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Editorial

The world and people are at their feet. A large number of countries is heavily indebted. Even the young and the educated are unemployed. The rate of unemployment is rising. Social rights are shrinking. What is going on? What is wrong? What are the real causes and solutions?

Herbert Simon, Nobel Prize winner in Economics in 1976, said that only a model of reality exists. Still, we learn from the models we created in the past. In education we refer to education models. From experience we build new ones that are supposed to solve the problems we are facing. The old models need not only to be fixed but also above all replaced by new innovative models. How do we arrive at these models?

There are many novelties, technological solutions based on computers are no longer mere aids but provide us with new directions in science, art, business, and schools. Technology also enables new relations among people. Rapid exchange of information worldwide has an impact on people's values and makes new value chains possible. These are external factors. On the inside, individuals as well as school systems and countries are faced with existing models that no longer fit the modern human and the society we live in.

Is a model, which predicts that first graders take tablet computers to school, the right solution? We believe it is. However this model requires other existing models to change, for instance publishing houses' business models for textbooks. Of course there are basic educational goals. Then again, already their subordinate goals are better suited for the education in the industrial society than the knowledge society. To claim that tablet computers in schools do not change anything does not make sense. A lot has to change and it can change.

Our perceptions of the world are catching up with the technology with a delay. In other words, humans are intrinsically lagging behind technological innovations that are occurring on the outside. Innovation of a 'business' model occurs internally within an individual, institution, company, corporation, country etc.

We need to internalize the changes and directly implement them in our environment. Since the changes are disruptive, a mere 'face-lift' does not suffice. Needed are new disruptive and innovative models, including in the field of education.

Capability to innovate is a human domain. Our head cannot be innovative if empty. It is not an option to store everything on the computer or Internet and forget about learning. Naturally, the question that arises is, what and when to learn with all the new technological advancements in order to best put to use the 'computer' between our ears. This question along with similar questions is addressed also in this special issue.

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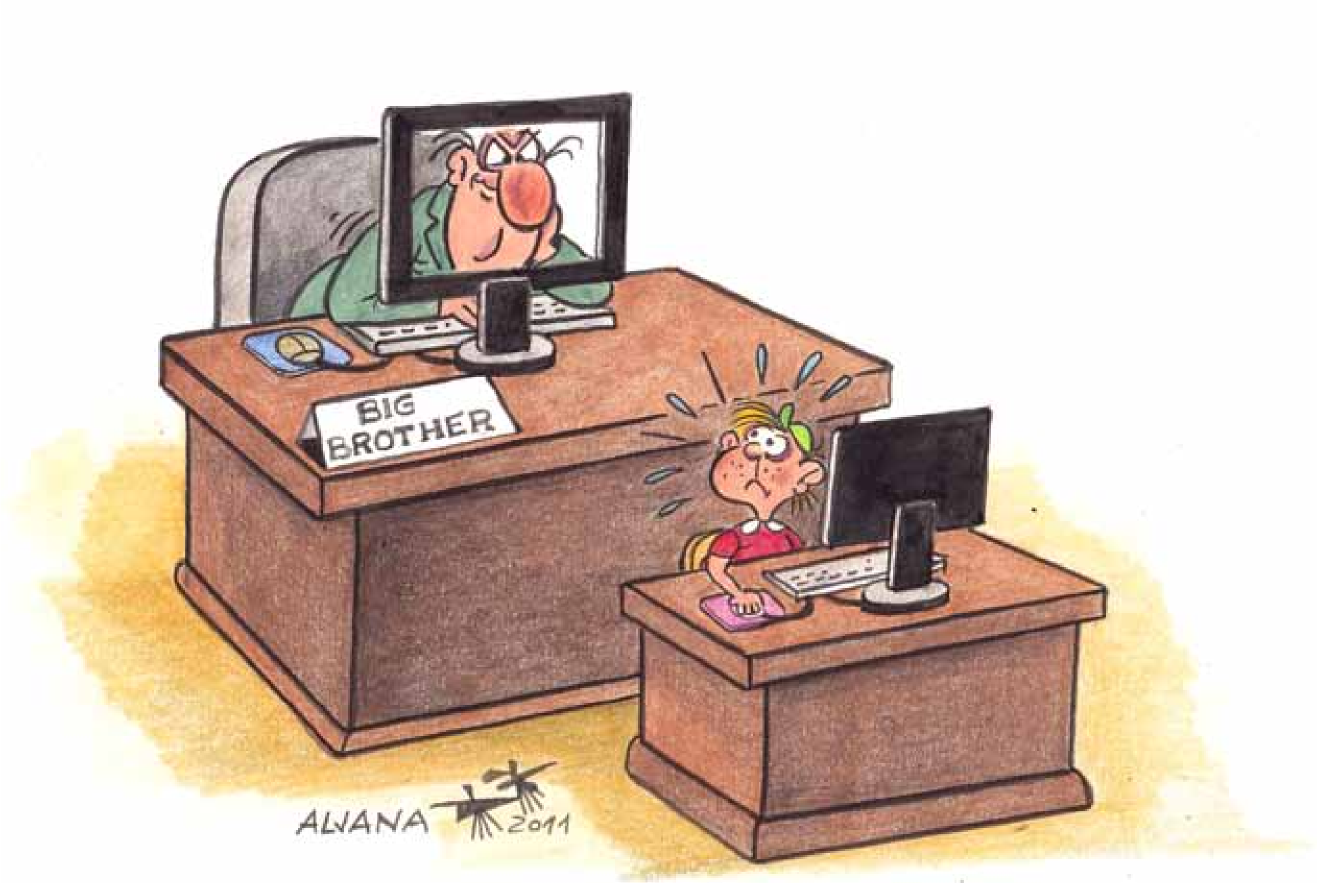

