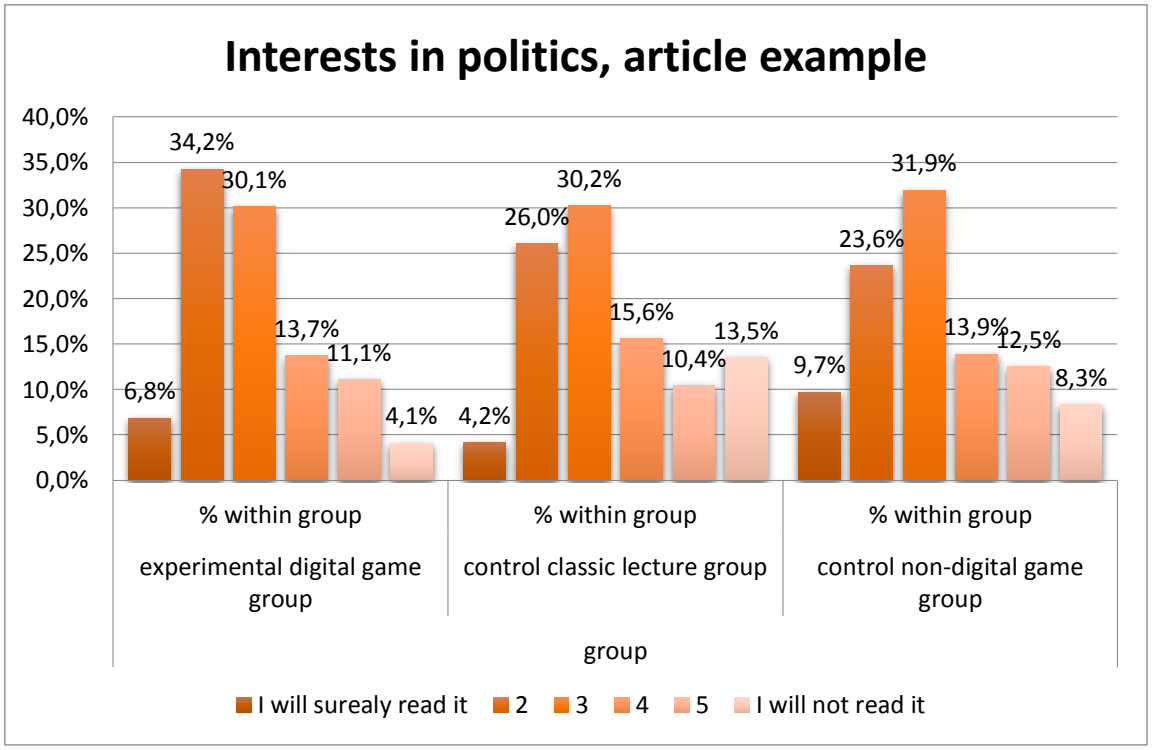
[2] Missing values ensues from not filled in or unreadable answers

Only group differences (but statistically not significant) appeared within the question exploring situational motivation for informal learning in the given theme "*Imagine that in the newspapers or on the internet you will come across the headline: 'The battle culminates in the EU budget. Nearly all threat by veto.' How much will you be interested in the article?*". On the Likert scale 1 - 6 (1=most interested, 6=least interested in reading) the mode value of the experimental digital game group was 2 while for both control groups it was 3 (for more details see Table 2).

experimental digital game group	N	Valid	73
		Missing[3]	31
	Mean		3,00
	Std. Deviation		1,26
	Median		3,00
control classic lecture group	N	Valid	96
		Missing[2]	34
	Mean		3,43
	Std. Deviation		1,43
	Median		3,00
control non-digital game group	N	Valid	72
		Missing[2]	24
	Mean		3,2
	Std. Deviation		1,414
	Median		3,00

Table 2: 1-Month delayed questioning outcome (an interest in reading the article)

[3] Missing is number of students who could not take part of 1-month delayed testing session



Graph 13: 1-month delayed questioning outcome (Interest in reading article)

In observed data there were no significant differences between groups $\chi^2(10, N = 241) = 8.0, p = .630$.

Beside the scope hypothesis no. 2 we found: the tendencies in information behavior correlated negatively (but not significantly) with gender, where boys showed stronger information behavior on the theme of international politics than girls (Pearson's r = -0.13); and positively with higher self-assessment in the area of the EU and international politics (Pearson's r = 0.35).

5.4 Conclusion

When exploring the long-term changes in information behavior, there did not appear to be any group differences. In the 1-month delayed post-test, students from all groups reported similar tendencies in information behavior in the themes of the European Union and international

politics. Even though students from all groups reported increased interest in given topics following the educational session, their information behavior changed minimally or not at all. All the students showed similar long-term tendencies within information behavior that basically were not affected when comparing results from pre-testing with results from 1-month delayed testing.

As our team's previous study (Brom et. al, 2010) shows, game-based methods of knowledge acquisition can influence situational information behavior: specific tasks and challenges embedded into strong narration, role-play activities etc. motivate a player to seek additional information at hand in order to succeed in the game context (Nyman, 2010).

The long-term effects on information behavior were not affirmed by this study but some partial outcomes indicated a possible correlation between reported self-assurance, as well as engagement in future information behavior. Self-assurance as a tendency for an individual to act with confidence in his own abilities in a specific theme/area might influence the frequency of future information behavior. At the same time the outcomes of the qualitative study focused on situational motivation and cognitive engagement, and showed a positive effect of game-like activities on self-assurance (see Chapter 6.2.2.4). This hypothesis, though, requires further verification.

6 Influence of different educational treatment on situational emotional affects

Hypothesis no. 3: *The experimental group will in learning situations show more positive affects which support learning and situational cognitive engagement.*

According to long-term research it seems that emotional experience during learning may have a significant influence on knowledge acquisition outcomes and on future learning motivation. In 1978 Isen et al. suggested that a positive emotional state improves recall, and positive emotions help as retrieval cues for long-term memory. In his research more positive emotions also resulted in readiness to invest more effort in learning tasks. As positive and negative emotions can be activating (happy, hopeful, anxious, angry) or deactivating (satisfied, calm, hopeless), they strongly impact situational activation during learning (Russel, 2003). Positive effect of game on situational learning motivation was also described in several studies (Ke, 2009, Wouters et al., 2013). Moreover, in a study by Craig et al. (2004), it appears that learning gains might be positively related to flow and slight confusion, and negatively related to boredom.

Most recently Um et al. (2012) conducted an experimental study focused on the correlation between situational positive and neutral emotions and learning outcomes of multimedia educational programs. Research controlled both external and internal emotional induction, where internal was arranged through color and shape design of multimedia materials and external was arranged through the so-called mood-induction procedure scheduled before the learning exposure. These measures aimed to explore correlations between internal and/or external emotional stimulants and learning effects. Results showed that individuals studying materials with the positive emotional design (internal or/and external) had better comprehensional and knowledge transfer, more positive perception of learning and better motivation toward learning. Positive emotions induced during the educational task also reduced the perceived difficulty of the task.

An opinion spectrum in the question of positive emotions within learning situations balances Richard Mayer and his cognitive load theory mentioning extraneous cognitive load (2001). In the context of cognitive load theory, emotional content as designed sounds, colors, shapes etc., is typically understood as a source of extraneous cognitive load, and is considered a disturbing element for learning. Nonetheless, in their recent studies, Moreno and Mayer (2007) incorporated into the cognitive theory some factors stimulating extraneous cognitive load but still having a motivational potential.

Alternative approaches suggest, that emotions may impact knowledge acquisition in a positive way, for example by increasing learners' interest and motivation. Keller for example suggests educational design based on the ARCS model where emotions are viewed as rooting strategies for attention, relevance, confidence, and satisfaction. Hidi (2006) proposes that emotional arousal might influence situational or individual interests, which directly influence attention and levels of learning. Litman and Jimerson (2004) pinpoint positive emotional connections as determinant factors of future information seeking behavior.

Emotional state is mostly monitored within class observations or direct questioning that may not always provide comparable data and largely lacks the ability to capture inner emotional richness. The following chapter describes the development of a qualitative measurement tool designed to capture emotional experience within learning. The chapter also depicts the pilot verification of the tool and analysis of data from the experimental research comparing three types of educational experience (digital game-based learning, classic lecture and educational life role-playing).

6.1 Methods of the hypothesis verification: Emotional graphs as evaluation tool

To track emotional experience during learning we developed a qualitative measurement tool called emotional graphs. The graphs originate in Meyer's life-chart (Meyer, 1951), a chronological graph capturing important life stages and breaks which Mayer created with an individual psychiatric patient. Meyer used this technique to correlate the patient's personal history and his/her subjective condition of experiencing (see one of the life-charts in Fig. 9).

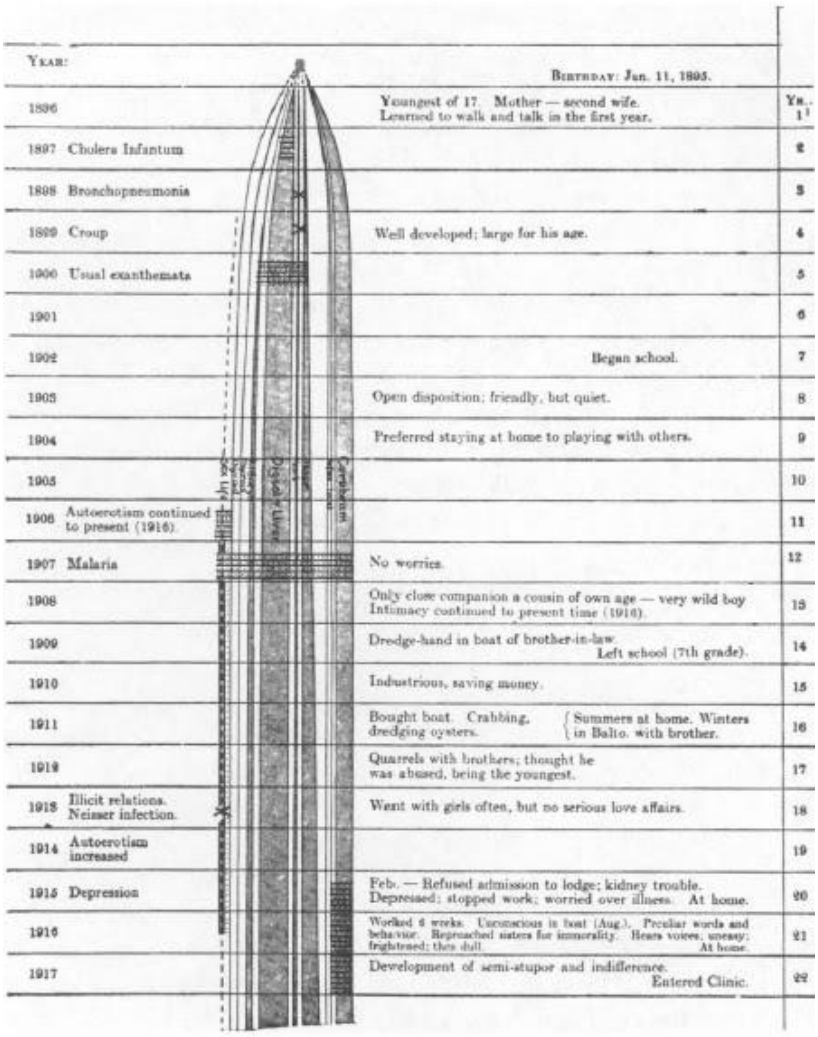


Figure 9: IllustrativeMeyer's life-chart, "Case of Schizophrenia" (Meyer, 1951)

Subjective experiencing of specific situations might in Meyer's opinion form future attitudes and behavior (Meyer, 1951). He basically went against classic psychiatric methods where external symptoms were observed and interpreted within framework of a specific diagnosis. He focused on the patient's inner reflection and developed a subjective evaluation of specific life situations.

Life charts have been systematically developed and abundantly used in psychiatry for monitoring patients with bipolar disorder (Leverich, 1997, Denicoff, 1997, Rasgon et al., 2003). Patients are generally self-reporting moods and other important details on paper sheets or through a standardized electronic system called ChronoRecord (Bauer et al., 2008). The strength of life charting lies in the process of patients recalling their recent history and memories. To describe and evaluate the events, he/she is required to activate autobiographical memories that contain information concerning: self-description, specific events and general events (Sunnqvist et al., 2007).

Within educational research emotional experiencing is mostly studied through external behavior such as verbal and nonverbal reactions or physical position (Frederics et al., 2004). Even later structured or semi-structured questioning can miss important data about subjective emotional experiencing and miss subtle variables influencing emotional state and observable characteristics.

Emotional graphs were designed to follow an individual learner's experience as he/she names and evaluates it; the graphs capture a respondents' mood, or more precisely, their positive and negative emotions and their development during a learning session. Students draw a curve representing their emotions/mood development during the session. They draw on a graph with a horizontal axis representing a value of emotion on negative-positive scale (-10 to 0 to +10) and a vertical axis capturing the learning time divided into three sections: before, during and after the lesson. They were also asked to add personal commentaries.

6.1.1 Development of the emotional graphs

The emotional graphs were developed in two stages: within the first implementation in pilot testing and redesigned afterwards based on outcomes from the pilot testing study (see the details about the pilot study in Chapter 3). The data for analysis below were collected with the redesigned tool from 319 experiment participants, 11 of them were excluded from the analysis because they left the experiment before and did not create an emotional graph.

Within the pilot study, after the educational session, all students were asked to draw an emotional graph with the following instructions (for the original sheet see Attachment 5): *"To the graph, please draw your mood development throughout the educational workshop. Add a short comment to the specific parts or peaks: write a short description why your mood has changed and add a picture or a number according to the legend on the right (if you are missing any emotion, write by your own words). On the horizontal axis, please indicate a period (e.g. start of the lesson, pause, etc.)."* The legend contained the following entries: enjoyment, immersion, interest, confusion, boredom, and frustration.

The pilot study confirmed that all students were able to draw emotional graphs without any trouble. Moreover, they included many additional comments appropriate to further content analysis. On the other hand, the pilot study also revealed problems that needed to be taken into account during further adjustments of the tool: in the graphs there appeared 1) huge individual differences in emotional range and 2) difficulties in evaluating individual emotions and their polarization.

According to (1), some students used the whole scale of the graph, while others worked only with a short range. To prevent any confusion in evaluation of emotional depth, I added a description to the scale, where the range -5 – +5 was specified as a classic "school experience" and everything above and below as an exceptional experience. -10 and 10 remained the extreme values. However, the values are mainly subjective without any definitive significance:

more important in the analysis are variations between different activities, e.g. learning session, break, the end of a session, etc.

While analyzing the individual comments, there appeared (2) difficulties in analysis and evaluation of emotions and their polarization. Students used the proposed legend but also added their own notes and descriptions. This feedback was not ready for quantification and evaluation on one specific scale. To offer a well-balanced tool to measure the emotional experience, for the next session students were supplied with small stickers of emoticons covering a 20-item scale of Positive and Negative Affect Schedule (PANAS). PANAS (Watson, 1988, Thompson, 2007) was designed to provide brief measures of positive and negative affect, and covers 10 positive emotions (interested, excited, strong, enthusiastic, proud, alert, inspired, determined, attentive, active) and 10 negative emotions (distressed, upset, guilty, scared, hostile, irritable, ashamed, nervous, jittery, afraid). To this list I added fatigue, because it spontaneously appeared in many students' comments. On the stickers, there were emoticons with name of the specific emotion from PANAS scale (See Fig. 10).

Figure 10: Stickers accommodating emotional graphs

The improved instruction of the second version of the graph: "*To the graph, please draw your mood development during the educational workshop. Place the line in the scale from + 10 (great*

enthusiasm, very positive feelings) to -10 (great frustration, very negative feelings). Add a short comment to the specific parts or peaks: write a short description why your mood has changed and add appropriate stickers (if you are missing any emotion: write by your own words). On the horizontal axis, please indicate a period (e.g. start of the lesson, pause, etc.)" (for the original sheet see Attachment 6).

6.2 Evaluation of emotional graphs

While digitizing data it was already possible to observe some firstsight tendencies repeating in the observed groups. Below you can see three graphs that (based on comparison of all emotional graphs from the study) can be considered as a "typical" example for the observed groups (Fig. 11 – 13):

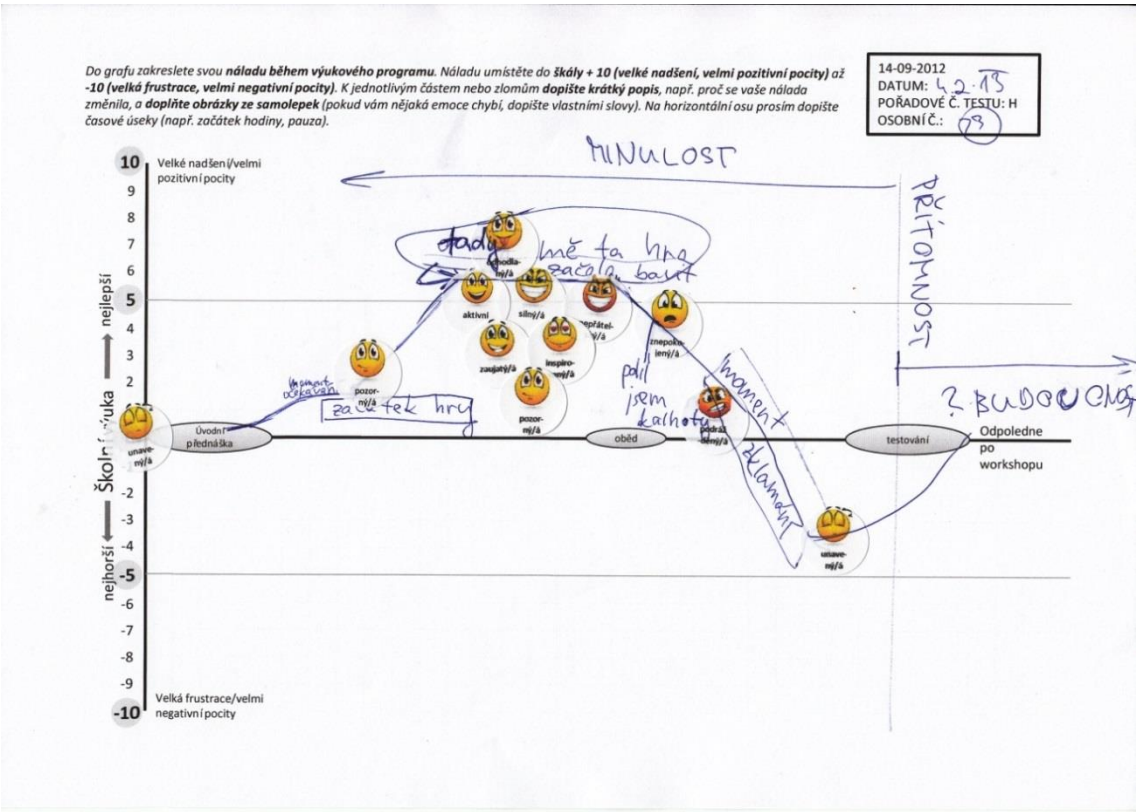


Figure 11: Emotional graph, the experimental digital game group

The students from the experimental digital game group used emoticon stickers mainly in educational sections. They used the largest amount of additional comments and their graph curves were characterized by a number of peaks and troughs describing mainly their gaming experience (see Fig. 11).

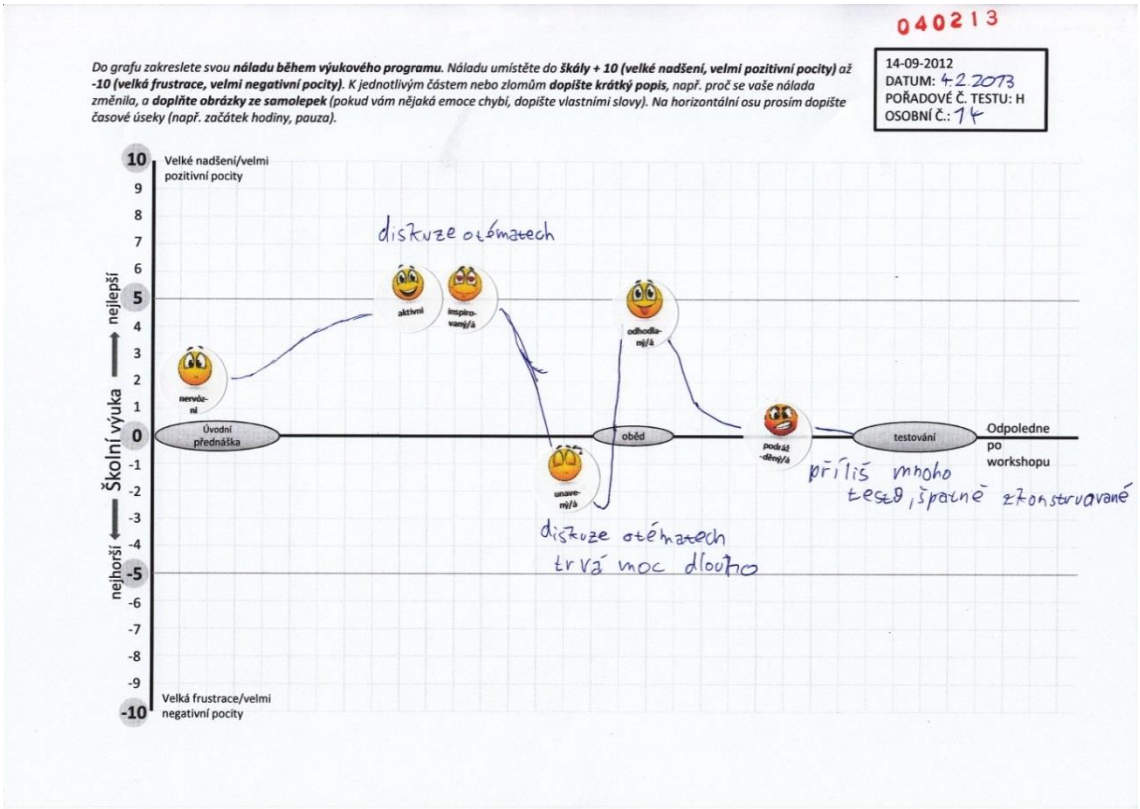


Figure 12: Emotional graph, the control classic lecture group

Emotional graphs from the control classic lecture group (see Fig. 12) contained the least amount of emoticon stickers. The additional comments were distributed uniformly throughout the length of the graphs, and generally the curves were flat without any remarkable peaks.

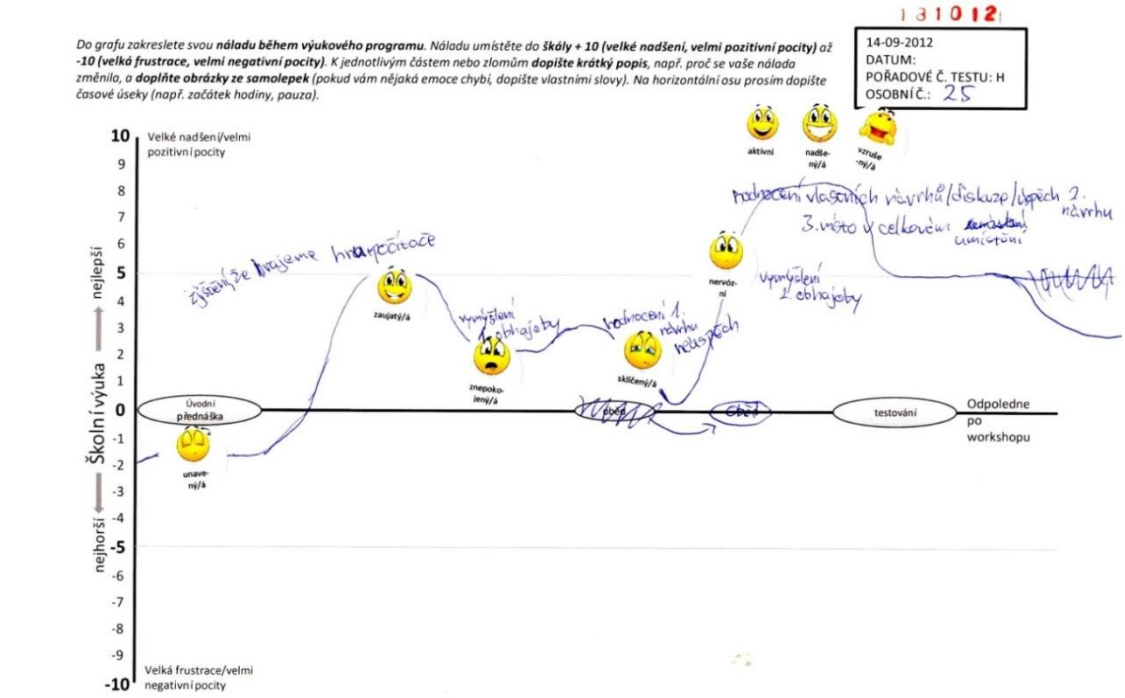


Figure 13: Emotional graph, the control non-digital game group

Emotional graphs from the control non-digital game group (se Fig. 13) were very similar to the graphs from experimental game groups. There were many peaks and troughs and more emoticon stickers in the educational sections. Additional comments were not that frequent and their totals were rather similar to the classic lecture group.

The horizontal axis of the graph was for the purpose of analysis needs divided into six sections: (1) introductory presentation, (2) 1st educational part, (3) lunch, (4) 2nd educational part, (5) final written tests, (6) after workshop, expectations. The analysis of emotional graphs had three parts:

1. Evaluation of graph lines,
2. PANAS scale in the form of emoticons and
3. content analysis of individual comments.

6.2.1 Graph line analysis

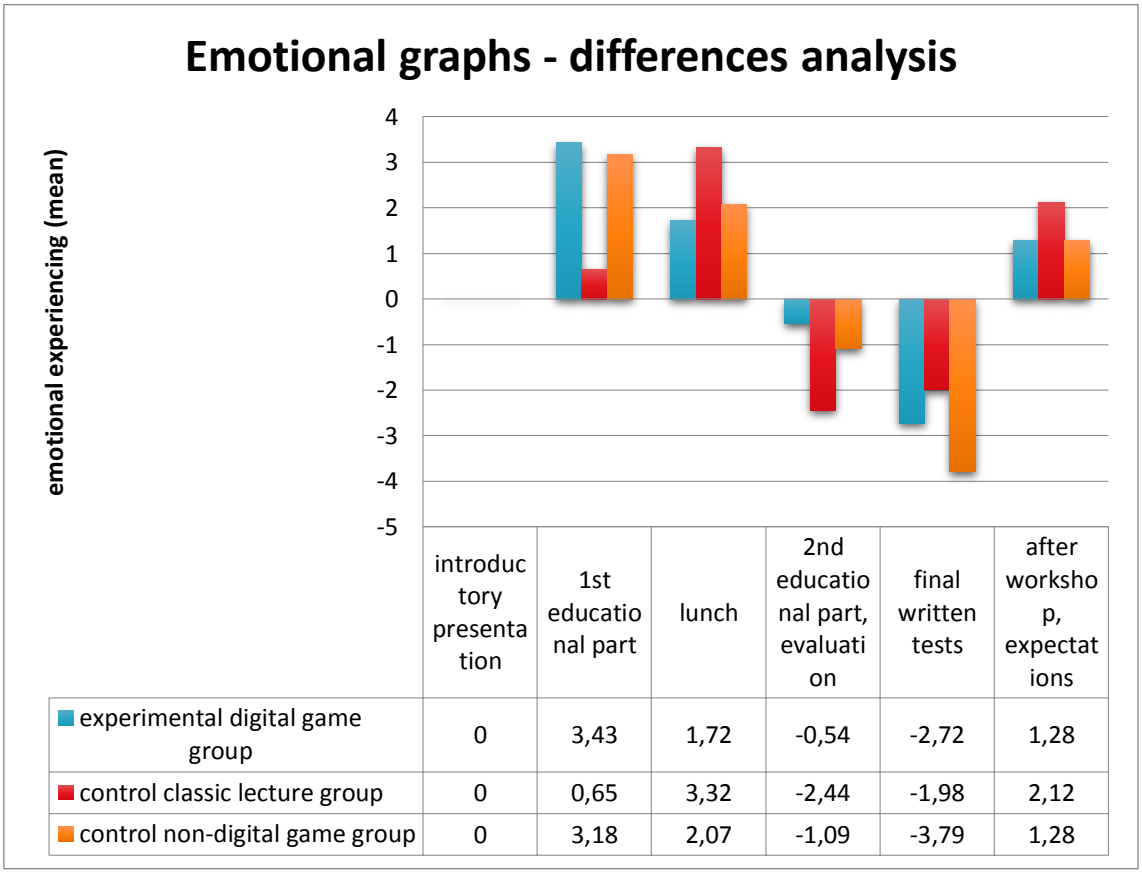
As mentioned above, each student used for her/his graph a different range of vertical axes. For this reason, the final emotional graph form contained an additional description on the vertical axis, ranging from -5 till +5 as "*the worst (-5) or the best (+5) school lesson*" that they experienced. Everything below and above was considered an exceptional experience.

The form of educational interaction in game-groups was fundamentally different from classic schooling methods in the Czech Republic: the average values of all students' graph curves did not reach above +5 or below -5 (SD = 3). The values reaching the extremes from +6 to +10 appeared mainly within educational sessions and were connected with comments about in-class discussions that were perceived very positively by all groups. The negative extremes between

-6 and -10 were connected with comments about public presentations in front of classmates, a stressful experience for all students. Additionally, many extreme positive values appeared during lunch and after workshop sessions, and negative values occurred in the final test session.

Even though the students might have understood well the instruction about vertical axis values, some graphs were obviously shifted more up or down. The individual differences in the evaluation of emotional experience were vast, and for this reason in the graph line analysis we do not consider numerical differences of the vertical axis scale as the absolute values. Instead, we focus on the differences between particular moments: how the emotional experience changes depending on the workshop activities (introductory presentation, 1st educational part, lunch, 2nd educational part, final written tests and after workshop expectations). Afterwards, we analyzed increases or decreases between particular sessions.

The biggest differences were observed between the educational session (morning or after-lunch) and introductory presentation and/or lunch (see Graph 14).



	introductory presentation	1st educational part	lunch	2nd educational part, evaluation	final written tests	after workshop, expectations
experimental digital game group	0	3,43	1,72	-0,54	-2,72	1,28
control classic lecture group	0	0,65	3,32	-2,44	-1,98	2,12
control non-digital game group	0	3,18	2,07	-1,09	-3,79	1,28

Graph 14: Emotional graphs comparison, curves development comparing the absolute differences (changes between particular workshop sessions)

In comparison to the introductory presentation, both game groups evaluated the learning activities around three points more positively: experimental digital game group mean value +3.43 (SD = 2.7) and control non-digital game group +3.18 (SD = 3). The control classic lecture group marked almost no difference: +0.65 (SD = 3.5). On the other hand for this group the biggest positive leap of the emotional curve was represented by lunch. Students from this group described its difference from the morning learning activities in average by +3.32 (SD = 3.1), while the return to the educational session after a lunch break reflected a two and half point drop: -2.44 (SD = 3.5).

The beginning of the lunch period was also perceived positively in other groups, but the leap was not that remarkable: experimental digital game group +1.72 (SD = 3.1) and control non-digital game group +2.07 (SD = 2.9). In those groups the increase was sustained even through the after lunch educational session; experimental digital game group -0.54 (SD = 3) and control non-digital game group -1.09 (SD = 3).

The most negatively perceived part of the educational workshop was the final written test session. The decrease in positive feedback after the educational session was more remarkable in game groups': the experimental digital game group -2.72 (SD = 3.4), the control non-digital game group -3.79 (SD = 3.5), the control classic lecture group -1.98 (SD = 3.7).

The expectations about the after workshop private activities compared to the test session were always positive: the experimental digital game group +1.28 (SD = 3.6), the control non-digital game group +1.28 (SD = 4.2), the control classic lecture group +2.12 (SD = 4.4). Interestingly compared to the educational sessions, students expected the after workshop time as only slightly more positive than the game-based learning activities: (1) compared to the 1st educational session - experimental digital game group described after workshop private time as +0.93 (SD = 3.3), control non-digital game group +0.79 (SD = 3.8), while the control classic lecture group by +2.01 (SD = 4.6); and (2) compared to the 2nd educational session - experimental digital game group +1.58 (SD = 3.8), control non-digital game group +1.89 (SD = 4.1), control classic lecture group +3.48 (SD = 5.5).

6.2.2 PANAS emoticons analysis

As the emotional graphs do not use the original PANAS 5-point scale and questionnaire, the analysis needs to be considered as a qualitative evaluation of situational emotional development and occurrence of PANAS standardized affects.

In each graph timeline section I followed the frequency of the emoticon stickers. The classic PANAS scale has 5 points indicating present affects from (1) very slightly or not at all to (5) extremely. While using emoticon stickers it is possible to consider a simple 2-point scale – (0) is present and (1) is not present. To see between-group differences in better resolution, we observed frequencies and percentages of emoticons in each graph section so we could track the situational affects occurrences.

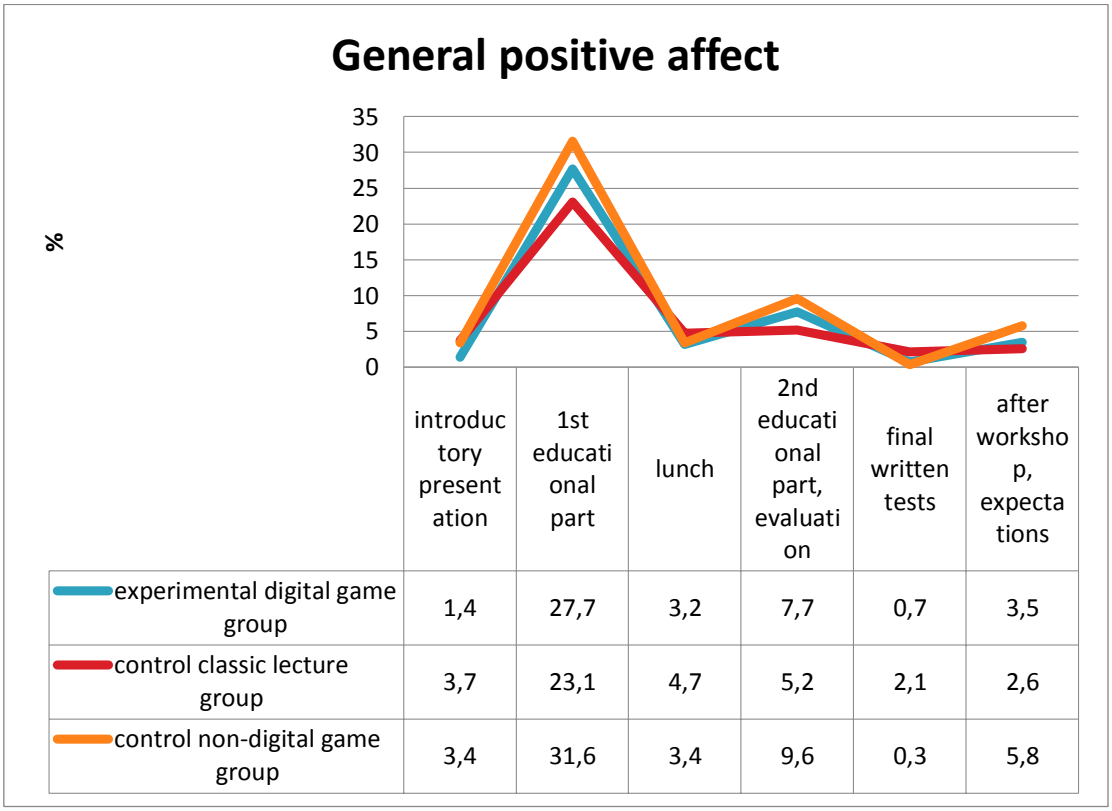
The amount of used stickers varied moderately between groups. For one emotional graph students from the experimental digital game group used on average 4.5 emoticons stickers, while in the control classic lecture group it was 3.8 stickers and in the control non-digital game group 5.6 stickers. Both game groups used more stickers in graph sections 1st educational part and 2nd educational part and evaluation. Those parts of the educational workshop were even more charged with emotions for the control non-digital game group as evinced by the fact that this group was involved in real-life role-playing activities which demanded deeper personal involvement and full-time face-to-face contact, and therefore higher emotional engagement.

Analysis comparing the three groups revealed some differences and trends in observed positive and negative emotional experiencing. The affects were evaluated composited into lower order PANAS scales (Watson and Clark, 1994): General positive affect (interested, inspired, active), general negative affect (distressed, upset, ashamed), joviality (excited, enthusiastic), self-assurance (strong, proud), guilt (guilty), fear (scared, nervous, jittery, afraid), hostility (hostile, irritable), attentiveness (attentive, determined, alert) and the additional category appropriate to this research – fatigue (tired). All the graphs below show the frequency of used emoticons in %.

6.2.2.1 General positive affect (interested, inspired, active)

General positive affect was reported the most frequently within the 1st educational part, by 23% in the classic lecture group, 28% in the experimental game group and 32% in the control non-digital game group. Such a peak might be connected with discussion activities that were highly appreciated by students in all groups. Similarly the 2nd educational part was perceived positively: the least by the control classic lecture group 5%, the experimental game group 8% and the most by the control non-digital game group group 10% (see Graph 15).

No significant between group differences were found.

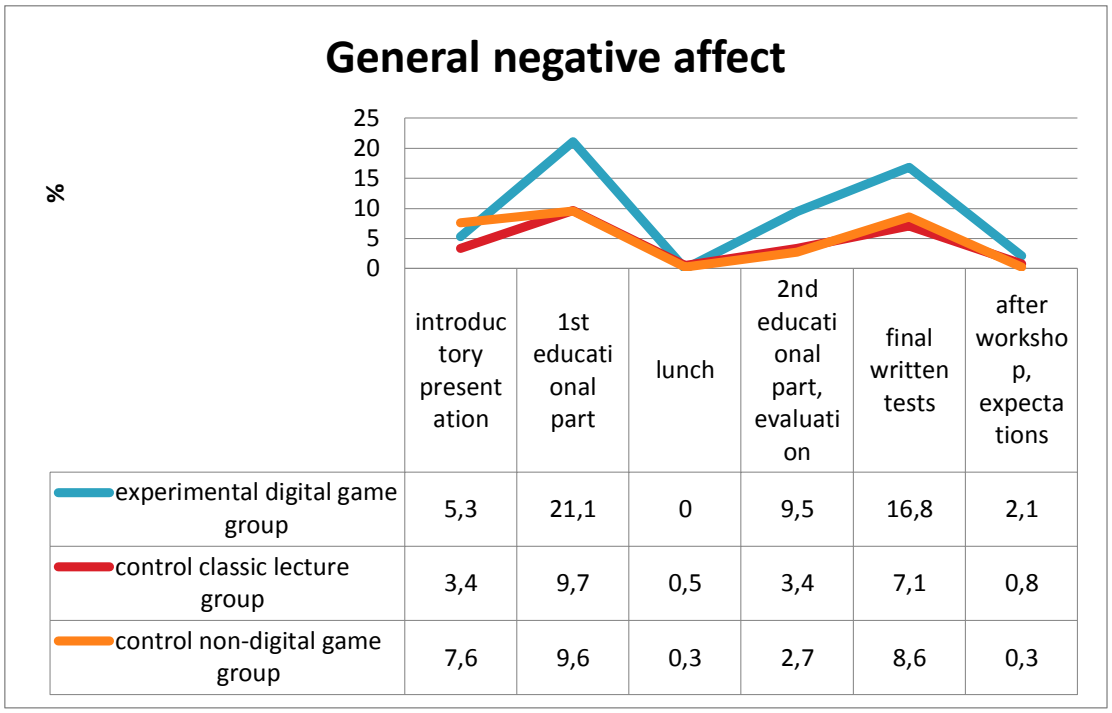


	introductory presentation	1st educational part	lunch	2nd educational part, evaluation	final written tests	after workshop, expectations
experimental digital game group	1,4	27,7	3,2	7,7	0,7	3,5
control classic lecture group	3,7	23,1	4,7	5,2	2,1	2,6
control non-digital game group	3,4	31,6	3,4	9,6	0,3	5,8

Graph 15: General positive affect (lower order scale of PANAS) reported within emotional graphs

6.2.2.2 General negative affect (distressed, upset, ashamed)

Compared to the other two groups, general negative affect was reported by the experimental game group with around a 10% higher frequency in the sections 1st educational part and final written tests (see Graph 16).



	introductory presentation	1st educational part	lunch	2nd educational part, evaluation	final written tests	after workshop, expectations
experimental digital game group	5,3	21,1	0	9,5	16,8	2,1
control classic lecture group	3,4	9,7	0,5	3,4	7,1	0,8
control non-digital game group	7,6	9,6	0,3	2,7	8,6	0,3

Graph 16: General negative affect (lower order scale of PANAS) reported within emotional graphs

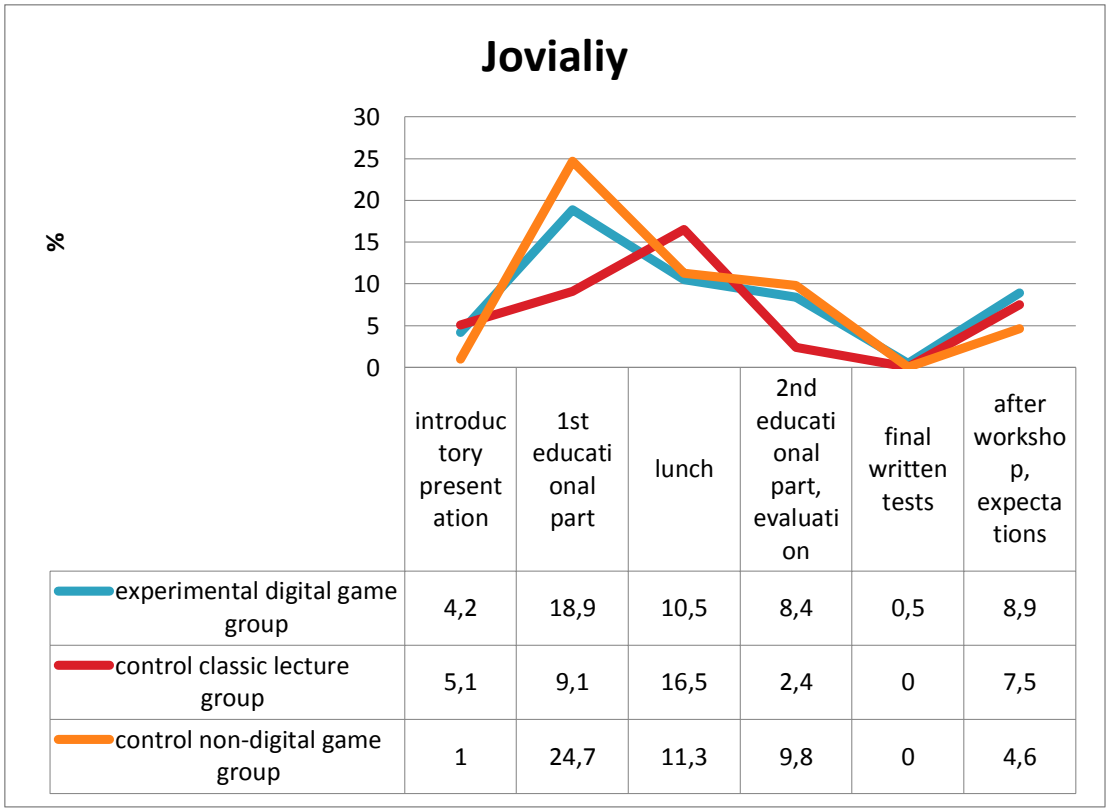
Additional negative written comments in the 1st educational section mainly pointed to students' in-class presentations of gaming projects (detailed descriptions of all educational activities in the Chapter 3.2). This activity was present in the other two groups as well, the only difference being that in the game groups, students chose three preferred projects by themselves (teacher assigned them one of those three) and the control classic lecture group got the project assigned by teacher. Arguably the experimental digital game group might have felt more personally involved and responsible for their performance; however this is a hypothesis that needs to be verified by further research.

The higher negative affect of the experimental digital game group during final written tests could be connected to frequent additional comments such as "*boring*", "*too long*" and/or "*too many tests*". But those comments appeared in comparable amounts in the other two groups as well. Only a few comments in the experimental digital game group foreshadowed another connection: three students pointed out feelings of disappointment; they felt that during the game-play they did not really learn and "*do not remember anything*". This outcome could be influenced by the strong schooling tradition in the Czech Republic where the curriculum mainly focuses on factual knowledge and "drill and practice" methods so students do not consider game or amusing activities to be learning (there has been an on-going school reform in the Czech Republic for about the last 10 years). This outcome also corresponds with findings from our previous research (Buchtová et al., 2012), yet this hypothesis needs to be investigated by further research.

6.2.2.3 Joviality (excited, enthusiastic)

Such positive emotions as excited and enthusiastic – the emotions connected with engagement – might enhance comprehensive and knowledge transfer, positive perception of learning and better motivation toward learning (e.g. Malone, 1981, Ke, 2009, Frederics et al., 2004, Um et al., 2012, Wouters et al., 2013).

Feelings of excitement and/or enthusiasm were reported within the 1st educational part by 19% of students from the experimental game group and by almost one quarter of students from the control non-digital game group group (25%). This part of the day appeared as a joviality peak for those two groups while the peak for the control classic lecture group was represented by lunch (17%) (see Graph 17).



	introductory presentation	1st educational part	lunch	2nd educational part, evaluation	final written tests	after workshop, expectations
experimental digital game group	4,2	18,9	10,5	8,4	0,5	8,9
control classic lecture group	5,1	9,1	16,5	2,4	0	7,5
control non-digital game group	1	24,7	11,3	9,8	0	4,6

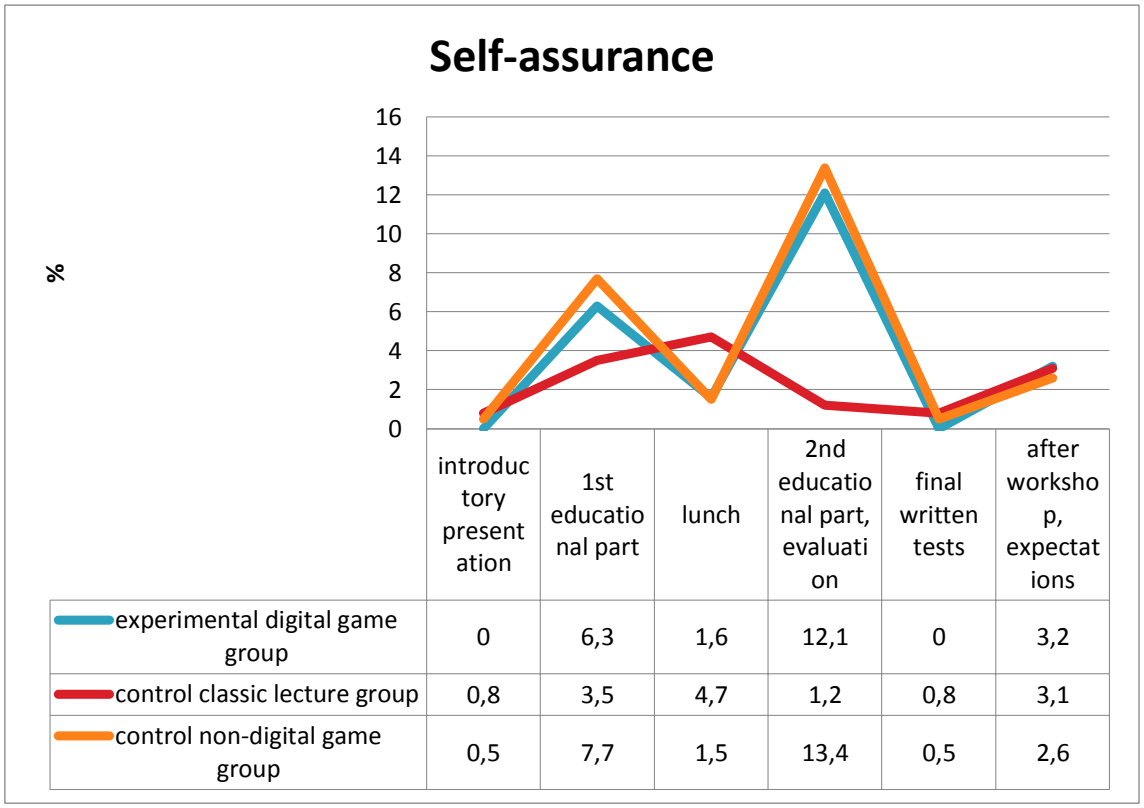
Graph 17: Joviality (lower order scale of PANAS) reported within emotional graphs

Even though the gaming activities followed also in the 2nd educational part, the joviality affects in the game groups tailed away: the control classic lecture group (2%), the experimental digital game group (8%), the control non-digital game group group (10%). This data may be a reflection of the repetitive design of the game activities in each game-round and/or growing fatigue as described below in Chapter 6.2.2.8.

6.2.2.4 Self-assurance (strong, proud)

The affects from the scale of self-assurance were stronger in both game groups. Compared to the classic lecture group, the other groups reported the affects “strong” and “proud” more frequently in the graph sections 1st educational part and 2nd educational part and evaluation. For those groups, the educational parts meant self-assurance peaks. The self-assurance curve

of the classic lecture group was mainly flat the students reported a very low peak in the lunch section (5%) (see Graph 18).



	introductory presentation	1st educational part	lunch	2nd educational part, evaluation	final written tests	after workshop, expectations
experimental digital game group	0	6,3	1,6	12,1	0	3,2
control classic lecture group	0,8	3,5	4,7	1,2	0,8	3,1
control non-digital game group	0,5	7,7	1,5	13,4	0,5	2,6

Graph 18: Self-assurance (lower order scale of PANAS) reported within emotional graphs

The general between group differences were slight in the 1st educational part: 6% students from the experimental digital game group and 8% from the control non-digital game group used emoticons from the self-assurance scale while 4% from the control classic lecture group reported the same affects. Significantly stronger differences were observed in the 2nd educational part: 12% students from the experimental digital game group and 13% from the control non-digital game group while only 1% of classic lecture students reported feeling self-assured and/or proud.