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Towards Understanding Collaborative Learning in the Social Media Environment

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'Social media', 'Web 2.0', 'collaborative learning' and user co-creation are just some of the terms that describe changes in the role of information and communication technology (ICT) in business, private life and society. The changing face of ICT has finally brought about the fulfilment of the term 'Information Society' and made an important impact on many fields of research, including collaborative learning. The effective use of ICT in support of group collaboration has been researched and discussed. The effectiveness was attributed to systematically organized and facilitated processes. Nevertheless, the results are not always better when group support systems (GSS) are used in comparison to face-to-face work. In contrast to the well-organized GSS-supported learning process, the social media environment is non-structured, rule-free and even chaotic. In this paper, we research the possibilities of eliciting group knowledge in the group-learning process in a social media environment. A total of 24 students assigned into three groups participated in the three-week long study. Their task was to solve a given research topic by solely using an unfamiliar social media environment and to present their findings after three weeks. Students were observed in their natural learning environment (school, home, the Flowr virtual environment), and their attitudes on collaborative work using social media tools were measured with a questionnaire at the end of the study. The results suggest that non-structured social media environment stimulates self-management of the group. Some insights into trust, motivation and conflicts in the collaborative problem solving are discussed.

Keywords: social networks, collaborative problem solving, learning

1 Introduction

Recent developments in computer virtual communities and social media suggest that collaborative problem solving can be as or even more efficient than highly controlled computer virtual environments (Tapscott & Williams, 2006, Barabasi, 2002, Potter, McClure, & Sellers, 2010). To be able to use collaborative problem solving while learning in educational, organizational and inter-organizational environments, we have to understand the environment and the learning processes. Our interest is focused on how people solve complex problems, and not the optimization of it, but the understanding of how it actually happens.

From previous research on simulation-based problem solving (Škraba, Kljajić & Leskovar, 2003; Škraba, Kljajić & Kljajić Borštnar, 2007; Kljajić Borštnar, Kljajić, Škraba, Kofjač, & Rajkovič, 2011), we have come to some understanding about the nature of groups working together in a computer-supported virtual environment. Specifically, in the process of complex managerial problem solving supported by a simulation model and a GSS, the role of facilitator in a group process was shown, and the group belonging effect was empirically proven (Kljajić Borštnar et al., 2011). Further, the structure of feedback information was shown to have a great impact on the performance of the group. When the individual feedback information of a simulation model efficiently supported individual learning (Škraba et al., 2003), the contribution of group information feedback was not as straightforward (Škraba et al., 2007). When group information feedback was provided in a controlled and facilitated process, it contributed to greater unity and better performance of the group members; in contrast, when it was freely accessible to the group members and the process was not facilitated, it caused the group to perform poorly and perceive the experiment poorly.