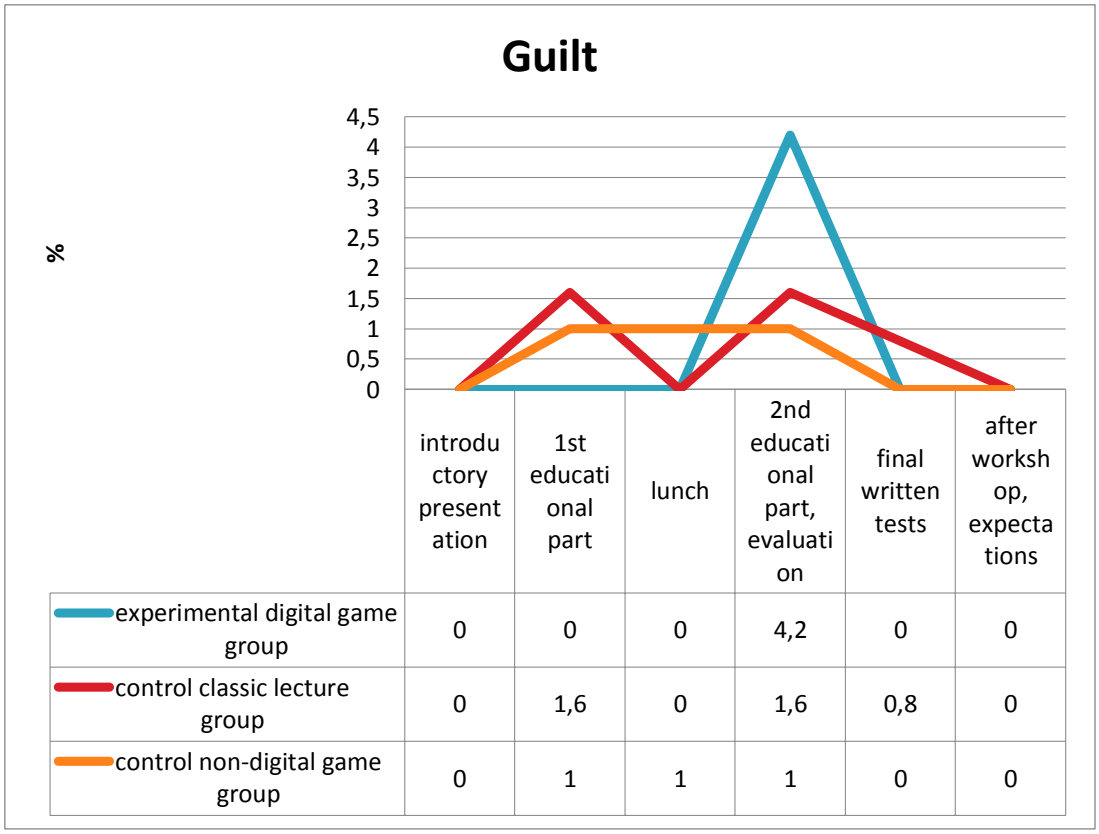
Gaming activities seemed to trigger self-assurance affects which were even stronger in the final part of the game which included the final evaluation and announcement of winners.

Situational emotional experience supporting self-assurance might have a positive effect on general self-assurance and self-esteem in the specific area, e.g learning theme. O'Brien & Pere (1985) suppose that self-assurance may positively influence the future estimate of one's ability to complete a task. Some experimental studies point out that perceived self-esteem might have a positive effect on learning (Cerezo, 2012; Baumeister, et al., 2003; Seabi, 2011), and consequently on academic achievement (Román, et al., 2008). Moreover, students with high self-esteem may be more willing to persist in the face of initial failure, instead of shrinking under paralyzing feelings of incompetence and self-doubt (Román, et al., 2008).

6.2.2.5 Guilt (guilty)

The emoticon of guilt was used very modestly: the only visible but not significant peak appeared in the 2nd educational part: the control classic lecture group (2%), the experimental digital game group (4%), the control non-digital game group (1%) (see Graph 19).

No significant between-group differences were found.

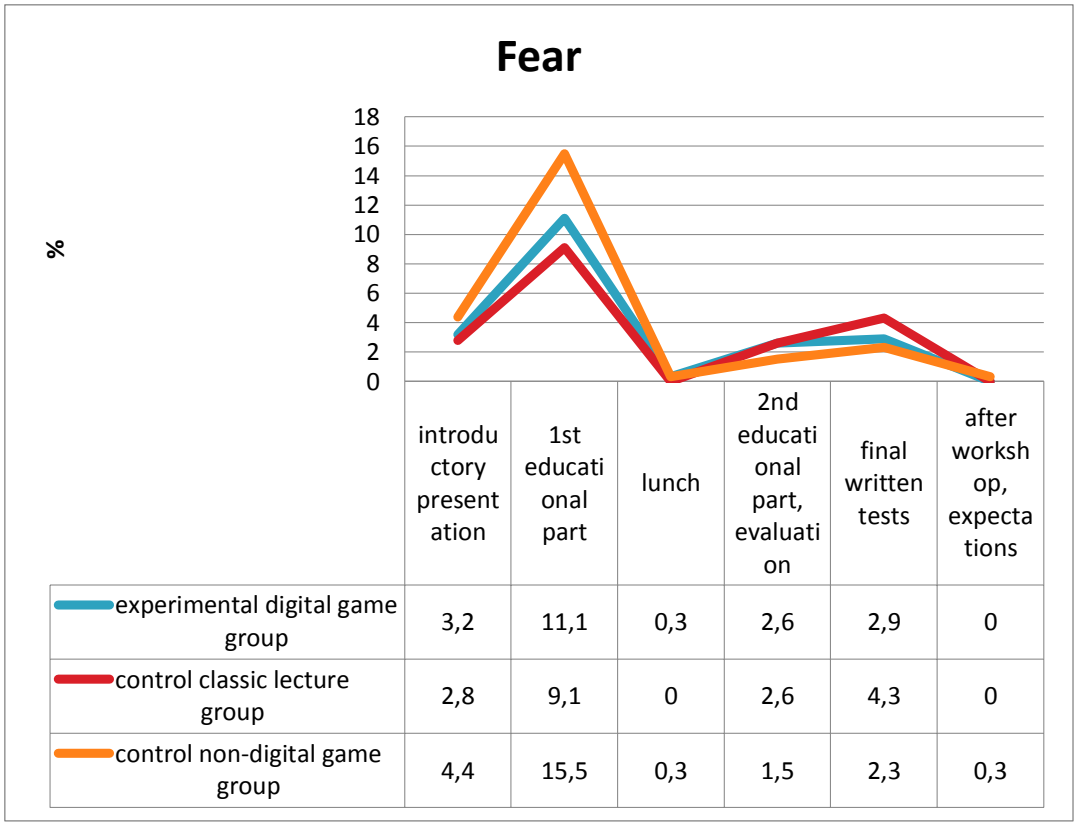


Graph 19: Guilt (lower order scale of PANAS) reported within emotional graphs

6.2.2.6 Fear (scared, nervous, jittery, afraid)

The emotion of fear appeared rarely within all parts of the workshop, except for lunch and expectation of after workshop activities where no such emoticons appeared. A slight increase can be observed in the 1st educational part, while students were confronted with new program in smaller groups and encouraged to publicly present and discuss; the control classic lecture group (9%), the experimental digital game group (11%), the control non-digital game group (16%) (see Graph 20).

No significant between group differences were found.

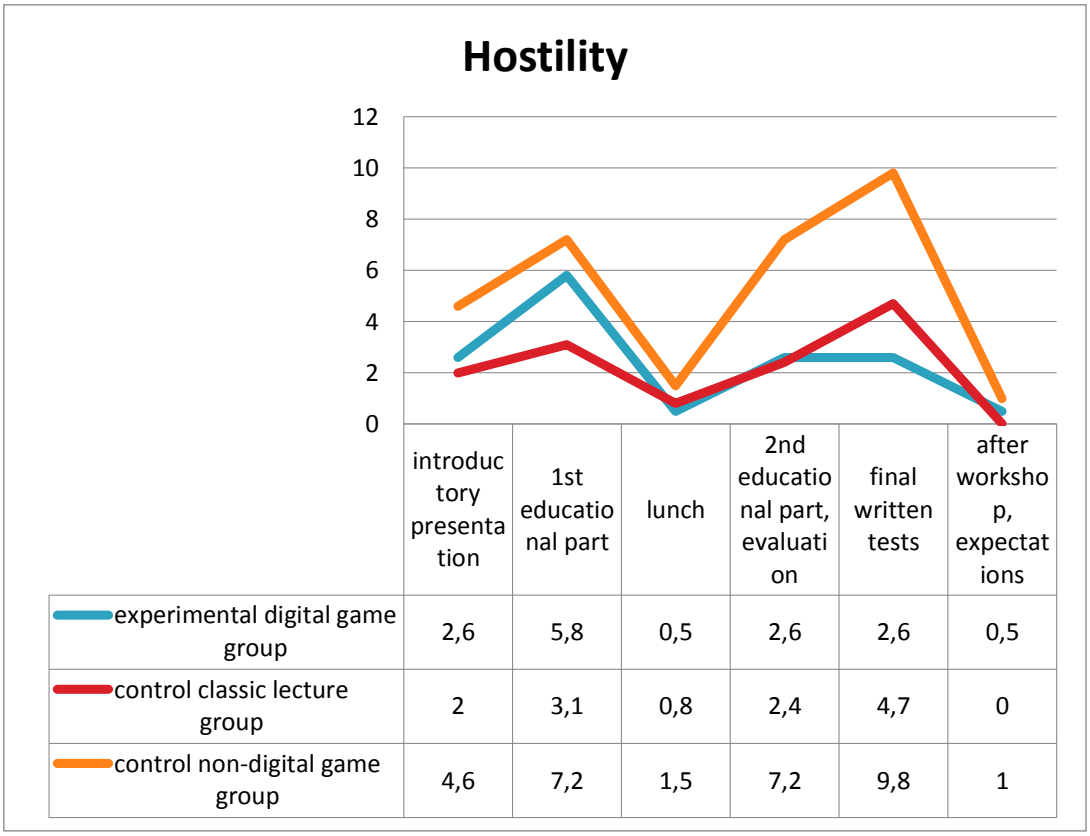


Graph 20: Fear (lower order scale of PANAS) reported within emotional graphs

6.2.2.6 Hostility (hostile, irritable)

Emoticons from the scale of hostility were used only rarely and equally within all workshop sessions (see Graph 21).

No significant between group differences were found.

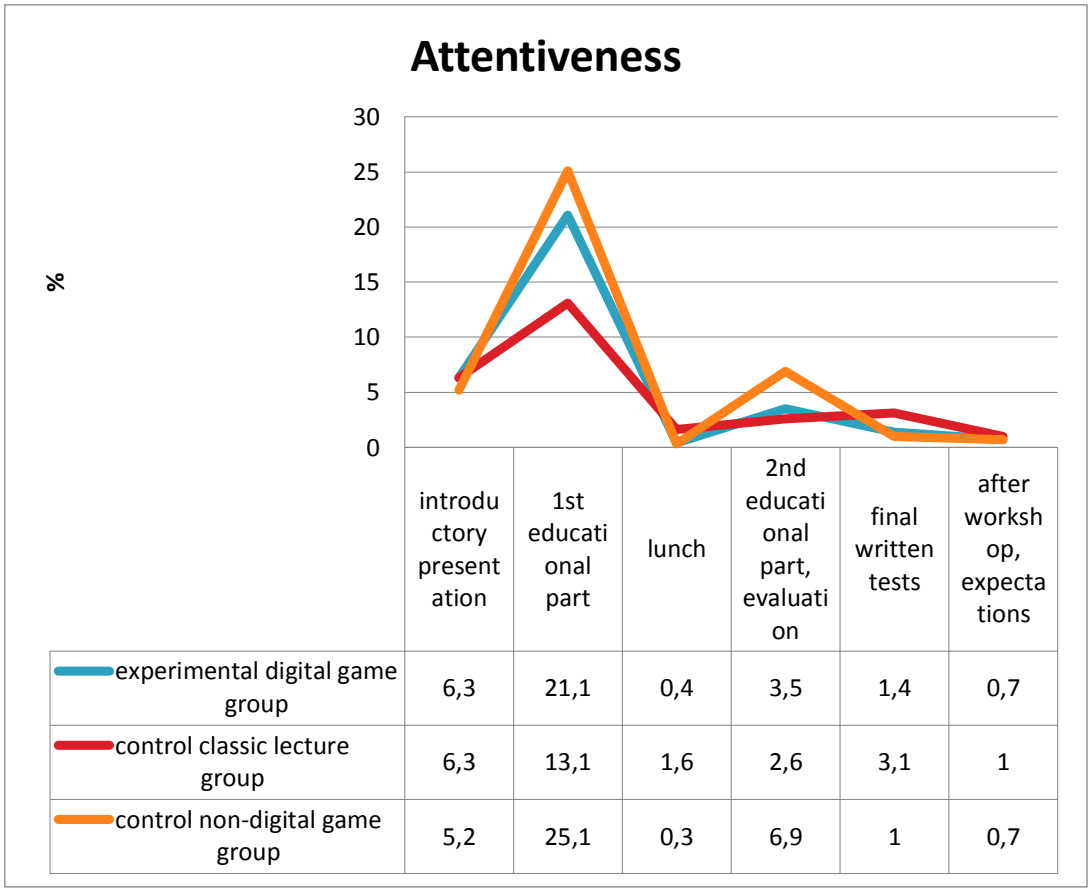


	introductory presentation	1st educational part	lunch	2nd educational part, evaluation	final written tests	after workshop, expectations
experimental digital game group	2,6	5,8	0,5	2,6	2,6	0,5
control classic lecture group	2	3,1	0,8	2,4	4,7	0
control non-digital game group	4,6	7,2	1,5	7,2	9,8	1

Graph 21: Hostility (lower order scale of PANAS) reported within emotional graphs

6.2.2.7 Attentiveness (attentive, determined, alert)

Attentiveness represents in education one of the most important affects that support learning engagement (Gagne & Medsker, 1996, Fredricks et al., 2004, Lau et al., 2008). The students from both game groups described themselves as attentive, determined and/or alert within the 1st educational part (21% the experimental digital game group, 25% the control non-digital game group) while only 13% in the control classic lecture group reported likewise (see Graph 22).



	introductory presentation	1st educational part	lunch	2nd educational part, evaluation	final written tests	after workshop, expectations
experimental digital game group	6,3	21,1	0,4	3,5	1,4	0,7
control classic lecture group	6,3	13,1	1,6	2,6	3,1	1
control non-digital game group	5,2	25,1	0,3	6,9	1	0,7

Graph 22: Attentiveness (lower order scale of PANAS) reported within emotional graphs

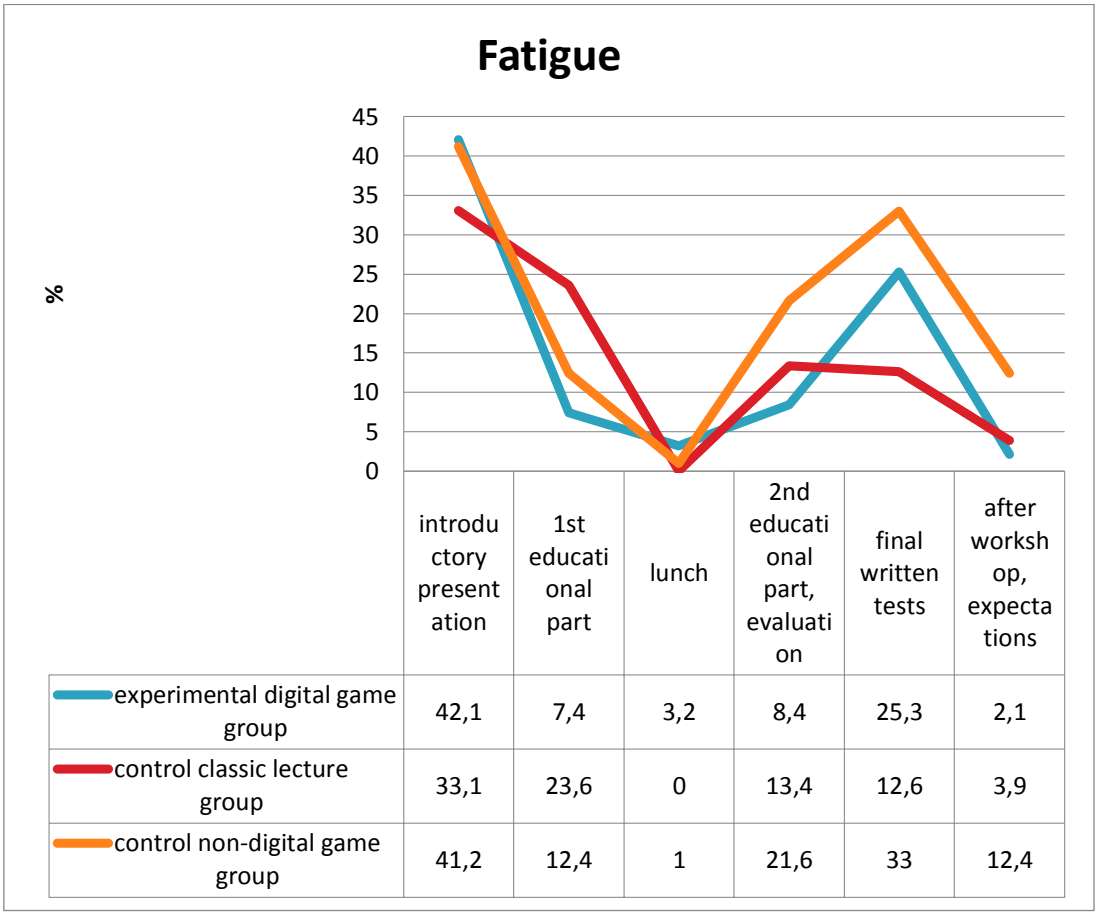
The information content and other settings were similar for all groups so variable of game activities seems to be responsible for such a variance.

Even though the gaming activities followed also in the 2nd educational part, the attentiveness in the game groups tailed away. That can be connected with thte repetitive design of game activities or growing fatigue as described below in Chapter 6.2.2.8.

6.2.2.8 Fatigue (tired)

The graph curves of fatigue varied the greatest between the groups and brought some interesting results. Within the introductory presentation students from all groups reported

fatigue in similar proportion. Most of their comments referred to the fact that they had to wake up a bit earlier than usually. However with the 1st educational part the group differences began to appear. Both game groups did report the fatigue in significantly lower extent: experimental game group used the fatigue emoticons in 35% less cases (fatigue reported only by 7% of students) and the control non-digital game group in 29% less cases (fatigue reported by 12% of students). The decrease within control classic lecture group was 10% with almost one fourth of students feeling tired (see Graph 23).



	introductory presentation	1st educational part	lunch	2nd educational part, evaluation	final written tests	after workshop, expectations
experimental digital game group	42,1	7,4	3,2	8,4	25,3	2,1
control classic lecture group	33,1	23,6	0	13,4	12,6	3,9
control non-digital game group	41,2	12,4	1	21,6	33	12,4

Graph 23: Fatigue reported within emotional graphs

After the lunch, during the 2nd educational part the experimental digital game group students did not feel more tired than during 1st educational part (8%). But for students from the control classic lecture group lunch meant an energy boost (according to several written comments)

and reduced their fatigue (13% students). On the other hand students form the control non-digital game group perceived the after lunch period as a mental inhibition caused by digestion (according to several written comments) and reported higher fatigue (22%).

When all educational activities finished – and the final written tests came – perceived fatigue did not change for the control classic lecture group (13%) but increased for the experimental digital game group (increase of 17% compared to the previous part) and the control non-digital game group (increase of 11% compared to the previous part).

Compared to other groups more fatigue was also reported by the control non-digital game group in after workshop expectations section (12%).

The form of educational intervention played a visible role in students' perceived fatigue. As the classic lecture does not demand a high individual involvement, the fatigue stayed more or less constant in this group and later on decreased after the lunch. Although game activities can be highly energy demanding, within the 1st educational part the students from both game groups felt significantly less tired. It seems that active individual involvement in game-activities does in general decrease a perceived fatigue and activates the students.

On the other hand the trend of low fatigue did not continue constantly for the control non-digital game group; the activities are based on full-time face-to-face contact and often demand individual actions that are in longer period tiring for the student-players involved. Those students felt more frequently tired after the lunch as compared to the game group and classic lecture group students; they were in more cases tired at the end of the educational day.

It is important to mention that in the experimental digital game group there were also several the control non-digital game group activities after every game-round (detailed description of all educational activities in the Chapter 3.4) but it did not have a visible effect on those students' perceived fatigue. Within other PANAS monitored affects, both game groups were comparably different than and opposing the classic lecture group, but it seems that computer

interaction in the game experience played a significant role in the fatigue reduction. The experimental digital game group did report fatigue within educational activities, though only minimally.

6.2.3 Individual comments content analysis

In the emotional graph instructions students were asked to add comments and short explanations to the points highlighting peaks, troughs and changes in their graph curve or important moments etc. Those comments helped in overall qualitative analysis and served as an additional explanation in the case of not very clean outcomes from two previous analyses.

The proportion of "reticent" respondents – respondents who added a maximum of two comments – was approximately 70% in both control groups and 57% in the experimental group. Consequently the qualitative analysis refers only to the 30 - 43% of respondents who shared their experience. The frequency of comments varied slightly across the groups. The biggest number of comments appeared in the experimental digital game group (M = 2.7 comments/one graph), after in the control non-digital game group (M = 1.8 comment/one graph) and least in the control classic lecture group (M = 1 comment/one graph). In approximately one third of the cases the comments were explaining a situation (e.g. "*lesson started*", "*division into groups*", etc.), while the rest reffered to individual experiencing of a specific situation (e.g. "*curious*", "*bored*", "*I do not know what to expect*", etc.).

6.2.3.1 Educational sessions

According to the additional comments, a majority of the students disliked public presentations of specific themes (in game groups in form of a game agenda and in the control classic lecture group as an assigned learning theme). The presentations were often connected with comments such as "*nervous*", "*I do not like presenting in front of my classmates*", etc.

On the other hand following in-class discussions about those themes were perceived completely conversely. The discussions were evaluated in all groups positively by an uprising tendency in the graph curve and/or by comments such as "*interesting discussion*". Importantly in both game groups those comments showed a stronger connection to specific topics, those students recalled themes more often (approximately in one fifth of the cases); such as "*discussion about European military*", "*representation of Environmental politics*", etc. The classic lecture group typically mentioned only "*discussion*".

The comment "*enjoyment*" or "*joy*" within the educational activity was common for game groups (the experimental digital game group 11%, in the control non-digital game group 12% of students reported such a comment) while in the control classic lecture group they appeared only once.

Other comments could be categorized as positive evaluation of the learning program: "*interesting information*"; negative evaluation of time-schedule and workshop design: "*lengthy*", "*repetitive*"; physical discomfort: "*I'm hungry*", "*I'm cold*". All those appeared with similar frequency across the groups. Only 8% of the control classic lecture students commented on pauses and snacks. This never appeared in game groups' graphs even though the schedule and timing was roughly identical. As the graph curve always went up with a pause or snack, it obviously complicated the enjoyment which was provided by game features in the game groups.

The after-lunch session revealed a similar tendency only the new comments "*stereotype*" and "*boredom*" appeared; the experimental digital game group 4%, the control non-digital game group 8%, the control classic lecture group 8%. Apparently this was caused by repetitive design of the game program.

Nine comments (three in each group) were related to lunch and those were interestingly distributed; in classic lecture group the students described feelings of pleasure after the food

while in both game groups students were rather disturbed by heavy feelings of digestion which might be caused by the game activities' higher demands on personal involvement.

6.2.3.2 Lunch

Comments in this section contained uninteresting descriptions of menu and food quality.

6.2.3.3 Introductory presentation

Most of the comments (81%) concerned early morning waking up; "*it's early*", "*fatigue*", "*waking up*". The introductory presentation was evaluated similarly by all groups (mainly "*boring*" but in some cases "*interesting information*").

As the emotional graphs were created after the educational experience, we can observe some retrospective evaluation of the workshop. Students from the classic lecture group noted in 6% of cases that they had some positive expectations about the day ("*I am looking forward*", "*positive expectations*"), in the control non-digital game group it was 5% while in the experimental digital game group only one student wrote such a comment. On the other hand a negative expectation in the morning ("*I am not looking forward*", "*I do not want to go*") was indicated by 5% of students from both game groups and one student from the control classic lecture group. Positive expectations may point to some disappointment the students had at the end of the day while negative expectations could mean a positive surprise. But for now this can be considered only as an assumption, and it would have to be confirmed by additional questioning etc.

6.2.3.4 After workshop, expectations

In all groups the after workshop plans accorded: "*sport",* "*pub*" or "*home*". More students from the control classic lecture group added comments such "*the end finally*" which was very rare in the game groups.

6.3 Conclusion

This chapter describes the development and the first outcomes of the emotional graph, a tool to measure the emotional experience of learning. The inspiration comes from life charting, a psychiatry technique correlating a patient's life-events and history with her/his personal experiences. The tool presented here was piloted on the research sample of 74 high-school students, and afterwards advanced based on the feedback and pilot evaluation. The final version was applied in the experimental research described by this dissertation. The emotional graph tool is a paper-based graph form with a horizontal axis capturing a timeline of an educational event and a vertical axis capturing emotional evaluation (from 0 to +5 as positive, from +5 to +10 as exceptionally positive, from 0 to -5 as negative, from -5 to -10 as exceptionally negative). The graph form was accompanied by two sets of 21 emoticon stickers, illustrating 20-item scale of Positive and Negative Affect Schedule (PANAS) and fatigue, an important variable in learning situations. Students were asked to draw into the graph a line curve representing their mood development during the educational workshop; they could accommodate it by written comments and emoticon stickers. The final evaluation of emotional graphs had three levels: (1) evaluation of graph lines, (2) PANAS scale in the form of emoticons and (3) content analysis of individual comments.

Emotional graphs varied through all three groups: the students from the experimental digital game-group used the largest amount of additional comments, and their graph curves were characterized by a number of peaks and troughs describing mainly their gaming experience;

the classic lecture group students used the least amount of emoticon stickers, and the additional comments were distributed uniformly within all lengths of the graphs. Generally, the curves were flat, without any remarkable peaks; and the control non-digital game group students' lines had many peaks and troughs and more emoticon stickers in the educational parts.

Evaluation of the graph lines showed many similarities between the experimental digital game group and the control non-digital game group. Both game groups evaluated the learning activities around three points more positively (higher on the vertical axis) than the control classic lecture group, whose positive peak was represented in most cases by lunch. After the lunch pause, the curve representing emotional experiencing in the classic lecture dropped down again. In contrast, the beginning of the lunch period was also perceived positively in other groups, but the leap was not that remarkable; additionally, the increase in those groups was sustained even through the after-lunch educational session.

As expected, the most negative experience was represented by the final tests session, but compared to the educational sessions, students anticipated the after-workshop time as only slightly more positive than the game-based learning activities.

The PANAS scale in the form of emoticons proved to be a very helpful tool in standardizing the personal emotional evaluation in graphs. Both game-groups used an increased amount of stickers in the graph sections 1st educational part and 2nd educational part and in the evaluation. The affects were evaluated through composition into lower-order PANAS scales from Watson and Clark (1994): general positive affect, general negative affect, joviality, self-assurance, guilt, fear, hostility, attentiveness and the additional category appropriate to this research – fatigue. Between group differences appeared in emotions important for the process of knowledge acquisition and cognitive engagement: some interesting differences appeared in general negative affect (distressed, upset, ashamed), joviality (excited, enthusiastic), self-assurance (strong, proud), attentiveness (attentive, determined, alert) and fatigue (tired).

General negative affect was stronger for experimental game-group within the 1st educational part and the written tests session. Negative additional written comments in the 1st educational part section mainly pointed to students' in-class presentations of gaming projects that was perceived negatively in all groups. The only difference was that in the experimental game group, students got assigned one project from the three they marked as preferred, while the classic lecture group got the project assigned by a teacher. That might have an effect on the experimental digital game group, where students might feel more personally involved and personally responsible for their performance (this is only a hypothesis, needing further research verification). An important aspect of the study which demands further research is to understand why the negative affect was higher only for the students learning with computer games, but only in connection with the final written tests session.

Excitement and enthusiasm were reported the most frequently within the 1st educational part by both game groups, but the peak for the classic lecture group was the lunch break; the case was similar for affects of self-assurance, which were stronger in both game groups. Compared to the classic lecture group, they reported the affects "strong" and "proud" more frequently in the 1st educational part and 2nd educational part graph sections and in the evaluation. Around 10% more students from both game-groups (compared to the classic lecture group) described themselves as attentive, determined and/or alert within the 1st educational part.

Reported fatigue had a different tendency in all three groups (except for lunch, where similarly for all groups only minimum reported fatigue appeared): for the control classic lecture group, fatigue had a rather descending tendency, while in both game groups fatigue increased with the time. The experimental digital game group did report fatigue minimally within all educational activities, but students from the control non-digital game group and the control classic lecture group were tired significantly more. Fatigue was reported within the control classic lecture group more often before lunch (reporting that it boosted their energy), and within the control non-digital game group more often after lunch (reporting that it took away their energy). It seems that highly demanding social activities (such as life action role-play) are

more tiring, and that the schema of a full-day workshop is too long for participants to remain active and fresh. Yet this does not seem to be a problem for the classic lecture group – students are able to participate for longer periods. It is significant, however, that the student participation in this case is almost purely passive compared to the other groups. On the other hand, the control classic lecture group was not able to "break" the morning fatigue which was reported by a similar number of participants in all groups. The game-group students felt rapidly less tired with the start of their educational activities. Only the experimental digital game-group students kept low fatigue during all educational activities, but they reported high fatigue just afterwards – during final written tests session. Playful activities combined with gameplay on a PC seem to have a lowering effect on students' perceived fatigue.

Evaluating the additional written comments, students from both game-groups added a larger amount of comments compared to other groups, which points to a slightly higher emotional richness in the learning experience. Those students also more often recalled a learning agenda connected with a specific event, which might show better retrieval cues (future research needed).

When evaluating the beginning phase of the workshop, we found that students from both game groups evaluated positively or negatively the introductory presentation about the EU. On the other hand, the students taught in a classic lecture format wrote mainly comments about initial positive expectations. That may suggest a kind of disappointment in the end of the day.

To summarize, the emotional graphs can bring promising data to bear on providing a deeper evaluation of educational activities. The tool allows for capturing the subjective evaluation of activities, the emotional changes and their sources. Thanks to additional written comments and the adapted PANAS scale, we are able to evaluate some important variables of cognitive engagement such as general positive and negative affect, self-assurance, attentiveness, fatigue, etc. Furthermore, the first results indicate differences between classic lecture and game-based learning activities.

7 Social interactions within learning situations

Hypothesis no. 4: *Verbal and non-verbal behavior showing positive engagement and willingness to develop learning situation will be present in (inter)actions of game participants.*

A long history of educational research repeatedly confirms the strong benefits of collaborative learning in comparison to individualistic and competitive approaches. Collaborative learning generates significantly higher achievement outcomes, higher level reasoning, better retention, improved motivation (e.g. Webb et al. 2006), positive engagement (e.g. Barron, 2003) and better social skills than traditional didactics (e.g. Johnson & Johnson, 1991). Research on short-term collaboration among school-aged children comparing group problem-solving outcomes to individual problem-solving outcomes found that group work leads to better problem-solving and learning outcomes (Barron, 2000; Johnson & Johnson, 1991; Stevens & Slavin, 1995). Kirschner et al. (2011) studied the problem of cognitive load and its capacity in the framework of individual and collective learning. The information-processing among group members - so called collective working memory effect - seems to be more efficient than the individual process of knowledge acquisition where the individual needs to cognitively invest in the associated activities. By giving groups and individuals low (i.e., low intrinsic load) and high-complexity (i.e., high intrinsic load) learning tasks from mathematics and then assessing their learning efficiency on an individual posttest, Kirschner et al. (2011) showed that group learning was superior to individual learning for high-complexity tasks, but inferior for low-complexity tasks.

Collaborative activities might enhance knowledge acquisition by many aspects; the above described model of collective working memory effect is one of it; the collective working memory effect is based on cognitive load theory, and it is the result of a trade-off between communication and coordination with the group reducing cognitive load due to sharing the overall load with other group members. The collective thinking is more than pooling

knowledge but efficient collaborative learning does not simply emerge while bringing students together, neither by only giving them a collaborative task. In this chapter we try to find out whether the game features can enhance the collaborative learning process and how. According to non-standardized class observations within our previous pilot study (design of the study described in Brom et al., 2010), students' interactions increased in multiplayer game while common game goal was present. Students were more engaged; sometimes they initiated out-of-classroom discussions about the game thematic.

The research presented here focuses on specific verbal interactions and observable social behavior supporting learning. The methods of verbal analysis and class observations in the experimental and control groups compare appearance and the quality of those interactions.

7.1 Social constructivism and learning in group

While studying collaborative learning activities, we need to take into account group dynamics, which means creating a discourse between participants and other socially constructed elements. Educational research in this framework operates with a constructivist approach. Järvelä et al. (2010) portrays motivation as a social construct, that is influenced by participants' interactions and affects, and Kirschner (2011) & Barron (2000) describe the synergic effects on cognitive functions of individuals in a group.

Social constructivism postulates that reality is created through social (inter)actions; the information from our environment is confronted with our prior knowledge and tested within the environment and with other participants in the interaction. Thus, all human knowledge (regardless of its validity or invalidity) is developed, transmitted and maintained in social situations (Berger & Luckmann, 1966). To better understand the social interaction processes and its effect on social construction of learning situations, we can apply the theory of social organization of experience (framing) from Erving Goffman (1974).

A frame in Goffman's point of view is a set of concepts and theoretical perspectives that organize experiences and guide the actions of individuals, groups, or societies. Therefore frame is a set of rules that – a participant of an interaction believes – shapes the social situation. Goffman's frame analysis tries to answer the question "*What is going on here*" that is repeatedly asked and answered within the process of a social interaction. The frame, that the participants of a social interaction create together, have a great influence on the individual experience of the situation and the outcome (knowledge, feeling, social information, etc.). A group of students immersing themselves in information resources about genetically modified food might perceive the situation differently if it is framed as a detective task for a group of scientists or as classwork for a group of students. The question "*how can a shared game goal and role-playing activities influence the learning experience?*" interlaces this chapter.

Within our research, we employed three different educational treatments – classic lecture, digital game and non-digital game – and all three groups learned the same content by different methods. But from the sociological point of view, the presence of a common game goal might change the social participants' perception of the learning situation, e.g. to play and win (game groups) in contrast to listening and learning (classic lecture group). The learning activities and in-class discussions (for experimental design see Chapter 3.2) were, in the game groups, enriched by the game's goal, i.e. through competitive and collaborative activities which the students were supposed to push through to form a specific vision of the European Union. The game (digital and non-digital) gave the participants an opportunity to role-play, to became a delegate of one the European countries, and to investigate different drafts of policy. The group comprehension of the situation might change students' involvement and learning engagement, whether comprehended as a collaborative/competitive problem-solving (the game groups) or an in-class discussion (the classic lecture group).

7.2 Method of hypothesis verification

Within our experimental research we did not use a video recording to assess verbal and non-verbal behavior. During our pilot study we learned that a video camera positioned in the classroom influences participants' behavior and they tolerate it with slight aversion. To preserve as natural an environment as possible we employed (1) audio recording equipment and (2) one human observer present in the classroom.

Audio records from in-class discussions were transcribed and analyzed by conversation analysis. This dissertation brings the results of our analysis from six groups (two experimental digital game groups, two control classic lecture groups and two control non-digital game groups), from the third discussion round in each. During the day, students went through four discussion rounds in total, and for the analysis we chose the third one because participants already well understood the process of negotiation. Firstly, the teachers' assistant presented an exemplary draft of policy (legalization of prostitution) and provoked a short discussion; later during the day, participants tried the first and, later on, the second discussion round deriving always from one participants' presentation of a draft of policy (1.30 min) and the following discussion on the topic (2 min).

The six groups were chosen based on the evaluation of experimental leaders. The participants came from different schools and each class varied in their knowledge level and the quality of their expression. For this part of our study we divided the classes based on following criterias. In the end of each educational workshop, a teacher from each group (and his assistant) wrote a subjective evaluation of the group, and in the end of all fieldwork two experimental leaders (Cyril Brom and Tereza Selmbacherová) evaluated, based on those reports, all classes on a scale of 1 – 3 (1 = the best level of knowledge in the EU thematic and expression, 3 = the worst level of knowledge in the EU thematic and expression). Thus, three different classes were included in the analysis: one class from October 29th 2012 evaluated as 3 (experimental game group A, control non-digital game group A), one class from November 20th 2012

evaluated as 2 (control classic lecture group A), and one class from February 4th 2013 evaluated as 1 (experimental game group B, control classic lecture group B, control non-digital game group B).

The in-class observations were pursued by trained observers who filled in observation protocols tracking non-verbal behavior, indicating the level of engagement in the in-class learning interaction. Data from 15 workshops were analyzed (N = 318).

7.2.1 In-class observations

The aim of the in-class observations was to evaluate engagement of the participants in the discussion activities. Engagement is an important concept in information behavior and learning that points to personal involvement in educational interaction (inter-personal, human-computer, other material, etc). Ito et al. (2010) consider peers' social interaction as more valuable resource of knowledge acquisition than classic schooling approaches, thus we focused on engagement in peer group discussion motivated by game (experimental digital game group and control non-digital game group) or frontal lecture (control classic lecture group). The engagement arises from interaction between individual and environment (Wigfield, 2000), thus we consider the three kinds of educational treatment from our experiment as the main independent variable influencing the participants' engagement.

Engagement within educational situations in the view of Frederics et al. (2004) is a multidimensional construct consisting of: behavioral, emotional and cognitive engagement. This chapter focuses only at situational behavioral engagement (level of involvement in academic social activities) while the situational cognitive engagement (readiness to master difficult skills and effort to comprehend complex ideas) was evaluated through the conversation analysis of the discussions (see Chapter 7.2.1) and the emotional engagement

(positive and negative reactions towards learning situation and its participants) through the emotional graph lines analysis (see Chapter 6.2).

Behavior engagement includes effort, concentration, attention etc. (Finn et al., 1995) and commonly is measured through teachers' written evaluation (Ladd et al., 1999; Finn et al., 1995) or various observation techniques (Stipek, 2002). We chose to evaluate situational behavioral engagement through observable non-verbal characteristics of behavior, while some current studies show connection between body postures and involvement in workload and task performance. Individuals actively involved in intellectually demanding task maintain upright or forward-leaning sitting position and contrary during common conversation they stay in more comfortable positions (Graf et a., 1995; Delleman et al., 2004). Balaban et al. (2004) focused in his research on human computer interaction while participants moved their head closer to the computer display when the task difficulty increased and they preferred to lean backward to the chair with lower intellectual demand.

The observation protocols used within our research contained three characteristics of non-verbal behavior:

1. not engaged; backward-leaning position, no eye contact with the active participant of a discussion, occupied by something else (mobile, book, talking with other participant on unrelated theme)
2. engaged; upright, actively listening, no eye contact with the active participant of a discussion
3. highly engaged; upright, forward-leaning position, eye contact with the active participant of a discussion

Observers were present in classroom for whole time of educational workshop and coded the non-verbal behavior within the discussion sessions (for the schedule and activities description see Chapters 3.2 – 3.4). Observer coded non-verbal behavior of each participant approximately each 1.5 minute, in sum six times during the discussion about one draft of policy (amount of

presented drafts of policy was mainly four but it depended on size of group). For the discussion time teacher instructed the participants to leave the computers (in the case of experimental digital game group) and to create a round shape which was, mainly in the classic lecture group, not always possible because of the classroom setting.

The hypothesis no. 4 was in the part of the non-verbal behavior specified by three detailed supporting hypothesis:

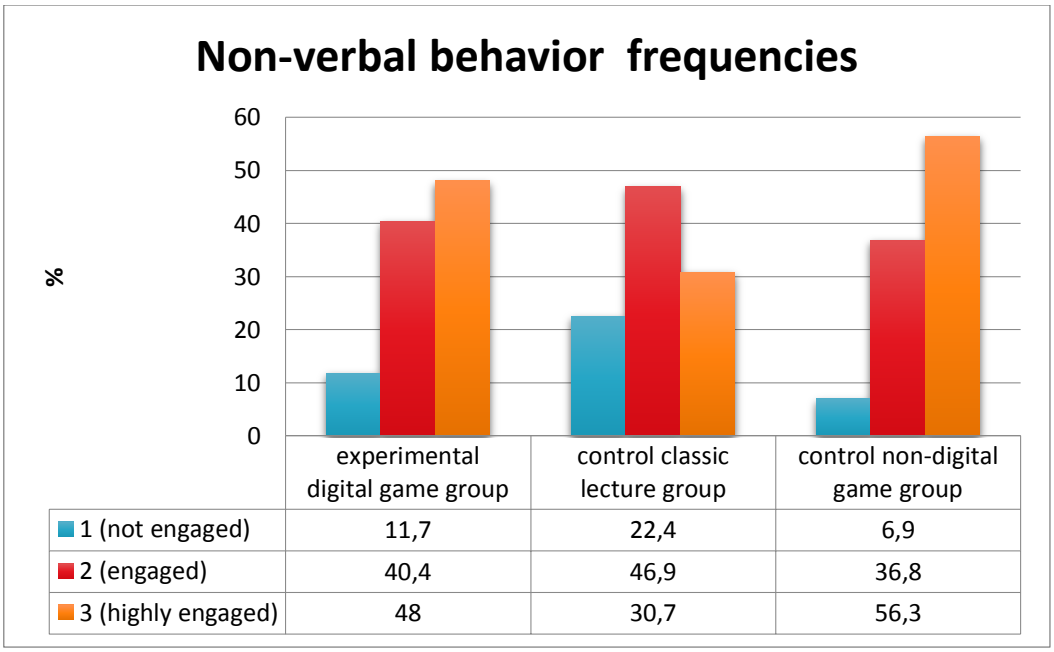
> Sub-hypothesis 4.1 *The behavior coded as "highly engaged" will be more frequent in the game groups (the experimental digital game group and the control non-digital game group) in comparison to the control classic lecture group.*
>
> Sub-hypothesis 4.2 *The average of all values measuring the engagement through non-verbal behavior will be higher in the game groups (the experimental digital game group and the control non-digital game group) in comparison to the control classic lecture group.*
>
> Sub-hypothesis 4.3 *The graph line constructed of all values measuring the engagement through non-verbal behavior will be in the case of the experimental digital game group less descenting than in both control groups (the control non-digital game group and the control classic lecture group).*

7.2.1.1 In-class observation: outcomes

Observations gathered data from 15 educational workshops, 317 participants involved in in-class group discussions were observed in total. During one workshop day the observers observed four discussions and coded the non-verbal behavior of each participant 96 times.

The frequencies of the three types of non-verbal behavior varied throughout the groups but showed similarities in the game groups (see Graph 24): the participants of the experimental game group were mostly "highly engaged" – on average 48% of time, "engaged" 40% and "not

engaged" 12% of time; the control non-digital game group showed slightly shifted frequencies towards the "highly engaged" value – on average 56% of time, "engaged" 37% and "not engaged" 7% of time. The participants of the control classic lecture group were most of the time "engaged" – on average 47% of time, "highly engaged" 31% and "not engaged" 22% of time. Those mean differencies were significant for the non-verbal behavior "highly engaged" $F(2, 317) = 17.847$, $p = .000$ and "not engaged" $F(2, 317) = 32.367$, $p = .000$ and not significant for the non-verbal behavior "engaged" $F(2, 317) = 2.664$, $p = .071$. So the sub-hypothesis 4.2 "*The behavior coded as 3 will be more frequent in the game groups (the experimental digital game group and the control non-digital game group) in comparison to the control classic lecture group"* can be accepted. The game (digital and non-digital) motivated the participants to higher engagement in discussions, specifically the presentations of the other participants. And eliminated moments in which students were not engaged in the presentations of the other participants. Those might positively influence the process of knowledge acquisition and its sustainability in long-term memory (the further research needed).

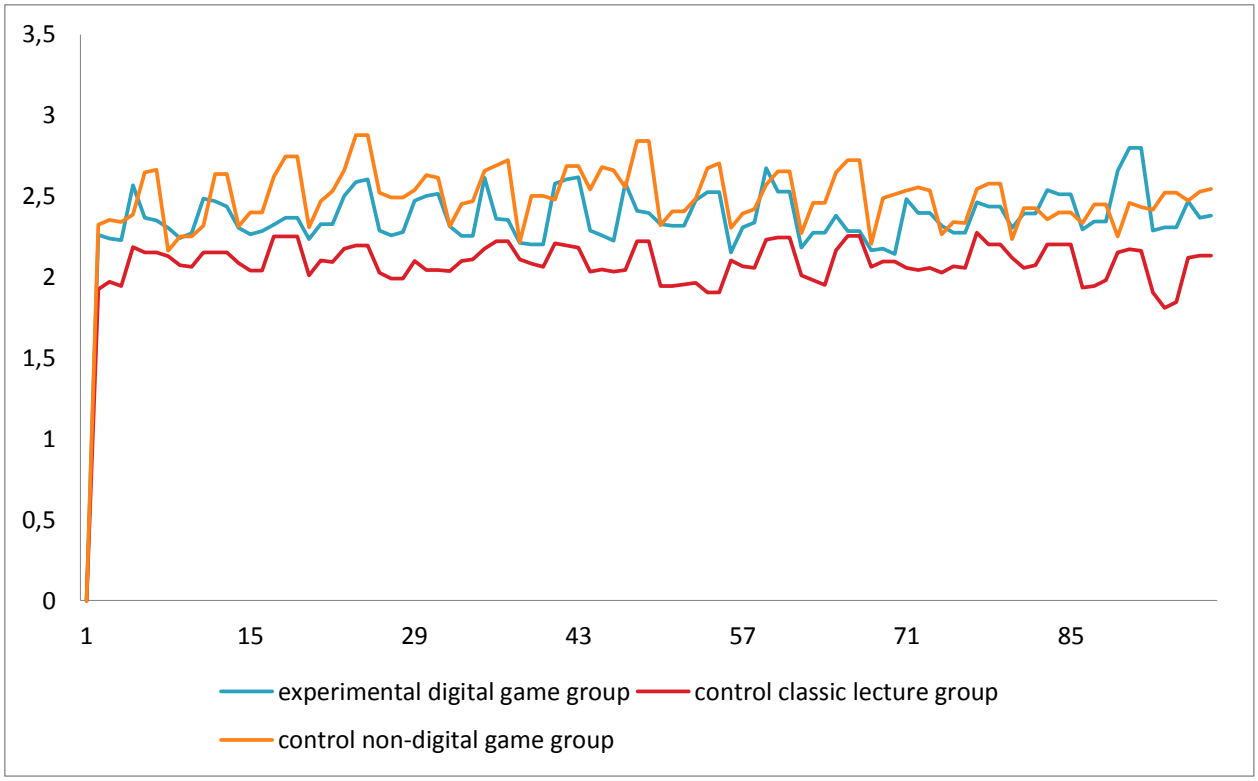


	experimental digital game group	control classic lecture group	control non-digital game group
1 (not engaged)	11,7	22,4	6,9
2 (engaged)	40,4	46,9	36,8
3 (highly engaged)	48	30,7	56,3

Graph 24: Non-verbal behavior frequencies

Similarly the average values showing the value of engagement for all four discussions from the educational workshop day showed significant differences while comparing the game groups with the control classic lecture group: $F(2, 316) = 28.025$, $p = .000$. Post hoc comparisons using the Tukey HSD test indicated that the mean scores for the experimental digital game treatment ($M = 2.32$, $SD = 0.4$) and the control non-digital game treatment ($M = 2.48$, $SD = 0.3$) were significantly different than the control classic lecture treatment ($M = 2.07$, $SD = 0.4$). The game groups did not significantly differ from each other. Thus the sub-hypothesis 4.2 "*The average of all values measuring the engagement through non-verbal behavior will be higher in the game groups (the experimental digital game group and the control non-digital game group) in comparison to the control classic lecture group*." can be accepted, the overall engagement of the discussions' participants was higher within the game-based treatment.

While exploring the sub-hypothesis 4.3 we have constructed graphs showing the development of the participants' engagement within the workshop day (see Graph 25). The graph lines did not show any descending tendencies so the sub-hypothesis 4.3 "*The graph line constructed of all values measuring the engagement through non-verbal behavior will be in the case of the experimental digital game group less descenting than in both control groups (the control non-digital game group and the control classic lecture group).*" cannot be accepted.



Graph 25: Development of non-verbal behavior throughout the workshop discussions

Nevertheless the graph line analysis showed that the non-verbal behavior of the game groups' participants oscillated rather between "engaged" (2) and "highly engaged" (3) while the non-verbal behavior of the classic lecture group' participants maintained around "engaged" (2) and was slightly descending in the last discussions. The highest values throughout whole workshop showed the participants of the control non-digital game group.

7.2.2 Audio records' analysis

To evaluate the audio records we have used methods of conversation analysis with an emphasis on Goffman's frame analysis, which can better explain the development of the social interaction towards a shared learning experience.

Conversation analysis is a qualitative method for analyzing the sequential organization and details of a conversation. It was developed in an intellectual environment shaped by Goffman's work and Garfinkel's ethnomethodology focusing on the interpretive procedures underlying social action. Like ethnomethodology, from which it developed, conversation analysis focuses on how reality is constructed, rather than on what it is (Schegloff, 2007).

The conversation analysis respects the following principles:

1. Interaction is sequentially organized, and talk can be analyzed in terms of the process of social interaction rather than in terms of motives or social status.
2. Talk, as a process of social interaction, is contextually oriented—it is both shaped by interaction and creates the social context of that interaction.
3. These processes are involved in all social interaction, so no interactive details are irrelevant to understanding it. (Gubrium & Holstein, 2000)

The frame analysis is employed to investigate the achievement of intersubjective understanding supporting efficient knowledge acquisition.

The strips of audio records containing the third discussion were transcribed below. Within the conversation analysis we focused on interactions creating discursive space pertinent for knowledge sharing and cognitive engagement. We evaluated the strips through following qualities:

(1) Size of active group (possible educational impact through active participation); measures:

- amount of students engaged in a discussion

(2) Level of cognitive engagement of participants; measures:

- comparison of amount of read text from supporting educational materials and amount of original ideas and personal speech in verbal presentation (procentual

proportion from verbal presentation, textread from the educational material is highlighted)

(3) Level of intellectual cooperation in group; measures:

- seeking interactions that develop ideas, reflect different points of view, search original solutions, explain deeper consequences of discussed theme, etc.

-code system used for the analysis bellow:


comments referring to ideological background, positive, negative aspects or consequences of the presented draft of policy


new argument or development of an argument from discussion, or new alternative proposal


personal opinion without an argument or a weak argument


the end of discussion, nobody develops it anymore

The dissertation analyses the data from limited number of discussion as described above. The data shows mainly the potentiality of such method and brings partial outcomes.

7.2.2.1 Experimental digital game groups

Experimental digital game group A (October 29th 2012, number 3; 8 participants in total)

Teacher: *Now, please delegates of Britain, Sweden, Austria and Italy to introduce their suggestions. You can stand up if you want, if not, I will not force you of course. So first, please Britain present briefly what it is that European law, why do you suggest disestablishing it, what are the main points and then briefly - in 30 seconds - summarize your main arguments. So now Great Britain has one minute to present us its proposal of disestablishing the institution of single European law.*

Presenting student: *So we, as Euro-sceptics, attempt to disestablish European law, it is a specific complex of legal standards that includes the principle of superiority of European law over state law, which we cannot tolerate. We consider it as the most serious interference into the sovereignty of the EU member states and democratic process in general. We therefore propose to abolish this principle. It would mean that the legislation would be established by local courts and then in the case of a non-standard issue the European law would be applied.*

1st draft of policy

22% from the educational material
78% of personal speech

explains theoretical background

Teacher: *Thank you, now you have a moment so please summarize the main points of your arguments.*

Presenting student: *So we actually want to disestablish it because it interferes that sovereignty of the member states and we also think that it is actually more important what the state law says than the EU law. And that the abolishment of the European law would not disturb the functioning of the EU, and that is*

3 arguments;
3 student's own

important for us.

Teacher: *Well done. Does anybody want to comment this draft of policy? Is anyone against it?*

Student 1: *We! We are against it, we do not want to disestablish that European law.*

Teacher: *And do you have an argument why?*

Student 1: *Not really, no…*

plays the game, knowing that should oppose but does not engage with the learning topic

Teacher: *And not to even France, supporter of the project Fortress Europe? Or some other country?*

Student 2: *We do not want that countries, with different cultures and different attitudes, have to respect some laws they disagree with. Only because they have to…*

new argument (not from the presentation)

uncovers negative aspect

Teacher: *Excellent, does somebody think that it is wrong? That we should be unified?*

Student 3: *I do not know, I think it would be the best to have a uniform law. Because it worked until now and nobody has complained.*

opposes with weak argument

Student 4: *I think that we agree with France.*

Student 5: *Germany as well, because if we disestablish it, everything would somehow fell apart.*

develops argument (S3)

adds possible consequences

Teacher: *Is there someone not decided yet? Who could be persuaded? I see... Spain and Austria... So now lets' move on to the proposal of Sweden: establishment of uniform social security*

discussion finished by teacher

benefits. Please Sweden, introduce us to the proposal.

Presenting student: *I want to introduce the Swedish project of common European policy for social security benefits, it means that actually in the whole Europe would exist one rule for assessing the amount of social security benefits. And it would take into account criteria such as non-discrimination of citizens, categories of beneficiaries etc. The old age pension scheme would provide all health care in the persons' state of residence. If this form would not suit to us, we could eventually follow the American system.*

2nd draft of policy

100% from the educational material

Teacher: *Good, thank you. Now in 30 seconds, please the main arguments...*

Presenting student: *Because of the extension of the EU in 2007 some member states practically blocked their social security systems and I think that people have right to the social security benefits.*

2 arguments;
1 from the educational material
1 student's own

Teacher: *Ok, so what do you think of it, Europe?*

Student 1: *I think it is a bad draft of policy, because I think that if we give social security benefits to people we will increase the European debt, so I think it is stupid.*

new argument

consequences

Student 2: *I think it should be established, because then everyone will be equal and there will not be any speculations between people, everyone will have the same…*

develops the argument from the presentation

positive aspect

Teacher: *Does anybody have another argument? Maybe Italy?*

nobody develops the discussion

Student 3: *Probably not, we disagree with it.*

plays the game, knowing that should

Student 1: *Why?*

oppose but does not engage with the learning topic

Teacher: *So who has decided to support this proposal, raise your hand... Well... I see, and who is clearly against it? Well, it means that there are many of you who have not decided yet, maybe we could convince them. So let's move to Austria and its proposal to establish a single European language.*

3rd draft of policy

Presenting student: *So everyone is certainly scared that it means only one single language for the whole Europe, but that I think will never happen. It's rather about allowing one or two languages for communication in the EU, like this it would be given... Now everybody learns English anyway, so why not to make it as a rule for all countries - to speak a single language in all EU countries. Nowadays the EU speaks English, German, French - because as I now read it is a legal language in the EU. Brussels feels now a bit like in Babylonia - when people did not understand to each other and therefore the tower Babel was destroyed.*

60% from the educational material
40% of personal speech

Teacher: *Thank you, now please a 30-second summary of the arguments.*

Presenting student: *Sure, be pro because today nobody is able to understand anywhere without an interpreter, and moreover the translation consumes so much paper, so the rainforests are really suffering.*

2 arguments;
2 from the educational material

Teacher: *Thank you, so now I am curious about a stormy reaction in Europe…*

Student 1: *France strongly opposes…*

interrupted by S2

Student 2: *For example me, I am fairly against because… maybe it is completely unrelated to politics… but the Italians would be definitely against it, for example, it may have a defense function. When people do not understand us, it has as well its advantages for our defense.*

new argument

negative aspect

Presenting student: *So the Italians could stay, just if someone came to Italy, everyone could understand.*

develops the argument from the presentation

Student 2: *Italians certainly not.*

Presenting student: *I think that even France could support it, because if they all spoke French…*

new argument

Student 3: *Yeah, but if they all spoke English…, French people are too proud to speak English.*

negative aspect

Teacher: *Does anyone have any supporting argument?*

Student 4: *I would for example support it, because if students learn more languages, they can choose a job elsewhere, so they can leave, if they do not want to stay in their state.*

new argument

positive aspect

Teacher: *Would someone convince Germany about the opposite? … And are you decided how you will vote? Raise your hands… Who is for? … I see*

nobody develops the discussion

Student 2: *So we will speak French everywhere?*

consequences (irony)

(whole class laughing)

Teacher: *Now please Italy to tell us about the declaration of European cultural heritage.*

Presenting student: *I would like to invite the EU to indorse to the Christian cultural heritage, so that Europe acknowledges the fact that Christianity has played an important role in its history and influenced the whole Europe. It's a topic that interests the whole society and the declaration was supposed to be signed within a signature of the Treaty of Lisbon. It did not happen because there were some states that had a problem with it, but I think that the declaration is quite important. By this step we would thus acknowledge Christianity was important.*

4th draft of policy

100% from the educational material

Teacher: *So please, summarize the main arguments.*

Presenting student: *Well, that Christianity influenced the whole culture, so I think it's good to support it.*

1 arguments;
1 student's own

Teacher: *Well, thank you, I wonder if anyone is against the Italian proposal...*

Student 1: *So we acknowledge something that happened thousands of years ago, something the young people have no idea about, but it does not change anything. The people will not begin to believe something that we have no tangible proof of. We can acknowledge it, but I think it's useless, we have surely more important things to decide about, the things that can affect us in the future.*

new argument

negative aspect

Presenting student: *We will more likely show an opposition to Islam, it would have rather this effect.*

new arguent

consequences

Student 1: *But anyway it will not change the percentage of believers in the country, for example the Czech Republic is the*

developing own argument

most atheistic country.

Presenting student: *Mhmmm… but the Czech Republic supports the declaration of European cultural heritage*

corrects the argument of S1 (new argument)

Student 1: *Well, but it does not do anything for the future, it will not help us to develop.*

consequences

Teacher: *Anyone else? Italy? Does somebody have a similar agenda? ... Anybody decided? Who would vote for? ... Who would vote against? And ... is anyone undecided? And now ... the backstage negotiations.*

nobody develops the discussion

Experimental digital game group B (February 4th 2013, number 1; 8 participants in total)

Teacher: *I would like to begin with the presentation of Spain, which wants to disestablish import barriers. Spain, space is yours.*

Presenting student: *Import barriers actually prevent us from buying cheap goods. In fact it would not be here at all.. For normal people it would be expensive. People can only buy goods coming from Europe. So other countries, for example the developing countries cannot export their agricultural products, which is in fact their only chance to improve their position. So it's a form of discrimination. So we should disestablish it. Actually it means preferring domestic producers in international competition…*

1st draft of policy

90% from the educational material
10% of personal speech

Teacher: *I interrupt you here, now it is time for your arguments.*

Presenting student: *I would like to disestablish it because it inhibits the production of foreign countries, developing countries*

3 arguments;
2 from the educational material
1 students' own

and that it actually supports an expensive production of European producers and developed states, it is actually unbalanced for citizens.

Teacher: *Well done, I thank the ambassador of Spain, is there any state willing to abolish import barriers? Yes… France, space is yours.*

Student 1: *Well, I think it is better to support the EU producers, it will support their development. Why to support foreign countries?*

develops the argument from the presentation (opposes)

Teacher: *Thank you, Spain wants to react?*

Presenting student: *Well, actually, it's discrimination… And in general we – as the EU - should support other countries and especially allow poor people to buy some products.*

repeats the arguments from the presentation

Teacher: *Does anybody have any comment?*

Student 2: *I would like to support Sue…*

(whole class laughing)

Teacher: *Does anyone else would like to express a sympathy? …So, anyone not decided yet? Austria, the Netherlands and Italy. Therefore I fluently move to the next agenda, the Netherlands who wants to disestablish the aid for sole traders in the EU. So can you tell us more?*

nobody develops the discussion

Presenting student: *Well, so… sole traders are self-employed and small organizations with volume of sale less than 50 million EUR. Actually European market does not offer the possibility to provide*

2nd draft of policy

100% from the educational material

services anywhere in Europe. We should not support small businesses and entrepreneurs, as this kind of business is quite risky. The smaller businesses are economically inefficient and they are unable to compete with large corporations.

Teacher: *Thank you, now please your arguments…*

Presenting student: *Because it's our money. Every citizen actually supports those businesses that are risky and might bankrupt, so we should rather encourage larger businesses.*

3 arguments;
2 from the educational material
1 personal

Teacher: *I thank the Netherlands, is there a state which is against? Yes, Sweden …*

Student 1: *I think the larger companies are also risky, but its consequence is that they often deliver low-quality goods, which the smaller businesses would not beard.*

new argument

consequences

negative aspect

Teacher: *Thank you, do you want to react?* (the Netherlands delegate)

Student 1: *Probably not*

Teacher: *Is there anyone who would like to comment? Who Is decided... So, basically, only the two main actors. Now, the Sweden agenda, which seeks to abolish the common European budget.*

nobody develops the discussion

Presenting student: *Thus this does not mean a complete abolishing, but we are concerned about smaller states, it affects the sovereignty of all countries, mostly it touches the richest countries, which contributes by the biggest amount of money, such as Germany, UK. The greater the state, the more money it pays. In*

3rd draft of policy

100% of personal speech

addition, there are agricultural embargos, like Cyprus, which seems to me somehow...

Teacher: *The arguments?*

Presenting student: *Everybody should have the same conditions. If each country will stand on its feet, it supports the economy of those states.*

2 arguments;
2 student's own

Teacher: *Well, thank Sweden, is there a state which is against?*

Student 1: *I am against, and btw. I did not much understand the Swedes*

(whole class laughing)

...what do they want to sell, but actually it should stay as it is, because the larger states need more money... but still everyone gets some budget.

develops the argument from the presentation (tries to clarify)

Presenting student: *But if you have more money, you are paying more*

develops the argument from the presentation (explaining)

Student 1: *Oh, yeah, yeah*

(whole class laughing)

Student 1: *Well, uh*

Teacher: *If you have questions, you can ask of course... So is there anyone else who would like to clarify something, argue... So... who is not decided yet? Yes, four, five... thank you. A final draft of policy, Germany, which is trying to establish European military. What is it about?*

nobody develops the discussion

Presenting student: *This is the project of a common European military, the unite military for the EU. We already discuss about it since the 2nd World War. Until 2000 we have established 18 military teams of Rapid action… when needed, 500 thousands men are always ready. I would like to establish this, people are against it because they are not able to study it more, it's mostly politics... I think if we had an army, we have a strong voice on international level ... and we'd be ... just great!*

4th draft of policy

75% from the educational material
25% of personal speech

1 argument;
1 student's own

Teacher: *So, is there anyone who would like to have European military?*

Student 1: *I am definitely against it! I think that most EU countries are in NATO and I think that we don't need to be scared that we would stay alone, I find it unnecessary. Moreover the EU would be stronger above us. It does not mean that we'd be great, but that the EU would be a great, with greater power above us.*

new argument
adds an aspect
new argument
consequences

Teacher: *Germany do you want to respond?*

Presenting student: *Yes! I do not think so. It is about to make everyone feel safe, not that the EU has power over everything, but we as the EU and each small member state, will be able to say: 'I feel safe'. We should have a good army.*

new argument
explains positive aspect

Student 1: *But it's the problem of the small member states…*

opposes (develops the previous argument)

Teacher: *I give the word to Sweden…*

Student 2: *Actually, why not to promote the UN, it's already here,*

gives new alternative

if we support it more, we do not need such a military, we do not spend money, and rather take advantage of what already exists.

Teacher: *Would you like to respond?*

Presenting student: *The… ! No … !*

Teacher: *Is there anyone else who would like to comment?*

Student 2: *I think that countries which are not in NATO, they need the protection.* — new argument

Teacher: *Thank you France. Let me ask you, who is not decided yet about votes? Yes, Austria again.* — teacher finishes the discussion

(whole class laughing)

7.2.2.2 Control classic lecture groups

Control classic lecture group A (November 20th 2012, number 2; 7 participants in total)

Teacher: *Let's start with number 16...*

Presenting student: *Jesus…*

Teacher: *…and the integration of minorities.*

Presenting student: (silent, shy)

Student 1: *So tell only the arguments*

Student 2: *Try without the time, just…*

Presenting student: *It's about, that they should assimilate themselves - to the majority, and the arguments... They live here, they moved here voluntarily, so they should assimilate themselves too. This is perhaps the single argument, mostly presented. But*

1st draft of policy

100% of personal speech

1 argument;
1 student's own

people are afraid that they will lose their culture and that they become the minority.

Teacher: *Thank you very much, this is really a sensitive issue, some other opinions?*

Student 1: *On the one hand it is necessary to say that they have moved, so they should follow the rules of the country, but on the other hand those people cannot afford to move anywhere, they have no money and it would be highly unethical to let them go to worse conditions.*

new argument

negative aspect

Teacher: *Thank you very much. Does anyone else want to express an opinion?*

Student 2: *I disagree with that, that our Czech heritage… I do not know, somebody who is not from here can live here, why not. They do not have to adopt everything from here.*

personal opinion without argument

Student 3: *In democracy there is the principle: 'what is not forbidden is accepted'. So why we don't have only simple general laws, that everyone will have to respect. In general I am for the cultural expression... the more opinions, the better democracy... Therefore when a Hindu comes here, in terms of culture and opinions, it improves our system.*

gives new alternative (weak without any argument)

new argument

Student 1: *Yes but now you've got a problem of positive racism.*

negative aspect

Teacher: *So, does anyone who has not talked yet an opinion?*

Student 4: *I think they are a minority and they should assimilate if they are here.*

personal opinion without argument

Teacher: *Well, we have heard the counterparty and now we have to go on. Number 13 and the draft of policy for disestablishing import barriers.*

teacher finishes the discussion

Presenting student: *Ok, I am supposed to say something about the import barriers… it is a kind of support of European economies against non-EU countries. It should ensure that the market is not flooded with cheap goods and agriculture products, which could compete with the European ones. Overall Europe acts against the foreign market. None member state does decide with whom to do a business, actually only the EU makes the decisions. And it should support the domestic production and agriculture in general. Therefore those agricultural benefits…, that should...*

2nd draft of policy

75% from the educational material
25% of personal speech

Teacher: *I am sorry your time is up, now it is the time to present the arguments for the disestablishment.*

Presenting student: *To support the disestablishment, there would be much smaller choice of products, we would have only products from the EU, which is only a part. We would lack the goods from the rest of the world, or if not, it would be more expensive.*

3 arguments;
3 from the educational material

Teacher: *So*

Student 1: *The possible argument could be that it threatens the economy. With the minimum wage here, we'll sell here the products of the country exploiting its employees so the price will be low… and we - with our minimum wage - will not have any opportunity to produce the product that cheaply. So the number of*

negative aspect

new argument

things on the market would reduce, but in reality the products would be only produced elsewhere.

consequences

Student 2: *I wanted to say that we should force China to improve the conditions of work there. Those products are cheaper due to lower wages and worse conditions. So if it compensates… it would solve the problem.*

gives new alternative (weak without any argument)

Student 3: *Mhmm but you cannot do it, you know…*

Presenting student: *So by this you more or less fight those conditions*

develops the argument from the presentation

consequences

Student 2: *Well, actually, yeah*

Presenting student: *Because if you don't make business with them because of those conditions, so just…*

Student 4: *I think it's irrelevant to discuss it. When someone goes to a shop in Prague and buys apples from Spain, it's irrelevant to block some other states from elsewhere… If apples that we can grow here are imported from Spain. It's more about the people that what can be Czech, we buy Czech, but the things we cannot grow here, we buy elsewhere.*

personal opinion without argument

Teacher: *So anyone else has an opinion? No, so thank you. And now number 7 and disestablishment of the regional cohesion policy.*

nobody develops the discussion

Presenting student: *So the regional cohesion policy is quite a simple thing, it is trying to help the weaker members of the EU and compensate the economic force of all members. For example,*

3rd draft of policy

36% from the educational material
64% of personal speech

Greece, you know... In the beginning there were six members and then they accepted some weaker countries, so they had to do something about it. This is that concept of a multi-speed Union, one third of the entire EU budget is spent on this. And I am supposed argue against it. Argument no. 1 is Greece; if we receive such countries it will drown the EU, it weakens the growth of stronger states, they will not be able to grow. The EU spends one third of the budget. And finally it does not motivate the weaker countries...

3 arguments;
2 from the educational material
1 student's own

Teacher: *I am sorry, your time's up. What do you think?*

Student 1: *In principle I agree, it hinders the developed countries, but on the other hand, if the large countries go into such association they should count on it.*

personal opinion without argument

Student 2: *On the other hand, the large states can economically exploit the weaker ones, maybe they do not care about their economy.*

personal opinion without argument

Presenting student: *Yeah, but they go into the association with those countries, even with those weaker and it's still better for them.*

develops the argument from the presentation (weak argumentation)

Student 2: *Maybe better would be whether those states send money or invest in something... for the future development of the country. Like for example In Greece, you invest in olives production, I don't know maybe it is economically stupid, but as example... It can develop Greece and after they can export the olives throughout Europe. But if they just send money, it gets lost.*

gives new alternative

new argument

Teacher: *Well done, interesting. Somebody else? So now, I will ask*

nobody develops the discussion

for another topic, the establishment of environmental taxes.

Presenting student: *Environmental tax is a tax that theoretically should not change the overall taxation. Where we add we take somewhere else and the basic idea is that we should reduce the tax for work and to increase the tax that energy and material. It should motivate the companies to make products more "heavy" on work "light" on materials. Such tax was introduced January 1, 2008 in the Czech Republic, it is...*

4th draft of policy

100% from the educational material

Teacher: *Your time is up, now I ask you about the various arguments for the introduction of this tax.*

Presenting student: *It's greener, partially it leads to a technological development. We need to develop better technologies that will not destroy the planet.*

2 arguments;
2 from the educational material

Teacher: *What do you think about the issue of environmental taxes?*

Student 1: *If it worked as you explained it's a nice idea…*

Presenting student: *That's what it is, but it is not fully respected, those strong industrial companies that coal mine… they do not like it. They don't need any changes.*

develops the argument from the presentation

Student 2: *That's it, after it is much more expensive*

consequences

Presenting student: *But this motivates them to invest into that expensive technologies*

develops the argument from the presentation

consequences

Student 1: *Well yeah, but that means they will use the expensive technologies and they will suffer, or they will use the old technology and they will suffer even more because they will pay the tax.*

develops the argument from the presentation

consequences

Presenting student: *But now with that old technology you don't suffer at all.*

explains negative aspect

Student 1: *Well, yeah, but if they use the new technologies, the price will horribly raise or they will suffer.*

clarifies his previous statement

Presenting student: *Well, the expensive part of technologies is the research, and that would be much less taxed.*

new argument

Student 1: *Well yeah, but you have to do the research.*

negative aspect

Teacher: *Well, thank you, we have now two clearly defined views.*

teacher finishes the discussion

Control classic lecture group B (February 4th 2013, number 1; 7 participants in total)

Teacher: *We start with a registered partnership, please no. 10.*

Presenting student: *So the registered partnership is the institution of relationship for two same-sex partners. For the first time it was established in Denmark, now it exists in countries like Belgium, France, Germany, Portugal, the Czech Republic and others. It is considered as a lower form of marriage, for example in France the pact of solidarity. It offers for example the opportunity to inform the partner about a health condition in hospital or to*

1st draft of policy

100% from the educational material

inherit.

Teacher: *Now please the main arguments.*

Presenting student: *Well, first of all it supports dignity of those couples, it will be formally easier for them, as the heritage, information in hospitals and adoption of children, or adoption of partner's children.*

2 arguments;
1 from the educational material
1 student's own

Teacher: *Thank you, now I want to ask about your opinion about registered partnership for all the EU member states.*

Student 1: *Yes*

Teacher: *Do you have any arguments?*

personal opinion without argument

Student 1: *We should have the same rights.*

develops the argument from the presentation

Student 2: *I do not think so, each state is completely different, for example Poland, there is a lot of Christians, it would probably not pass…*

negative aspect

Student 1: *Well, some other opinions?*

Student 3: *We should even have an institution equal to marriage - all states in the EU should be secular, religion should not interfere the government. Like this we do not accept the Charter of human rights and freedoms, on which our culture is based.*

new argument

new argument

Teacher: *Thank you for your opinion, anyone else?*

Student 4: *We cannot put it on the same level as marriage, because its main purpose is procreation, which in the case of gays and lesbians is out of the question, adoption is not equal to it.*

new argument

Student 2: *But like this you restrain their fundamental rights, we should support this by additional research.*

repeats the previous argument

Teacher: *Thank you. Anyone else? So let's move now to the question of minimum wage.*

nobody develops the discussion

Presenting student: *So I have a plan of establishing a minimum wage for all European member states. Nowadays about minimum wage decides the government of each member state, and the minimum wage exists in 21 states out of 27 member states… and there are big differences between them. For example in Luxembourg there is the highest minimum wage form the whole EU and it is 10 times higher than in Romania. Nowadays it is discussed in the EU and probably it will not be implemented.*

2nd draft of policy

95% from the educational material
5% of personal speech

Teacher: *And your main arguments?*

Presenting student: *The main arguments call for improving the working position, more efficient movement of people in the EU, it is the element for reducing unemployment so the work will be more advantageous than to ask for social benefits.*

3 arguments;
3 from the educational material

Teacher: *Well done, what is your opinion on the minimum wage?*

Student 1: *I am for example against it, because if it should be completely balanced in Romania and in Luxembourg, it would completely subvert state.*

new argument

conseqences

Student 2: *Maybe it should be done gradually in the whole EU, it is crucial for the European integration and it balances economic differences, but it should not be too radical.*

gives new alternative

Teacher: *Anyone else want to add any opinion? Ok, so let's get to the missile defense complex, number 11.*

nobody develops the discussion

Presenting student: *The EU is planning development of missile shield. There are two projects, the first is the project of the U.S. including radar in the Czech Republic and missile base in Poland, that project was paused in 2009 by U.S. Then there is the NATO project including the active defense of the battlefield or NATO member states, but this is now delayed due to the dispute between Cyprus and Turkey. There is the idea to merger those two projects or to create our own missile shield for the EU.*

3rd draft of policy

87% from the educational material
13% of personal speech

Teacher: *Please the arguments.*

Presenting student: *If we had the EU shield, it would bring protection for all member countries, international prestige and a stronger position, as well the EU would be leader in the technology.*

3 arguments;
3 from the educational material

Teacher: *Thank you, please what are your opinions on the missile shield... do you feel threatened?*

Student 1: *The shield is not an active attack, we will have missiles to defend ourselves, we should be ready.*

develops the argument from the presentation

Teacher: *When there was the discussion about the U.S. radar, you were all against it?*

Student 2: *I think there should be some active protection. If we get rid of all weapons does not mean that nobody will attack us.*

new argument

Teacher: *Does anyone else would like to share an opinion? So let's get to the smoking ban.*

nobody develops the discussion

Presenting student: *Not the smoking ban completely, but at all public places. In 1989 the European Council declared that all member states should make legislative changes to prevent dissemination of smoking. Today, smoking is prohibited in places like hospitals, theaters, schools, public transport, but then there are other public places such as pubs, bars and restaurants and it is different in each member state. For example in Ireland and the UK is the smoking forbidden at all places.*

4th draft of policy

100% from the educational material

Teacher: *Please, now your arguments.*

Presenting student: *Well, the arguments for those who are opposed, those arguing that from smoking we have so much taxes thus we are becoming richer… it is associated with cancer which is expensive to cure, so those finances cancels each other.*

2 arguments;
2 from the educational material

Teacher: *Thank you, please other opinions…*

Student 1: *I think that in restaurants, the decision should not be done by the EU, but by the owner of the restaurant. In the Czech Republic there are a lot of smokers in the pubs, so…*

weak argument

Presenting student: *I think that it should be determined if the place is for to have a meal or to have a beer and smoke… there nobody minds it. If someone smokes beside and I want to eat, I do not really enjoy my meal.*

gives new alternative

Student 2: *I would support it, but I would limit the smoking ban on specified public places - such as restaurants, there I agree completely. At the bus stops there are some pros and cons.*

personal opinion without argument

Student 3: *So ok when somebody smokes a cigarette at the bus stop, where other people are waiting for the bus, ok… but if he smokes in the park, there I find it overdone.*

an out of context comment

Student 4: *He can smoke on his balcony.*

Teacher: *So thank you for the discussion.*

teacher finishes the discussion

7.2.2.3 Control non-digital game group

Control non-digital game group A (October 29th 2012, number 3; 6 participants in total)

Teacher: *Well, the customs union, Spain please, you can start…*

1st draft of policy

72% from the educational material
28% of personal speech

Presenting student: *So the customs union is the base building block in the free market and the member states' services. Custom duties are abolished between all member states, there is established a uniform customs tariff. They can export and import as many goods as needed. Can I justify it now?*

Teacher: *Yes, please*

3 arguments;
1 from the educational material
2 student's own

Presenting student: *We want to disestablish the customs union, because the project of open Europe supports the permeability of borders for all goods. And I think there is no reason if for example France imports from UK, why they do not pay customs duty when Spain exporting to Africa need to pay so. Although it represents some finances for the EU cash desk, but it is an insignificant item.*

Teacher: *Is there anyone who would like to argument? Yes, France, the floor is yours…*

Student 1: *Well, first of all it's a thing that has been working for over 50 years and was quite efficient. Although there is not a large income for the EU cash desk, but it's still something. Just I am not sure if I have understood correctly… but when I export from France to UK I do no pay anything. That's it. It unites the whole EU and it helps better cooperation and prosperity of the EU as a whole.*

new argument

new argument

Teacher: *Thank you, Spain*

Presenting student: *Well, certainly, you do not pay anything but tell me why you should pay when you export to Africa, it does not make sense.*

negative aspect

Teacher: *Would you like to respond?*

Student 1: *But I pay it to Africa, it has nothing to do with that*

explains and clarifies

Presenting student: *Well, yeah*

Student 1: *It makes it advantageous for the EU countries, that between each other they do not have to pay the duty.*

develops the argument from the presentation

positive/negative aspect

Teacher: *Ok, Great Britain*

Student 2: *You said that it is negligible share into the EU cash desk, do you know how much is it exactly?*

develops the argument from the presentation

Presenting student: *No*

Student 2: *Thank you*

Teacher: *So, the delegates can ask if they want*

Student 2: (muttering) *No money is negligible*

Teacher: *Are there states that do not know how they will vote? Yes, thank you, there is room for negotiations. In addition, we have a proposal to introduce a smoking ban in Austria. You have the floor.*

teacher finishes the discussion

Presenting student: *Well, the smoking ban in indoor areas of public officials is a problem, that the EU pays great attention to. They are trying to push through the complete smoking ban in all public areas, such as restaurants, bars, workplaces, transport, etc. The first country that agreed on the smoking ban in indoor spaces was Ireland in 2007, later on UK joined and Bulgaria, Greece, Spain, Hungary, most of the Baltic countries. Well, that's all. So, I would support it, because 25 % of deaths caused by cancer and 12 % of deaths overally is caused by smoking. Those are pretty terrible numbers. Also the expensive treatment... The restaurants, I understand that a smoker wants to have a cigarette after a good lunch, but there should be some respect between us...*

2nd draft of policy

90% from the educational material
10% of personal speech

3 arguments;
2 from the educational material
1 student's own

Teacher: *Thank you. It was a proposal of Austria, anybody wants to react? Great Britain...*

Student 1: *We have quite huge income from tobacco products. People smoke voluntarily, if we forbid smoking in public places, it does not mean they will stop smoking. Afterwards it does not make sense to talk about the treatment, it will exist always.*

develops the argument from the presentation

consequences

Teacher: *Ok, France*

Student 2: (overacting) *I would like to support Austria and I would like to say that by smoking we endanger not only ourselves, smoking can also affect other person! Do you understand that you endanger yourself? And not only yourself, your future!*

new argument

consequences

(whole class laughing)

Student 3: *So, I wanted to react, that yes –we smoke voluntarily. But there are also passive smokers. Me personally I do not smoke and if I sit in a restaurant with three smokers, who smoke over my plate and my face, they force me to inhale a toxic. I am involuntarily forced to do what I did not choose. There are not just the active smokers but also the passive smokers. Everyone is complaining about the 12-year-old children that walk the streets smoking… and why… because they see the adults do it, they do not smoke voluntarily. To some extent yes, but unfortunately it is a pose, it is involuntary, and if we want to get rid of it, we must be a good example for the next generation. The approval of this program is a certain alternative.*

new argument

negative aspect

negative aspect

new argument

consequence

Student 1: *Sure, but the kids - it has nothing to do with the smoking ban in public places. That does not forbid smoking completely, that's bullshit. The only profit of it will be that people will say... the passive smokers will say... 'yeah, it's better here' And the smokers will have bad lungs anyway and the youngsters will find their way if they want. That kid does not say, ok thats my role model, so I will smoke. They smoke because their parents smoke. At home people will continue to smoke anyway.*

develops own previous argument

Teacher: *Sweden*

Student 4: *I think it's all about education, it is difficult to raise a child, if he sees it at home. The child will find the way when he sees it at home.*

new argument

Teacher: *France*

Student 2: *We are not educated only by parents but everything, the people on the streets. We have to say that smoking is now a trend, but we can change it. We are generally benevolent when it comes to smoking. We can now avoid future smokers, to make them stop to hurt themselves.*

develops the argument of S4

consequences

Teacher: *The time is almost over, Austria*

Presenting student: *I would like to react. The education, I completely agree with the delegate of France, that not only parents are our main example, but also schools, media, and everything we see around us. This is A, but B… our generation will not get rid of smoking, but if you we want to help the future generations, we need to introduce such changes. And if despite all this someone chooses to smoke, they can smoke at home, not necessarily in a restaurant, it would be good to change this trend, turn it all around.*

develops the argument of S4

Teacher: *Thank you, the last argument, delegate of Great Britain*

Student 5: *Tobacco smoking is a pleasure, enjoyment. You cannot forbid a pleasure, if for somebody it is a pleasure to wear a sweater made of cotton and it is white… You will not forbid someone to wear a sweater or smoking. Someone has the pleasure of it. Because I do not like it, I can not forbid it.*

weak new argument

Presenting student: *Please, please – I want to react!*

students actively ask to continue in discussion

Teacher: *Our time is over, we have the final proposal. Sweden who wants to reduce emission. Sweden, you have the floor.*

teacher finishes the discussion

Presenting student: *From what I could read about the theme of emissions reduction, there are plenty of rules and there is also the international Kyoto Protocol that will come to its end soon. We have approved a commitment to reduce emissions till 2020 by at least 20 %, which is unrealistic. We are dependent on industrial production and there we have a lot of employees. It would increase unemployment, if these emissions should be reduced.*

3rd draft of policy

42% from the educational material
58% of personal speech

Teacher: *You have 30 seconds for your arguments*

Presenting student: *I would cancel the commitment of emissions reductions due to the unemployment. Till the time it would be solved we could obtain new funds to reduce emissions, I would rather support organic farms till the time we find another direction.*

2 arguments;
2 student's own

Teacher: *Thank you, it was the proposal of Sweden, is there a delegate, who is against? Now there is the space for others who would like to participate in the discussion. So..., UK*

Student 1: *I totally agree with Sweden, the Kyoto Protocol will be canceled and they are trying to replace it by something else but nothing works. All private business companies would lose competitiveness. To me it sounds utopian, that we would live in such clean environment, so far we do not have the technology for it.*

develops the argument from the presentation

consequences

negative aspect

Teacher: *Thank you, France…*

Student 2: (overacting) *I would like to warmly support in Sweden, Sweden is doing what is good for our environments, for our health.... This is an ideal condition for life in this environment…*

personal opinion without any argument

(whole class laughing)

(overacting) *Furthermore, I like the proposal of tax relief for organic farms, it is brilliantly designed and it is a nice intermediate step before we move on... clean healthy, protecting the citizens and production*

develops the argument from the presentation

positive aspect

Teacher: *Thank you.... (laughing) Is there anyone else who would like to join the discussion? So I will close the discussion. Now you have five minutes for negotiations.*

nobody develops the discussion

Control non-digital game group B (February 4th 2013, number 1; 6 participants in total)

Teacher: *Now, I ask the representative of Austria, your presentation, shall we?*

Presenting student: *I would like to establish a smoking ban in all public places inside, because it generally worsens the health of all. 25 % of lung cancer deaths are caused by smoking. Basically, I think that we should successfully defend the health of smokers and non-smokers. It encourages smokers to quit smoking.*

1st draft of policy

40% from the educational material
60% of personal speech

Teacher: *Now your arguments…*

Presenting student: *I think it should be introduced mainly because smoking causes health problems for many people, it has*

2 arguments;
1 from the educational material
1 student's own

also a lot of support, why 77 % of people go to smoke-free restaurants... and that's what is it about.

Teacher: *Thank you, what do you think, the rest of you?*

Student 1: *I have a question, whether the smoking ban includes also a ban on the sale of tobacco products.*

clarifies

Presenting student: *No, it's just about smoking in public places, it will be forbidden to smoke inside.*

explains, clarifies

Student 1: *So for example on the bus stop...*

Presenting student: *There you endanger other people.*

develops the argument from the presentation

Student 1: *Oh...*

Student 2: *We strongly oppose. Because it interfers with the personal liberty*

consequences

Teacher: *Well, someone else has something to say? If not, I'll ask France…*

nobody develops the discussion

Presenting student: *So I want to establish a missile network in the EU, which would help the EU in defense and it would strengthened its' international position. It could have a negative impact on good relations with Russia. That's all I think.*

2nd draft of policy

100% from the educational material

Teacher: *Now the arguments*

Presenting student: *It would help our international position, it would increase our defense capability and... well that's about it.*

2 arguments;
2 from the educational material

Teacher: *Thank you, So what do you think about the missile shield?*

Student 1: *What is it? It's like the European military?* — clarifies

Presenting student: *No, it is a defense system, would for example Britain enjoy if some Taliban bomb fell on them?* — clarifies; consequences

(laughter, silent discussion)

Teacher: *Is there anyone else who would like to comment?*

Student 2: *Where would you like to build the missile shield?* — consequences

Student 3: *Greece , Ukraine, somewhere*

Student 4: *Somewhere in the EU*

Student 5: *Somewhere in…*

Presenting student: *No, or Britain*

Student 1: *Jesus*

Teacher: *Yes, Austria*

Student 2: *And how it would help to our international position?*

Presenting student: *Well, the defence system…* — weak argument

Teacher: *I ask the representative of Germany to present his proposal.*

Presenting student: *We have a proposal to establish a European military under a single command. Under the flag of EU the foreign missions already deployed over 100 thousand soldiers, policemen and observers, so that individual member states should commit their troops to the common European military and should contribute to the common EU foreign policy. I'm sure it will turn*

3rd draft of policy

100% from the educational material

Europe into a competitive and strong player, and...

Teacher: *Unfortunately the presentation time is up, now I ask you for the arguments.*

Presenting student: *The EU military would bring us a strong position on the international scene, and could solve some international conflicts and all member states would be able to reduce the costs of military equipment, as if it would be shared*

3 arguments;
3 from the educational material

Teacher: *I thank you very much and now, what do you think?*

Student 1: *I would support Germany, it would be a shared amount of money for whole military.*

develops the argument from the presentation

positive aspect

Student 2: *I wonder Germany, what is the demand on arsenal from each country? What military force it will have?*

consequences

Presenting student: *That's a good question, great. It depends on negotiations.*

Teacher: *Anyone have any questions or opinions about the European military?*

Student 3: *Well, if we are not a federation, why should we have something special? Now it works pretty well, each state has its own military and we can combine our forces, if needed ...only in the case of an emergency situation*

new argument

Student 4: *I call upon all states that have supported the European president to support the proposal of Germany...*

political background (connection with other draft of politicy)

Teacher: *Well done, thank you.*

teacher finishes the discussion

7.2.2.4 Audio records'analysis outcomes

Six discussions were analysed in total; those six groups of participants came from three different classes: one class evaluated as a group with the worst level of knowledge in the EU thematic and expression (experimental digital game group A, control non-digital game group A), the second class evaluated as a group with a moderate level of knowledge in the EU thematic and expression (control classic lecture group A), and the third class evaluated as a group with the best level of knowledge in the EU thematic and expression (experimental digital game group B, control classic lecture group B, control non-digital game group B).

Each discussion consisted of three or four drafts of policy that were discussed. One student always presented his/her draft of policy and afterwards there was a space for overall discussion. To evaluate the level of cognitive engagement of participants, we followed the proportion of original ideas and personal speech and text from supporting educational materials in the introductory presentations. We suppose personal speech to be more valuable for knowledge acquisition because it signifies additional mental work with received information (Braten et al., 2014). The analysis of audio records did not show big differences in this part; the experimental digital game group read the text from 68%, the control classic lecture group from 74%, and the control non-digital game group 74%.

Students were also asked to present arguments supporting or opposing the presented draft of policy. The preparation of original arguments demands some cognitive engagement and creativity. Generally, participants presented two or three arguments while the experimental digital game group presented on average: 1) the argument from the educational material, and 1.1) their own argument, similarly the control non-digital game group presented on average 1.5 argument from the educational material and 1 own argument. In contrast, the control classic lecture group presented on average 2 arguments from the educational material and 0.4 own argument.

The experimental digital game groups had eight participants (and four drafts of policy discussed), the control classic lecture group had seven participants (with four drafts of policy), and the control non-digital game group had six participants (with three drafts of policy). The participants' sampling is described in detail in Chapter 3.3. Within our analysis we searched possible educational impact through active participation and therefore evaluated the size of active groups, i.e. students who took part in the discussion about given draft of policy (see Table 3).

	exp. dig. game gr. A				exp. dig. game gr. B				contr. classic lecture gr. A				contr. classic lecture gr. B				contr. non-dig. game gr. A			contr. non-dig. game gr. B		
Draft of policy:	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	1st	2nd	3rd
All participants	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	7	6	6	6	6	6	6
Active participants	5	3	4	2	2	2	2	3	5	5	3	3	5	3	3	4	3	6	3	3	6	5

Table 3: Active participants in dicsussions

The experimental digital game group had the least number of active participants in discussions; only 36% of the group took an active part in the discussion. In the control classic lecture game group, it was 55%, and in the control non-digital game group it was 72%. As our sample is limited, additional analysis would be needed to support a sustainable hypothesis.

Because the quality of a discourse does not depend only on the number of the active participants but mostly on the quality of the discussed content, in the last part of the analysis we evaluated the intellectual work of the group. We observed new arguments that students

presented as pros or cons to a draft of policy, how they developed the arguments of the presenting participant and how they worked with the given topic in general, i.e. did they search for a socio-political or ideological background of the topic?; did they reflect positive and negative aspects of it?; or its consequences?

The discussion in all three groups was quite similar when focusing the participants' effort to point out the positive and negative aspects or consequences of the presented draft of policy (see Table 4); the experimental digital game group had 17 such comments (A group 12, B group 5), the control classic lecture group had 12 such comments (A group 10, B group 2), and the control non-digital game group had 17 such comments (A group 11, B group 6). Also, the number of new arguments or valuably developed arguments from the introductory presentation did not vary much across the three educational treatments; the experimental digital game group had 22 (A group 13, B group 9), the control classic lecture group had 20 (A group 11, B group 9), and the control non-digital game group had 18 (A group 15, B group 3). In contrast, the participants of the control classic lecture group used in their discussions weaker arguments or only personal opinions not supported by any argument (A group 8, B group 4). Those were exceptional cases in the game groups only; the experimental digital game group (A group 1, B group 1), the control non-digital game group (A group 2, B group 1).

Surprisingly, while considering the amount of arguments employed and the level of work with the topics, we observed differences within the groups that were evaluated by our team as demonstrating a good or bad level of knowledge in the EU thematic and expression (more details in Chapter 7.2). Those with the worst or moderate level of knowledge were more active in the discussion, i.e. developed more valuable arguments and analyzed the topic more deeply. The groups evaluated as knowledgeable did not develop such a good quality discourse.

	the worst knowledge and expression - exp. digital game gr. A	the best knowledge and expression - exp. digital game gr. B	moderate knowledge and expression - contr. clas. lecture gr. A	the best knowledge and expression - contr. clas. lecture gr. B	the worst knowledge and expression - contr. non-digital game gr. A	the best knowledge and expression - contr. non-digital game gr. B
explaining background, positive or negative aspects and consequences	12	5	10	2	11	6
new arguments/ developing the arguments from the presentation/ offering new alternatives	13	9	11	9	15	3
weak argument or personal opinion not supported by an argument	1	1	8	4	2	1

Table 4: Audio records' analysis overview

7.3 Conclusion

Through the audio record analysis and the in-class observations, we evaluated specific verbal interactions and observable non-verbal behavior in discussion activities which can influence engagement and thus support learning. The engagement is a multidimensional construct that is influenced by many elements of inter-personal and social character. In our research we focused on verbal and non-verbal specifics in discussion activities that point to the existence of (in Goffmanian language) a learning frame, i.e. the socially shared experience where learning is fostered.

Within the discussions embodied in three different educational treatments – classic lecture, digital game and non-digital game – we followed the process of construction a discourse space (audio record analysis) and marks of participants' engagement (in-class observations of non-verbal behavior). We supposed that the game (digital and non-digital), by giving the participants an opportunity to role-play, might influence the group comprehension of the situation and change students' involvement and learning engagement levels.

For the audio records analysis, we used transcriptions of six discussions from six different groups (two experimental digital game groups, two control classic lecture groups and two control non-digital game groups; N = 42). We chose those groups depending on the external evaluation of their level of knowledge in the EU thematic and quality of their expression; three the best, two the worst and one moderate group. The analyzed discussions consisted of three or four short debates on the topic of one draft of policy. In the beginning of each short debate one participant presented a draft of policy (1.30 min) and the discussion followed (2 min).

The in-class observations were carried out by trained observers who filled in the observation protocols tracking non-verbal behavior indicating the level of engagement in the in-class learning interaction. Data from 15 workshops were analyzed (N = 318).

In the audio record analysis, we followed several characteristics of the discussions: the amount of original speech and arguments used within the participant's presentation of a draft of policy (opposed to text read from the supporting educational material); the number of students actively participating in a discussion.

Students from all three groups used a similar amount of read text in their presentations, but the students from both game groups developed more original arguments. Generally, participants presented two or three arguments, while the experimental digital game group presented on average 1 argument from the educational material and 1.1 own argument, similarly the control non-digital game group presented on average 1.5 argument from the educational material and 1 own argument. In contrast the control classic lecture group presented on average 2 arguments from the educational material and 0.4 own argument. Thus it seems that the game-goal motivated participants to construct arguments that were clear and understandable for their peers (which might help in efficient knowledge acquisition; this hypothesis needs future research verification).

However, the experimental digital game group had the least number of discussing participants. Only 36% of the group actively took part of the discussion; in the control classic lecture game group it was 55%, and in the control non-digital game group 72%.

Also, for students who only listen to the discussion, the quality of the discourse is important. We observed new arguments that students presented as pros or cons to a draft of policy, how they developed the arguments of the presenting participant and how they worked with the given topic in general, i.e. the explication of the socio-political or ideological background of the topic, its positive and negative aspects, and its consequences. All three groups showed similar outcomes, but the participants from the control classic lecture group used more weak arguments or only personal opinions not supported by any argument – 12 cases in total (A group 8, B group 4). Those were in the game groups only exceptional; the experimental digital game group had 2 in total (A group 1, B group 1), the control non-digital game group 3 in total

(A group 2, B group 1). Thus the game-goal might motivate participants to support their hypothesis by more stable arguments to persuade their opponents.

Surprisingly, while considering the amount of arguments employed and the level of work with the topics, we observed differences within the groups that were evaluated as good or bad with respect to their level of knowledge in the EU thematic and expression. Those with the worst or moderate level were more active in the discussion, i.e. developed more valuable arguments and analyzed the topic more deeply. The groups evaluated as knowledgeable did not develop such a good quality discourse. This outcome might be influenced by the fact that those individuals did not learn much about EU affairs before so the safe discussion environment stimulated the cognitive process in this novice field (the hypothesis needs future research verification).

The in-class observations gathered data from 15 educational workshops (N = 317) and trained observers coded the participants' body posture on a scale of 1 – 3 (1 = not engaged, 3 = highly engaged).

The observation data supported our two sub-hypotheses: *"The behavior coded as 3 will be more frequent in the game groups (the experimental digital game group and the control non-digital game group) in comparison to the control classic lecture group",* and "*The average of all values measuring the engagement through non-verbal behavior will be higher in the game groups (the experimental digital game group and the control non-digital game group) in comparison to the control classic lecture group."* The game goal (digital and non-digital) motivated the participants to higher engagement in discussions, i.e. their body postures portrayed greater immersion in the presentations of the other participants. Also, the game treatment eliminated moments in which students were not engaged in those presentations. Longer and deeper engagement might positively influence the process of knowledge acquisition and the knowledge sustainability in long-term memory.

The third sub-hypothesis "*The graph line constructed of all values measuring the engagement through non-verbal behavior will be in the case of the experimental digital game group less descenting than in both control groups (the control non-digital game group and the control classic lecture group)" w*as not supported by our data. The graph lines did not show any descending tendencies. The highest values throughout whole workshop showed the participants of the control non-digital game group. Overall, the graph line analysis showed that the non-verbal behavior of the game groups' participants oscillated rather between "engaged" and "highly engaged" while the non-verbal behavior of the classic lecture group' participants maintained around "engaged" and was slightly descending in the last discussions.

8 General conclusions

The information boom of the 21st century changed the ways information is represented and reached by its final users. This dissertation reacts to the current need to find effective ways of information representation that motivate individuals to invest cognitive effort, stimulate their curiosity and lead them to effective knowledge acquisition. New media offer innovative ways to communicate multimedia content and to make it attractive. This work focuses on one of the most complex digital systems of information representation, digital games and simulations. Those dynamic systems are, in comparison to other media, able to provide some additional representational aspects: they can depict spatial information, visualize relations of different objects, differ objects and categories of objects by assigning specific audiovisual attributes to them, simulate system behavior, and control the emotions of its users.

Educational digital games and simulations offer interactive moments and experiences that build on constructivist theories of learning rather than on the transmission model of learning. In this process, the individual is an active agent who constructs mental models to understand the world around her/him. Therefore the knowledge is constructed, not received.

But as Alan Kay, handheld educational technology pioneer, pointed out it is not the technology that is important for education but the content – program and proposed activities. It is not a game itself that makes knowledge acquisition efficient. We need to identify the features and aspects that enhance those processes.

The core interest of this dissertation lies in specification of information behavior and describing some specific aspects of knowledge acquisition as motivation, engagement and creation of mental models within the use of digital simulation. It explores the process of knowledge acquisition on a wider scale than classic educational approaches. The theoretical background of research presented by the dissertation is based on information science

bordering with cognitive and educational science. Thus, pedagogic vocabulary interfuses with the concepts from information science as well as applied cognitive science.

The presented outcomes are based on long-term educational experiment involving one experimental and two control groups: (1) the experimental digital game group interacting with digital simulation *Europe 2045 Exp.*„ (2) the control non-digital game group copying the program of the experimental group but without a computer (the game-play does not take place in virtual environment), and (3) the control classic lecture group receiving the same educational content through traditional teaching methods. Different methods were used to evaluate the various aspects of the learning process on an individual, social and cognitive level.

The experimental research was part of a long-term experimental study conducted during September 2012 – May 2013 on 282 high school students (males = 126, females = 156; mean age M = 16.5, SD = 0.9), one class of younger high school students (N = 17, males = 10, females = 7; mean age M = 13, SD = 1) and two groups of college students (N = 31, males = 21, females = 10; mean age M = 23.5, SD = 0.5), in total 330 partcipants.

The experimental design was created in collaboration with Cyril Brom (Faculty of Mathematics and Physics, Charles University in Prague), Vít Šisler (Faculty of Arts, Charles University in Prague), Michaela Buchtová (Faculty of Arts, Charles University in Prague), Ivo Šebek (Faculty of Arts, Charles University in Prague) and Tereza Selmbacherová (Faculty of Arts, Charles University in Prague). This dissertation describes the outcomes of the qualitative part of the experiment, which focused on information behavior and processing, emotional experiencing, motivation, and behavior patterns. Qualitative design was mostly developed by Michaela Buchtová, i.e. the author of this dissertation.

The hypotheses for the qualitative part of the experiment, i.e. this dissertation, derrived from four crucial aspects for knowledge acquisition where cognitive, educational and information science interweave; building of mental models, individual affective experience, social processes in the learning group, and information behavior following the intervention:

1. Educational games help in efficient building of complex mental models; hypothesis no. 1 *"The concept maps will be more complex and retentive within the experimental group."*

2. Educational games foster curiosity and learning motivation, which if aroused within game-play have a stronger and longer-lasting impact on information behavior as compared to traditional lecturing;
   hypothesis no. 2 *"The experimental group will within one month following the educational intervention show a higher engagement in information behavior."*

3. Educational games arouse positive emotions linked to a particular learning theme, and those emotions stimulate situational cognitive engagement;
   hypothesis no. 3 *"The experimental group will in learning situations show more positive affects which support learning and situational cognitive engagement."*

4. Educational games and simulations played collectively in one physical space, e.g. the classroom, might stimulate the creation of a motivating and engaging 'learning frame';
   hypothesis no. 4 *"Verbal and non-verbal behavior showing positive engagement and willingness to develop learning situation will be present in (inter)actions of game participants."*

   sub-hypothesis 4.1 "*The behavior coded as 'highly engaged' will be more frequent in the game groups (the experimental digital game group and the control non-digital game group) in comparison to the control classic lecture group.*"

   sub-hypothesis 4.2 "*The average of all values measuring the engagement through non-verbal behavior will be higher in the game groups (the experimental digital game group and the control non-digital game group) in comparison to the control classic lecture group.*"

sub-hypothesis 4.3 "*The graph line constructed of all values measuring the engagement through non-verbal behavior will be in the case of the experimental digital game group less descending than in both control groups (the control non-digital game group and the control classic lecture group).*"

Within the experiment we organized 16 workshop days, always for 15-26 participants. Afterwards, we collected data from a set of written questionnaires four to five weeks later, during the "1-month delayed testing session". The qualitative methods of data collection and analysis involved some classic tools such as questionnaires, participated observations, conversation analysis of audio records; and some newly developed tools that were piloted - content analysis of concept maps for mental models evaluation and emotional graphs for a detailed analysis of learners' inner affective experience. The outcomes of this pilot study are presented in this dissertation as well.

The experimental group interacted with the educational simulation *Europe 2045 Exp. ,* which is a team-based serious game for eight players. *Europe 2045 Exp.* combines the principles of two game genres: multi-player on-line videogames and social role-playing games. Therefore the players interact with the virtual environment and partly role-play during discussion activities in the classroom. The first control group copies all the activities of the experimental group, but the technology is not present, thus the activities parallel to the PC-based ones are replaced by face-to-face interaction. In the second control group, participants receive all the information through traditional teaching methods, i.e. classic frontal lecture, simple pen-and-paper activities and discussions moderated by a teacher. The classic game features such as role-playing activities and voluntary actions such as the chance to choose the specific agenda to study, competitive and collaborative features were avoided.

We supposed that a different educational treatment will influence the process of knowledge acquisition and its outcome. Our research observed the knowledge acquisition on the individual and social level, and we evaluated its outcome through the observation of mental

model creation and information behavior. On the individual level, we analyzed the emotional affects known as positively influencing knowledge acquisition and sought for the specific features of the educational interaction that influence their appearance and sustainability. On the social level, we focused on the verbal interactions and observable non-verbal behavior in discussion activities that are able to influence engagement and thus support learning. The potential of digital games and simulations for learning was analyzed through evaluation of information behavior one month following the educational workshop, and the process of mental model creation and its development within one month.

The development of students' mental models were observed through concept maps created by participants right after the educational intervention (maps #1) and one month later (maps #2). We evaluated the concept maps using a somewhat uncommon method for this purpose - content analysis - because it allowed us to see the development of the model "architecture" and to observe the concrete changes in students' mental models. Thus, the content analysis of the concept maps served as a pilot study of possibilities and limits of such a method for mental models evaluation.

According to the analysis, the mental models created throughout the game-based educational session seem to be more sustainable; the control classic lecture group maps #2 lost in comparison with their maps #1 a larger and more significant, portion of sub-concepts than the game groups. Moreover, within maps #2 the game groups worked in higher proportion with the sub-concepts (relevant or irrelevant) created throughout the educational session, while the control classic lecture group implemented new sub-concepts, i.e. their concept maps did not show a continuous development of their mental models within the following month. Furthermore, the experimental digital game group had the biggest and significantly higher number of up-graded sub-concepts.

The number of irrelevant sub-concepts developed after the educational intervention (in maps #1) was proportionally very similar across the groups. After one month (in maps #2,) fewer

students from game groups presented mental models with mistaken concepts, while the control classic lecture group stayed on the same level (as in maps #2). The content analysis revealed that within one month more than half (54%) of the students from the experimental digital game group corrected the mistaken concepts (over 30% in the other two groups) and fewer students from both game groups developed new inaccurate concepts (around 16%, in the classic lecture group 30%).

Qualitative evaluation of the concept maps development showed a tendency of all students to forget specific factual details (dates, names and specific institutions); participants of all three educational interventions forgot within the following month half of such information.

The pilot study showed that the concept maps content analysis seems to be a helpful tool for understanding the mental model development. The preliminary outcomes open the field for future research where at least three maps should be compared (preliminary knowledge, after the educational intervention and at least one month after). Also, to get knowledgeable results, two independent correctors should evaluate those concept maps.

The key to sustainable learning is in fostering motivation for future information-seeking and learning behaviors, and in establishing a pattern of self-motivated knowledge-seeking behavior in students. Self-directed information-seeking behavior is defined as one of the crucial parts of the learning process and of mental model creation.

Within our research, we evaluated the information behavior in the area of EU affairs in three phases – in the pre-tests (before the educational intervention), post-tests (right after the educational intervention) and in the delayed post-test (1 month after).

When exploring the long-term changes in information behavior, there did not appear to be any group differences. In the 1-month delayed post-test, students from all groups reported similar tendencies in information behavior in the themes of the European Union and international politics. Even though students from all groups reported increased interest in given topics

following the educational session, their information behavior changed minimally or not at all. All the students showed similar long-term tendencies within information behavior that basically were not affected when comparing results from pre-testing with results from the 1-month delayed testing. This part of the qualitative study revealed only partial outcomes indicating a possible correlation between reported self-assurance and engagement in future information behavior. Self-assurance as a tendency for an individual to act with confidence in his own abilities in a specific theme/area may influence the frequency of future information behavior.

The long-term research revealed that emotional experience during learning may have a significant influence on knowledge acquisition outcomes and on future learning motivation. To track emotional experience during learning, we developed qualitative measurement tools, called emotional graphs, that originate in Meyer's life-chart (Meyer, 1951). Each one is a chronological graph capturing important life stages and breaks which Mayer created with an individual psychiatric patient.

Emotional graphs were designed to follow an individual learner's experience as he/she names and evaluates it; the graphs capture a respondents' mood, or more precisely, their positive and negative emotions and their development during a learning session. Students draw a curve representing their emotions/mood development, and they draw on a graph with a horizontal axis representing a value of emotion on negative-positive scale (-10 to 0 to +10) and a vertical axis capturing the learning time. They were also asked to add personal commentaries. To get additional, more standardized information about their affective experiencing, students were also supplied with small stickers of emoticons covering a 20-item scale of Positive and Negative Affect Schedule (PANAS). Therefore, the final evaluation of emotional graphs was procesed in three steps: (1) evaluation of graph lines, (2) PANAS scale in the form of emoticons and (3) content analysis of individual comments.

Evaluation of the graph lines showed many similarities between the experimental digital game group and the control non-digital game group. Both game groups evaluated the learning activities around three points more positively than the control classic lecture group, whose positive peak was represented in most cases by lunch. After the lunch pause, the curve representing emotional experiencing in the classic lecture dropped down again. In contrast, the beginning of the lunch period was also perceived positively in the game groups, but the leap was not that remarkable; additionally, the increase in those groups was sustained even through the after-lunch educational session.

The affects were evaluated through composition into lower-order PANAS scales: general positive affect, general negative affect, joviality, self-assurance, guilt, fear, hostility, attentiveness and the additional category appropriate to this research – fatigue. Between-group differences appeared in emotions important for the process of knowledge acquisition and cognitive engagement: some interesting differences appeared in joviality, self-assurance, attentiveness and fatigue.

Excitement, enthusiasm and self-assurance were reported the most frequently by both game groups. The students from both game groups described themselves as attentive, determined and/or alert within the 1st educational part; fewer students from the control classic lecture group reported likewise. Reported fatigue had a different tendency in all three groups. The experimental digital game group did report fatigue minimally within all educational activities, but students from the control non-digital game group and the control classic lecture group were tired significantly more. Fatigue was reported within the control classic lecture group more often before lunch (reporting that lunch boosted their energy for later), and within the control non-digital game group more often after lunch (reporting that it took away their energy). It seems that traditional schooling activities are tiring in general, and for the highly demanding social activities (such as live-action role-play), the schema of a full-day workshop is too long for participants to remain active and fresh. Only the experimental digital game-group kept low fatigue during all educational activities, though they reported high fatigue just

afterwards. Playful activities combined with gameplay on a PC seem to have a lowering effect on students' perceived fatigue.

The additional written comments evaluation showed that students from both game-groups added a larger amount of comments compared to other groups, which points to a slightly higher emotional richness in the learning experience. Those students also more often recalled a learning agenda connected with a specific event, which might show better retrieval cues (future research needed).

To sum up, the emotional graphs tool can bring promising data to bear on providing a deeper evaluation of educational activities. The tool allows for capturing the subjective evaluation of activities, the emotional changes and their sources. Thanks to additional written comments and the adapted PANAS scale, we are able to evaluate some important variables of cognitive engagement, such as general positive and negative affect, self-assurance, attentiveness, fatigue, etc. Furthermore, the first results indicate differences between classic lecture and game-based learning activities.

Collaborative activities might enhance knowledge acquisition by many aspects, collective working memory effect, shared motivation etc. Within our research, we evaluated specific verbal interactions and observable social behavior supporting learning. The methods of verbal analysis and class observations in the experimental and control groups compared the appearance and the quality of those interactions.

The dissertation explains the results from a conversation analysis of a limited number of discussions; three classes were involved. Participants of both game groups showed higher involvement in seeking original arguments supporting their opinions in the group discussions. While evaluating the quality of the discourse, all three groups showed similar outcomes but the participants from the control classic lecture group used more weak arguments or only personal opinions not supported by any argument. Thus, the game-goal might motivate

participants to support their hypothesis by more stable arguments to persuade their opponents.

The results from in-class observations showed that game goal (in the digital and non-digital game) motivated the participants to a higher engagement level in discussions, i.e. their body postures portrayed greater immersion in the presentations of the other participants. Also, the game treatment eliminated moments in which students were not engaged in those presentations. Longer and deeper engagement might positively influence the process of knowledge acquisition and the knowledge sustainability in long-term.

In general, our research indicated that the digital and non-digital simulation used as a learning tool may positively influence the construction and sustainability of mental models, affective and emotional perception of a learning situation, and the quality of group discourse and engagement in the group activities.

8.1 The hypotheses conclusions, short overview:

Hypothesis no. 1 *"The concept maps will be more complex and retentive within the experimental group."* Accepted: thus, it seems that games as complex systems of information representation allow for the creation of sustainable mental models that can be qualitatively developed through time. The traditional classic lecture influences the creation and conceptual change of mental models through theoretical description, explanation, questioning and discussion. Games immerse a learner directly into the problematic and let him/her test the mental models in (inter)action. This cause-and-effect system might develop more coherent and sustainable mental models than only verbal intervention.

Hypothesis no. 2 *"The experimental group will within one month following the educational intervention show a higher engagement in information behavior."* Refuted: the long-term effects on information behavior were not affirmed by this study, but some partial outcomes indicated

a possible correlation between reported self-assurance, as well as engagement in future information behavior. All the students showed similar long-term tendencies within information behavior that basically were not affected.

Hypothesis no. 3 *"The experimental group will, in learning situations, show more positive affects which support learning and situational cognitive engagement."* Accepted: the game groups reported more joviality, self-assurance and attentiveness within the educational activities. Both game group reported lower fatigue, while the control non-digital game group started to be tired in the after-lunch period; the experimental digital game group stayed fresh throughout all the learning activities. Moreover, in their individual comments, the game groups participants more often recalled a learning agenda connected with a specific event, which may signal better retrieval cues.

Hypothesis no. 4 *"Verbal and non-verbal behavior showing positive engagement and willingness to develop learning situation will be present in (inter)actions of game participants."*

> sub-hypothesis 4.1 "*The behavior coded as 'highly engaged' will be more frequent in the game groups (the experimental digital game group and the control non-digital game group) in comparison to the control classic lecture group.*" Accepted: the body postures of participants involved in game-based activities showed greater engagement in the presentations of the other participants.
>
> sub-hypothesis 4.2 "*The average of all values measuring the engagement through non-verbal behavior will be higher in the game groups (the experimental digital game group and the control non-digital game group) in comparison to the control classic lecture group.*" Accepted: the game particiants treatment avoided a high proportion of moments in which students were not engaged in the presentations of the other participants.

sub-hypothesis 4.3 "*The graph line constructed of all values measuring the engagement through non-verbal behavior will be in the case of the experimental digital game group less descenting than in both control groups (the control non-digital game group and the control classic lecture group).*" Refuted: the graph lines did not show any descending tendencies. Rather, the game groups' participants vascillated between "engaged" and "highly engaged" while the non-verbal behavior of the classic lecture group' participants maintained around "engaged".

References

ARNONE, Marilyn P., SMALL, Ruth V., CHAUNCEY, Sarah A., McKENNA, H. Patricia (2011). Curiosity, interest and engagement in technology-pervasive learning environments: a new research agenda. Education Tech Research Dev, 59, 181–198.

ADAMS, Deanne M., MAYER, Richard E., MACNAMARA, Andrew, KOENIG, Alan, WAINESS, Richard (2012). Narrative games for learning: testing the discovery and narrative hypotheses. Journal of Educational Psychology, 104 (1), 235 - 249.

BAIN, Ken (2004). What the best college teachers do. Massachusetts: Harvard University Press.

BALABAN, Carey D., COHN, Joseph, REDFERN, Mark S., PRINKEY, Jarad, STRIPLING, Roy, HOFFER, Michael (2004). Postural control as a probe for cognitive state: Exploiting human information processing. International Journal of Human-Computer Interaction, 17, 275-287.

BARRON, Brigid (2000). Problem solving in video-based microworlds: Collaborative and individual out-comes of high achieving sixth grade students. Journal of Educational Psychology, 92, 391–398.

BARRON, Brigid (2003). When smart groups fail. The Journal of the Learning Sciences, 12(3), 307–359.

BAUER, Michael, KOZUCH, Elin, GLENN, Tasha, GROF, P., GUTZMANN, C., KIERMEIER J., NEUHAUS K., RASGON, Natalie, RICKEN, Ronald, SASSE, Jan, SCHMID, Russel, WHYBROWN, Peter C. (2008). Die elektronische Erfassung des longitudinalen Verlaufs bipolarer Störungen (The electronic assessment of the longitudinal course of bipolar disorder with ChronoRecord software) Nervenheilkunde. 27,165–172.

BAUMEISTER, Roy F., CAMPBELL, Jennifer D., KRUEGER, Joachim I., VOHS, Kathleen D. (2003). Does High Self-Esteem Cause Better Performance, Interpersonal Success, Happiness, or Healthier Lifestyles? Psychological Science in the Public Interest, 4(1).

BAYRAM, Sevinc (1995). The effectiveness of concept and software mapping for representing student data and process schema in science, Thesis University of Pittsburgh.

BELKIN, Nicholas J. (1980). Anomalous states of knowledge as a basis for information retrieval. The Canadian Journal of Information Science, 5, 133-43.

BERGER, Peter L., LUCKMANN, Thomas (1966). The Social Construction of Reality: A Treatise in the Sociology of Knowledge. New York: Allen Lane.

BESTERFIELD-SACRE, Mary, GERCHAK, Jessica, LYONS, MarryRose, SHUMAN, Larry J., WOLFE, Harvey (2004). Scoring concept maps: An integrated rubric for assessing. Journal of Engineering Education, 93(2), 105–115.

BOYAN, Andy, SHERRY, John L. (2011). The Challenge in Creating Games for Education: Aligning Mental Models with Game Models Child Development Perspectives. The Society for Research in Child Development, 5 (2), 2011, 82–87.

BRATEN, Ivar, FERGUSON, Leila, STROMSO, Helge, ANMARKRUD, Oistein (2014). Students working with multiple conflicting documents on a scientific issue: Relations between epistemic cognition while reading and sourcing and argumentation in essays. British Journal of Educational Psychology, 84(1), 58-85.

BROM, Cyril, ŠISLER, Vít, SLAVÍK, Radovan (2010). Implementing digital game-based learning in schools: augmented learning environment of 'Europe 2045'. Multimedia Systems,16(1), 23-41.

BROM, Cyril, BROMOVÁ, Edita, DECHTĚRENKO, Filip, BUCHTOVÁ, Michaela, PERGEL, Martin (2014). Personalized messages in a brewery educational simulation: Is the personalization principle less robust than previously thought? Computers & Education 72, 339–366.

BROM, Cyril, BUCHTOVÁ, Michaela, ŠISLER, Vít, DECHTĚRENKO, Filip, PALME, Rupert, GLENK, Lisa M. (2014). Flow, Social–Interaction Anxiety and Salivary Cortisol Responses in Serious Games: a Quasi-Experimental Study. In the process of publishing.

BUCHTOVÁ, Michaela, BROM, Cyril, ŠISLER, Vít (2012). Educational Games and Simulations at School: The High-School Students' Experiences and Attitudes. A Qualitative Study. 7th DisCo Conference Reader: New Media and Education, Prague: Centre for Higher Education Studies.

BUCKLEY, Barbara C., BOULTER, Carolyn, J. (2000). Investigating the role of representations and expressed model in building mental models. In J. K. Gilbert & C. J. Boulter (Eds.), Developing models in science education, Netherlands: Kluwer Academic Publishers, 119-135.

CAILLOIS, Roger (1961). Man, play, and games. The Free Press, Glencoe, New York.

CAMERON, Brian, DWYER, Francis (2005). The effect of online gaming, cognition and feedback type in facilitating delayed achievement of different learning objectives. Journal of Interactive Learning Research, 16, 243–258.

CASE, Donald O. (2007). Looking for Information: A Survey of Research on Information Seeking, Needs, and Behavior. Amsterdam: Elsevier.

CEREZO, Catherine (2012). Un serious game junior, vecteur d'estime de soi et d'apprentissages pour des eleves de CM2. Revue Adolescence, 30(1), 133-143.

CHI, Michelene T. H. (1992). Conceptual change within and across ontological categories: Examples from learning and discovery in science. In R. Giere (Ed.), Cognitive models of science: Minnesota studies in the philosophy of science, 129-160.

CHI, Michelene T. H., SLOTTA, James D., DE LEEUW, Nicholas (1994). From things to processes: A theory of conceptual change for learning science concepts. Learning and Instruction, 4, 27-43.

CHIOU, Guo-Li (2009) Exploring beyond Mental Models: An Interview-based Study of Students' In-depth Understanding of Heat Conduction from A Multi-dimensional Cognitive Perspective. Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy under the Executive Committee of The Graduate School of Arts and Sciences Columbia University.

COLL, Richard K., TREAGUST, David F. (2003). Learners' mental models of metallic bonding: A cross-age study. Science Education, 87, 685-707.

CRAIG, Scotty, D., GRAESSER, Arthur, C., SULLINS, Jeremiah, GHOLSON, Barry (2004). Affect and learning: An exploratory look into the role of affect in learning with AutoTutor. Learning, Media and Technology, 29, 241– 250.

CRAIK, Kenneth (1943). The nature of explanation. Cambridge: Cambridge University Press.

CRAWFORD, Chris (1982). The Art of Computer Game Design. Vancouver: Washington State University.

CSIKSZENTMIHALYI, Mihaly (2008). Flow: The Psychology of Optimal Experience. Harper Perennial Modern Classics. ISBN 978-0061339202.

DELLEMAN, Nico J., HASLEGRAVE, Christine M., CHAFFIN, Don B. (2004). Working postures and movements: Tools for evaluation and ingeneering. Boca Raton, FL: CRC Press.

DENICOFF, Kirk D., SMITH-JACKSON, E. E., DISNEY, E. R., SUDDATH R. L., LEVERICH, Gabriele S., POST, Robert M. (1997). Preliminary evidence of the reliability and validity of the prospective life-chart methodology (LCM-p). J Psychiatr Res, 31, 593-603.

DERVIN, Brenda (1992). From the mind's eye of the user: The sense-making qualitative-quantitative methodology. In Jack D. Glazier and Ronald R. Powell (Eds.). Qualitative Research in Information Management, 68-70. Englewood, CO: Libraries Unlimited.

DICKEY, Michele D. (2011). Murder on grimm isle: the impact of game narrative design in an educational game-based learning environment. British Journal of Educational Technology, 42, 456–469.

DIJK, Teun A., KINTSCH, Walter (1983). Strategies of discourse comprehension. New York: Academic Press.

EGENFELDT-NIELSEN, Simon (2005). Beyond Edutainment: Exploring the Educational Potential of Computer Games. IT-University Copenhagen.

FINN, Jeremy D., PANNOZZO, Gina M., VOELKL, Kristin E. (1995). Disruptive and inattentive-withdrawn behavior and achievement among fourth graders. Elementary school journal, 95, 421-454.

FRANKLIN, Nancy, TVERSKY, Barbara (1990). Searching imagined environments. Journal of Experimental Psychology, 119, 63-76.

FREDERICS, Jennifer A., BLUMENFELD, Phyllis C., PARIS, Alison H. (2004). School Engagement: Potential of Concept, State of the Evidence. Review of Educational Research, 74(1), 59 - 109.

GAGNE, Robert M., MEDSKER, Karen L. (1996). The conditions of learning: Training applications. Fort Worth: Harcourt Brace College.

GLYNN, Shawn M., DUIT, R. (1995). Learning science meaningfully: Constructing conceptual models In S. M. Glynn & R. Duit (Eds.), Learning science in the school: Research reforming practice (pp. 3-33). Mahwah, NJ: Lawrence Erlbaum Associates.

GOFFMAN, Erving (1974). Frame analysis. An essay on the organization of experience. Boston: Northeastern University Press.

GRAF, Marion, GUGGENBUHL, Urs, KRUEGER, Hartmunt (1995). An assessment of seated activity and postures at five workplaces. International Journal of Industrial Ergonomics, 15, 81-90.

GRECA, Ileana M., MOREIRA, Marco A. (2000). Mental models, conceptual models, and modelling. International Journal of Science Education, 22, 1-11.

GREELISH, David (2013). An Interview with Computing Pioneer Alan Kay. TIME INTERVIEWS, 4/2/2013. [Online] http://techland.time.com/2013/04/02/an-interview-with-computing-pioneer-alan-kay/

HABGOOD, Jacob M. P., AINSWORTH, Shaaron E. (2011). Motivating children to learn effectively: Exploring the value of intrinsic integration in educational games. Journal of the Learning Sciences, 20, 169–206.

HAMMER, Jessica, BLACK, John (2009). In EDUCATIONAL TECHNOLOGY, March–April.

HARTSHORNE, Charles, WEISS, Paul (1931). Collected papers of Charles Sanders Pierce. Edited by Charles and Paul Weiss, Principles of philosophy, Cambridge Harvard University Press.

HAYS, Robert T. (2005). The Effectiveness of Instructional Games: A Literature Review and Discussion, Technical Report 2005-004, Orlando: Naval Air Warfare Center Training Systems Division.

HIDI, Suzanne, RENNINGER, Ann K. (2006). The Four-Phase Model of Interest Development. Educational Psychologist, 41 (2), 111-127.

ISEN, Alice M., SHALKER, Thomas E., CLARK, Margaret, KARP, Lynn (1978). Affect, accessibility of material in memory, and behavior: A cognitive loop? Journal of Personality and Social Psychology, 36, 1-12.

ITO, Mizuto, BAUMER, Sonja, BITTANTI, Matteo, BOYD, Danah, CODY, Rachel, HERR-STEPHENSON, Becky, HORST, Heather A., LANGE, Patricia G., MAHENDRAN, Dilan, MARTÍNEZ, Katynka Z., PASCOE, C. J., PERKEL, Dan, ROBINSON, Laura, SIMS, Christo, TRIPP, Lisa (2010). Hanging Out, Messing Around, Geeking Out. Kids Living and Learning with New Media. Cambridge, Massachusetts: The MIT Press.

JÄRVELÄ, Sanna, VOLET, Simone, JÄRVENOJA, Hanna (2010). Research on Motivation in Collaborative Learning: Moving Beyond the Cognitive–Situative Divide and Combining Individual and Social Processes. Educational Psychologist, 45(1), 15–27.

JOHNSON-LAIRD, Philip N. (1983). Mental models. Cambridge, MA: MIT Press.

JOHNSON-LAIRD, Philip N. (1986). Mental Models: Towards a Cognitive Science of Language, Inference, and Consciousness. Harvard University Press.

JOHNSON-LAIRD, Phillip (2005). The history of mental models. In The Cambridge Handbook of Thinking and Reasoning.

JOHNSON, David W., JOHNSON, Roger T. (1991). Learning together and alone: Cooperative, competitive, and individualistic learning. Englewood Cliffs: Prentice Hall.

JUUL, Jesper (2003). The Game, the Player, the World: Looking for a Heart of Gameness. In Level Up: Digital Games Research Conference Proceedings, edited by Marinka Copier and Joost Raessens, 30-45. Utrecht: Utrecht University.

HARTLEY, David (1995). Teaching and learning in an expanding higher education system. Studies in Higher Education. 20(2), 147-158.

Litman and Jimerson (2004)

KASHDAN, Todd B., YUEN, Mantak (2007). Whether highly curious students thrive academically depends on perceptions about the school learning environment: A study of Hong Kong adolescents. Motiv Emot, 31, 260–270.

KASHDAN, Todd B., ROBERTS, John E. (2004). Trait and state curiosity in the genesis of intimacy: Differentiation from related constructs. Journal of Social and Clinical Psychology, 23(6), 792-816.

KAY, Alan (1972). A Personal Computer for Children of All Ages. ACM '72 Proceedings of the ACM annual conference, 1.

KE, Fengfeng (2008). A case study of computer gaming for math: Engaged learning for gameplay? Computers and Education, 51(4).

KIRSCHNER, Femke, PAAS, Fred, KIRSCHNER, Paul A. (2011). Task complexity as a driver for collaborative learning efficiency: The collective working-memory effect. Applied Cognitive Psychology, 25.

KOH, Kyungwon, DRESANG, Eliza (2010). Modeling and assessing radical change youth information behavior in the digital age: A pilot study. Proceedings of the American Society for Information Science and Technology, 46 (1), 1–7.

KLOPFER, Eric, HAAS, Jason (2012). The More We Know. NBC News, Educational Innovation, and Learning from Failure. Massachusetts: The MIT Press.

KUHLTHAU, Carol Collier (1993). Seeking meaning: A process approach to library and information services. Norwood, NJ: Ablex Publishing.

LADD Garry W., BIRSCH, Sandra H., BUHS, Eric S. (1999). Children's social and scholastic lives in kindergarten: Related spheres of influence. Child development, 70, 1373-1400.

LAU, Shun, LIEM, Arief D., NIE, Youyan (2008). Task- and self-related pathways to deep learning: The mediating role of achievement goals, classroom attentiveness, and group participationBritish Journal of Educational Psychology, 78, 639–662.

LEVERICH, Gabriele S., POST, Robert M. (1997). The NIMH Life Chart Manual for Recurrent Affective Illness: The LCM. NIMH Monograph, Bethesda.

LITMAN, Jordan A., JIMERSON, Tiffany L. (2004). The measurement of curiosity as a feeling of deprivation. Journal of Personality Assessment, 82, 147-157.

LOEWENSTEIN, George (1994). The psychology of curiosity: A review and reinterpretation. Psychological Bulletin, 116, 75–98.

MALONE, Thomas W. (1981). Toward a Theory of Intrinsically motivationg Instruction. Cognitive Science, 4, 333-370.

MAYER, Richard E., DYCK, Jennifer, COOK, Linda K. (1984). Techniques that help readers build mental models from scientific text: Definitions pretraining and signaling. Journal of Educational Psychology, 78(6), 1089 – 1106.

MAYER, Richard E. (2001). Multimedia learning. New York: Cambridge University Press.

MAYER, Richard E., JOHNSON, Cheryl. I. (2010). Adding instructional features that promote learning in a game-like environment. Educational computing research, 42(3), 241-265.

MEYER, Adolf (1951). The Collected Papers of Adolf Meyer, vol. by EE Winters.

MINTZES, Joel J., WANDERSEE, James H., NOVAK, Joseph D. (2001). Assessing understanding in biology. Journal of Biological Education, 35(3), 118-124.

MORENO, Roxana, MAYER, Richard E. (2005). Role of guidance, reflection, and interactivity in an agent-based multimedia game. Journal of Educational Psychology, 97, 117–128.

MORENO, Roxana, MAYER, Richard E. (2007). Interactive multimodal learning environments. Educational Psychology Review, 19, 309– 326.

NERSESSIAN, Nancy J. (2002). The cognitive basis of model-based reasoning in science. In P. Carruthers, S. Stich & M. Siegal (Eds.), The Cognitive Basis of Science, 133-153. Cambridge, UK: Cambridge University Press.

NERSESSIAN, Nancy J. (2008). Mental modeling in conceptual change. In S. Vosniadou (Ed.), International handbook of research in conceptual change (pp. 391-416). New York: Routledge.

NORMAN, Donald A. (1983). Some observations on mental models. In D. Gentner & A. L. Stevens (Eds.), Mental models, 7-14. Hillsdale, NJ: Lawrence Erlbaum Associates.

NOVAK, Joseph D., GOWIN, Bob D. (1984). Learning how to learn. Cambridge, UK: Cambridge University Press.

NYMAN, Nils (2010). Information behaviour in World of Warcraft. Master thesis, Umea University: Department of sociology, Library and information science.

PAPASTERGIOUS, Marina (2009). Digital game-based learning in high school computer science education: Impact on educational effectiveness and student motivation. Computers and Education, 52(1), 1-12.

PITTS, Judy M. (1994). Personal Understandings and Mental Models of Information: a Qualitative Study of Factors Associated with the Information Seeking and Use of Adolescents. Ph.D. thesis. The Florida State University: School of Library and Information Studies.

O'BRIEN, Gordon, PERE, Thomas K. (1985). The effects of ability, self-esteem and task difficulty on performance and task satisfaction. Australian Journal of Psychology, 37(3), 309-323.

RUIZ-PRIMO, Maria A., SHAVELSON, Richard J., LI, Min, SCHULTZ, Susan E. (2001). On the validity of cognitive interpretations of scores from alternative concept-mapping techniques. Educational Assessment, 7(2), 99-141.

RYAN, Richard M., DECI, Edward L. (2000). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. Contemporary Educational Psychology, 25, 54 - 67.

PIAGET, Jean (1932). The language and thought of the child. New York: Harcourt, Brace.

POOLE, Dennis, DAVIS, Tamara (2006). Concept mapping to measure outcomes in a study abroad program. Social Work Education, 25(1), 61–77.

RASGON, Natalie, BAUER Michael, GLENN, Tasha, ELMANN Shana, WHYBROW Peter C. (2003). Menstrual cycle related mood changes in women with bipolar disorder. Bipolar Disord. 5, 48–52.

ROMÁN, Sergio, CUESTAS, Pedro J., FENOLLAR, Pedro (2008). An examination of the interrelationships between self-esteem, others' expectations, family support, learning approaches and academic achievement. Studies in Higher Education, 33(2), 127–138.

RUSSELL, James. A. (2003). Core affect and the psychological construction of emotion. Psychological Review, 110, 145– 172.

SALEN, Katie, ZIMMERMAN, Eric (2003). Rules of Play: Game Design Fundamentals. Massatchisets: MIT Press. ISBN 978-0262240451.

SALEN, Katie, TORRES, Robert, WOLOZIN, Loretta, RUFO-TEPPER, Rebecca, SHAPIRO, Arana (2011). Quest to Learn Developing the School for Digital Kids. The MIT Press Cambridge, Massachusetts, London, England.

SCHWARTZ, Daniel L., BLACK, John B. (1996). Shuttling between depictive models and abstract rules. Cognitive Science, 20(A), 457-497.

SEABI, Joseph (2011). Relating learning strategies, self-esteem, intellectual functioning with academic achievement among first-year engineering students. South African Journal of Psychology, 41(2), 239-249. ISSN 0081-2463.

SHE, Ching (2004). Fostering radical conceptual change through dual-situated learning model. Journal of Research in Science Teaching, 41, 142-164.

SHEGLOFF, Emanuel A. (2007). Sequence Organization in Interaction: Volume 1: A Primer in Conversation Analysis. Cmbridge: Cambridge University Press.

SITZMANN, Traci (2011). A meta-analytic examination of the instructional effectiveness of computer-based simulation games. Personnel Psychology, 64(2), 489-528.

STEVENS, Robert J., SLAVIN, Robert E. (1995). The cooperative elementary school: Effects on students' achievement, attitudes, and social relations. American Educational Research Journal, 32, 321–351.

STIPEK, Deborah J. (2002). Good instruction is motivating. In. A. Wigfield & J. Eccles (Eds.), Development of achievement motivation. San Diego, CA: Academic Press.

SUITS, Bernard: The Grasshopper. University of Toronto Press, Toronto, 1978.

SUNNQVIST Charlotta, PERSSON Ulla, LENNTORP Bo, TRÄSKMAN-BENDZ Lil (2007) Time geography: a model for psychiatric life charting? Journal of Psychiatric and Mental Health Nursing 14, 250–257.

SQUIRE, Kurt (2005). Changing the game: what happens when video games enter the classroom? Innovate, 1 (6).

STEWART, John, VAN KIRK, John, ROWELL, Russel (1979). Concept maps: A tool for use in biology teaching. American Biology Teacher, 41(3), 171–175.

ŠISLER, Vít, BROM, Cyril (2008). Designing an Educational Game: Case Study of 'Europe 2045'. In Transactions of Edutainment I. Berlin: Springer-Verlag, 1-16.

ŠISLER, Vít, BUCHTOVÁ, Michaela, BROM, Cyril, HLÁVKA, Zdeněk (2012). Towards Empirical–Theoretical Framework for Investigating Learning Efects of Serious Games: A Pilot Study of Europe 2045. In Applied Playfullness. Proceedings of the Vienna Games Conference 2011: Future and Reality of Gaming. 2012, Braumüller Verlag: Vienna.

THOMPSON, Edmund R. (2007). Development and validation of an internationally reliable short-form of the Positive and Negative Affect Schedule (PANAS). Journal of Cross-Cultural Psychology, 38, 227–242.

TOBIAS, Sigmund, FLETCHER, J. D., DAI, David Y., WIND, Alexander P. (2011). Review of research on computer games. Computer games and instruction, Charlotte, NC: Information Age, 127–222.

UM, Eunjoon, PLASS, Jan L., HAYWARD, Elizabeth O., HOMER, Bruce D. (2012) Emotional Design in Multimedia Learning. Journal of Educational Psychology, 104(2), 485-498.

VAN ECK, Richaerd (2006). Digital Game-Based Learning: It's Not Just a Digital Natives Who Are Restless. In Educause Review, 41(2), 16 – 30.

VOSNIADOU, Stella, Brewer, William (1992). Mental models of the Earth: A study of conceptual change in childhood. Cognitive Psychology, 24, 535-585.

VOSNIADOU, Stella, IOANNIDES, Christos. (1998). From conceptual development to science education: A psychological point of view. International Journal of Science Education, 20, 1213-1230.

VOSNIADOU, Stella (2003). Exploring the relationships between conceptual change and intentional learning. In G. M. Sinatra & P. R. Printrich (Eds.), Intentional conceptual change (pp. 377-406). Mahwah, NJ: Lawrence Erlbaum Associates.

WANG, Chia-Yu (2007). The role of mental-modeling ability, content knowledge, and mental models in general chemistry students' understanding about molecular polarity. A Dissertation presented to the Faculty of the Graduate School University of Missouri – Columbia.

WATSON, David, CLARK, Lee A., TELLEGAN, Auke (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. Journal of Personality and Social Psychology, 54(6), 1063-1070.

WEBB, Noreen M., NEMER, Kariane Mari, ING, Marsha (2006). Small-roup Reflections: Parallels Between Teacher Discourse and Student Behavior in Peer-Directed Groups. Journal of the Learning Sciences, 15(1).

WHITEBREAD, David, COLTMAN, Penny, JAMESON, Helen, LANDER, Rachel (2009). Play, cognition and self-regulation: What exactly are children learning when they learn through play? Educational & Child Psychology, 26(2).

WHITEHEAD, Alfred North (1929). The Aims of Education and Other Essays. New York: The Free Press.

WIGFIELD Allan, ECCLES, Jacquelynne S. (2000). Expectancy-Value Theory of Achievement Motivation. Contemporary Educational Psychology, 25(1), 68-81.

WILSON, Thomas D. (2000). Human Information Behavior. Informing Science, 2(3).

WINNE, Philip H. (1995). Inherent details in self-regulated learning. Educational Psychologist, 30(4), 173-185.

WOUTERS, Pieter, VAN OOSTENDORP, Herre, BOONEKAMP, Rudy, VAN DER SPEK, Erik (2011). The role of Game Discourse Analysis and curiosity in creating engaging and effective serious games by implementing a back story and foreshadowing. Interacting with Computers, 23, 329–336.

WOUTERS, Pieter, VAN NIMWEGEN, Christof, VAN OOSTENDORP, Herre, VAN DER SPEK, Erik (2013). A Meta-Analysis of the Cognitive and Motivational Effects of Serious Games. Journal of

Educational Psychology. Advance online publication. [Online] http://ocw.metu.edu.tr/pluginfile.php/11786/mod_resource/content/1/A%20Meta-Analysis%20of%20the%20Cognitive%20and%20Motivational%20Effects%20of%20Serious%20Games.pdf

ZIMMERMAN, Barry J., BLOM, Doke E. (1983). Toward an empirical test of the role of cognitive conflict in learning. Developmental Review, 3(1), 18–38.

ZWANN, Rolf A., RADVANSKY, Gabriel A. (1998). Situation models in language comprehension and memory. Psychological Bulletin, 123, 162-185.

List of graphs

List of tables

List of figures

Attachment 1

Concept map form

Attachment 2

A1. Dění na mezinárodní politické scéně:

a. nesleduji vůbec
b. sleduji asi 1 krát týdně: *(zatrhněte příp. i více možností)* TV, on-line, rádio, tisk, jinde……..
c. sleduji 2 – 3 krát týdně *(zatrhněte příp. i více možností)* TV, on-line, rádio, tisk, jinde……..
d. sleduji denně *(zatrhněte příp. i více možností)* TV, on-line, rádio, tisk, jinde……..

A2. Dokázal/a byste vysvětlit, jaká jsou přístupová kritéria, která musí splňovat země usilující o vstup do EU? *(zatrhněte jednu možnost na škále 1 - 5)*

vůbec ne 1 2 3 4 5 určitě ano

A3. V tématech Evropské Unie se považujete za: *(zatrhněte jednu odpověď)*

a. začátečníka(ci), něco málo o tom vím
b. mírně pokročilého(ou), vím toho středně
c. pokročilého(ou), vím o tom docela dost
d. nevím, o toto téma se nezajímám

A4. Když slyším o politickém dění v EU, dokáži si představit, co ovlivňuje politická rozhodnutí. *(zatrhněte jednu možnost na škále 1 - 5)*

vůbec ne 1 2 3 4 5 určitě ano

A5. Předmět Základy společenských věd: *(zatrhněte jednu odpověď)*

a. je můj nejoblíbenější předmět
b. mě celkem baví; často se zajímám o témata, která se zde probírají
c. mě příliš nebaví; o většinu témat se příliš nezajímám
d. je můj nejneoblíbenější předmět, mám k němu vysloveně negativní vztah

A6. Kdo je v současné době předsedou Evropské Komise? *(zatrhněte jednu možnost)*

a. Herman Van Rompuy
b. Catherine Margaret Ashton
c. Vladimír Špidla
d. José Manuel Durão Barroso

A7. Kolik je v současnosti států v EU? *(zatrhněte jednu možnost)*

a. 12
b. 15
c. 27
d. 28

A8. Kdy přistoupila Česká republika do EU? *(zatrhněte jednu možnost)*

a. 1998
b. 2001
c. 2003
d. 2004

A9. Štefan Füle je český eurokomisař pro oblast: *(zatrhněte jednu možnost)*

a. zaměstnanost a sociální věci
b. rozšíření a politiku sousedství
c. zemědělství a rozvoj venkova
d. zdraví a spotřebitelskou politiku

A10. Jste:

a. muž b. žena

A11. V kolik hodin jste dnes ráno vstávali? *(napište, prosím, co nejpřesněji)*

……

A12. V kolik hodin obvykle vstáváte ve všední dny? *(napište váš odhad, +/- 15 minut)*

……

A13. Věk: *(prosím, dopište číslo)*

……

A14. Jste povahově spíše ... ? *(zatrhněte pro každý řádek jednu možnost na škále 1 - 5)*

a) aktivní 1 2 3 4 5 pasivní

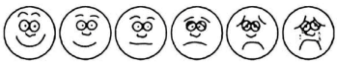
b) otevřený 1 2 3 4 5 uzavřený

Attachment 3

C1. Jak byste ohodnotili dnešní workshop ve srovnání s běžnou školní hodinou? *(vyberte jeden smajlík)*

líbil se mi výrazně více  **líbil se mi výrazně méně**

C2. Myslíte si, že jste se dnes něco naučil/a? *(vyberte jeden smajlík)*

mnoho poznatků  **vůbec nic**

C3. Myslíte si, že dokážete nahlédnout, jak se politické problémy na úrovni EU řeší ve skutečnosti? *(vyberte jeden smajlík)*

určitě ano  **určitě ne**

C4. Napište 5 věcí, které jste podle vašeho názoru nevěděl(a) a naučil(a) jste se je během dnešního dne:

1. .....
2. .....
3. .....
4. .....
5. .....

C5. Co vás na dnešním výukovém programu nejvíc bavilo a proč?

.....

C6. Co se vám na dnešním výukovém programu líbilo nejméně a proč?

.....

C7. V tématech Evropské Unie obecně se považujete za: *(zatrhněte jednu odpověď)*

a. začátečníka(ci), vím toho jen málo nebo nic
b. mírně pokročilého(ou), trochu už o tom vím

c. středně pokročilého(ou), vím toho středně
d. pokročilého(ou), vím o tom docela dost
e. nevím, o toto téma se nezajímám

C8. Když uslyšíte o politickém dění v EU, myslíte, že si dokážete představit, co ovlivňuje politická rozhodnutí?

určitě ano  **určitě ne**

C9. Dění na mezinárodní politické scéně:
(zatrhněte příp. i více možností v závorce)

a. nemám zájem sledovat
b. možná budu občas kontrolovat: *(zatrhněte příp. i více možností)* TV, on-line, rádio, tisk, jinde……...
c. rád(a) bych sledoval(a) několikrát týdně: *(zatrhněte příp. i více možností)* TV, on-line, rádio, tisk, jinde……...
d. rád(a) bych sledoval(a) denně: *(zatrhněte příp. i více možností)* TV, on-line, rádio, tisk, jinde……...

C10. Změnilo se během dnešního dne vaše vidění fungování EU?
(zatrhněte jednu možnost)

a. vůbec ne
b. znám více faktů
c. dokážu si procesy lépe představit
d. znám více faktů a dokážu si procesy lépe představit
e. jiné *(doplňte)*.....

C11. Jak často hrajete počítačové hry? *(zatrhněte jednu odpověď)*

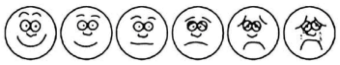
a. méně než 1 hod týdně (nebo nikdy)
b. 1-5 hod. týdně
c. 6-10 hod. týdně
d. častěji než 10 hod. týdně

C12. Kdybyste měli doporučit, jak dlouhý by tento workshop měl být příště:
(zatrhněte jednu odpověď)

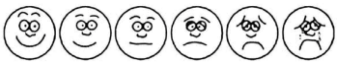
a. výrazně delší
b. trochu delší
c. stejně dlouhý
d. trochu kratší
e. výrazně kratší

Attachment 4

C13. Jak byste ohodnotili workshop, který jste navštívili před měsícem, ve srovnání s běžnou školní hodinou? *(vyberte jeden smajlík)*

líbil se mi výrazně více  **líbil se mi výrazně méně**

C14. Myslíte si, že jste se tehdy na workshopu něco naučil/a? *(vyberte jeden smajlík)*

mnoho poznatků  **vůbec nic**

C15. Myslíte si, že dokážete nahlédnout, jak se politické problémy na úrovni EU řeší ve skutečnosti? *(vyberte jeden smajlík)*

určitě ano  **určitě ne**

C16. Napište 5 věcí, které jste podle vašeho názoru nevěděl(a) či neuměl(a) a naučil(a) jste se je během workshopu před měsícem:

1. .....

2. .....

3. .....

4. .....

5. .....

C17. Máte zpětně pocit, že vám workshop něco přinesl, nebo že se nějak změnil váš vztah k tématům EU, mezinárodní politiky či procesům politického rozhodování? Popište prosím:

.....

.....

.....

.....

.....

C18. V tématech Evropské Unie obecně se považujete za: *(zatrhněte jednu odpověď)*

f. začátečníka(ci), vím toho jen málo nebo nic
g. mírně pokročilého(ou), trochu už o tom vím
h. středně pokročilého(ou), vím toho středně
i. pokročilého(ou), vím o tom docela dost
j. nevím, o toto téma se nezajímám

C19. Když jste během posledního měsíce slyšel(a) o politickém dění (například v EU), dokázal(a) jste si představit, co reálně ovlivňuje politická rozhodnutí?

určitě ano  **určitě ne**

C20. Dění na mezinárodní politické scéně jste v posledním měsíci:
(zatrhněte příp. i více možností v závorce)

e. vůbec nesledoval(a)
f. občas zkontroloval(a): *(zatrhněte příp. i více možností)* TV, on-line, rádio, tisk, jinde……...
g. sledoval(a) několikrát týdně: *(zatrhněte příp. i více možností)* TV, on-line, rádio, tisk, jinde……...
h. sledoval(a) denně: *(zatrhněte příp. i více možností)* TV, on-line, rádio, tisk, jinde……...

C21. Jak často jste se za poslední měsíc s někým bavil(a) o tématu EU, procesu politického rozhodování či mezinárodní politice? *(zatrhněte jednu možnost)*

a. nikdy
b. jednou nebo dvakrát
c. třikrát či čtyřikrát
d. více než čtyřikrát

C22. Napište, prosím, jestli jste ve škole od workshopu probírali látku z workshopu:

Na jakém předmětu:	Kolik vyučovacího času:	Jaké téma:
……	……	……
……	……	……
……	……	……

C23. Dohledával(a) jste si po skončení workshopu sam(a) z vlastního zájmu informace o nějakém tématu vyučovaném během workshopu? *(zatrhněte jednu možnost)*

a. ne
b. jednou nebo dvakrát
c. třikrát či čtyřikrát
d. více než čtyřikrát

Pokud si vybavíte, dopište prosím, o jaké téma šlo:

……

C24. Změnilo se díky workshopu před měsícem vaše vidění fungování EU?
(zatrhněte jednu možnost)

f. vůbec ne
g. znám více faktů
h. dokážu si procesy lépe představit
i. znám více faktů a dokážu si procesy lépe představit
j. jiné *(doplňte)*.....

C13. Představte si, že v novinách nebo na internetu narazíte na titulek: „*Bitva o rozpočet EU vrcholí. Skoro všichni hrozí vetem.*" Jak moc Vás bude článek zajímat?

určitě hodně, přečtu si ho  **vůbec ne, přeskočím ho**

Attachment 5

Emotional graph form (pilot study)

Attachment 6

Emotional graph form