The decision process can be regarded as complex problem solving: because it is a complex cognitive process comprised of systematic processing of knowledge and rationalisation, which should minimize the possibility of making a mistake (Wang, 1997). It is being described as a learning process that should provide sufficient knowledge for efficient decision making. The basic role of information systems must be to provide the right information when needed. Nevertheless, information alone is not sufficient for successful decision making. The decision-making process often takes place in a

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social context. Decisions generated in organizational systems are not dependent on the individual decision of a subject, but rather on a group of individuals participating in decision making (i.e. experts working in a specific field). The group as a whole understands the problem better (Hale, 1997), which should lead to synergistic effects. Nevertheless, the group process is often hindered by the effects of group dynamics, such as conformity and manipulation. In the end, the quality of decision-making is difficult to evaluate and the process is bounded by the rationality of the people in it (Simon, 1991; Dubois, 2010). Group support systems are designed to manage these problems and enhance the positive effects of group work. Nevertheless, the positive effects of GSS are not unanimous in literature (Fjermestad, 2004). The problem lies in complexity of the process itself, with people as creative actors: there are problems with the level of facilitation, quantity, content, and frequency information feedback (Hsiao & Richardson, 1999; Khalifa, Davison & Kwok, 2002; Rouwette, Größler & Vennix, 2004). The importance of process facilitation was shown by Kljajić Borštnar et al. (2011) and Limayem, et al. (2002). Furthermore, the study of Limayem et al. (2002) reported no difference between live and computer facilitation. Kim (2010) argued that the role of a leader is turned into a facilitator and that "… facilitation encourages uncooperative members to improve their participation in order to increase group cohesiveness." (Kim, 2010: 1569); therefore, the role of a facilitator is similar to the role of a teacher.

As the effectiveness of GSS is often attributed to its systematically organized and facilitated process, with high emphasis on control, contemporary networked and open structured organizations prove to be as efficient and even more creative in generating new knowledge and problem solving without enforcing structure and facilitation. In particular, the social media and Web 2.0 environment facilitate a setting for what is called 'collective problem solving' or 'crowd sourcing' or 'social computing'. In contrast to the well-organized GSS-supported learning process, the social media environment is non-structured, rule-free and even chaotic. Social media engagement is so vast that we can find it in daily life, business; innovation, politics, science (Hafkesbrink & Evers, 2010). The power of social media was first perceived in marketing, branding, user-oriented problem solving, and in generating public opinion. In recent years, it is seen as an opportunity to support student learning and engagement. In this context, it is important that students learn how to use social media to expand their approaches to solving problems and making decision in a collaborative ways (Minocha, 2009).

Exploring the term 'collaborative learning' takes us back to the 1990s where a large portion of research was devoted to the theme. In fact, the terms used varied considerably between authors, from 'collaborative learning' (Beckman, 1990), which is used most frequently to date, to 'peer-group learning' used by Collier (1980), 'cooperative learning' coined by Cooper (1990), and 'learning groups', researched by Fiechtner and Davis (1992). Common to all these studies was the framework of meticulously planned and engaged organization of groups (formation of groups, small number of up to five participants in groups), supporting the groups in planning and proceeding the group work, preparing instructions for group work, performing check-up of the group work, and providing help with uncooperative members. Since the 1990s many things have changed, not only the technological advances, like the emergence of the Web 2.0 participative environment, but also the changes in concepts of collaborative living, work and learning. 'Social media', 'Web 2.0', 'collaborative learning', and 'user co-creation' are just some of the terms that describe changes in the role of information and communication technology in business, private life and society. The changing face of ICT has at last fulfilled the long-used term 'Information Society' and made an important impact on many fields of research, including collaborative learning. Collaboration tools like wikis, blogs, microblogs and other so-called social media tools have influenced society as a whole and have changed the way we do things. The collaboration in a social media environment is not limited to a classroom, a set time and a small number of participants. Collaboration is considered to be any process of working with others with common objective. Similar to the description of a group learning process that may or may not result in a measurable learning outcome, but still displays the underlying group learning process (Lizeo, 2005), the collaboration process does not necessarily end up in creating values within specified spaces (Dillenbourg, 1999). This means that all collaboration tools available for supporting and promoting participative behaviour are not sufficient for the group to learn. In search of the concept of collaborative learning in the social media environment, Garrison, Anderson and Archer (2000), Freire (2000) and Wells (1999) argue that a critical discourse is of great importance within collaborative learning environments. Rosen (2007), in his book on the culture of collaboration, proposes ten cultural elements that support value creation: trust, sharing, goals, innovation, environment, collaborative chaos, constructive confrontation, communication, community, and value.

The preliminary research of collaborative problem solving phenomenon in a social media environment is presented in this paper. It is based on the assumption that collaborative learning can be efficiently supported in a rule-free and social media unstructured environment, and that it has a positive impact on the self-organizing of the group and thus contributes to problem solving and learning. Students had three weeks' time to complete the assigned study tasks using the Flowr social media (www.theflowr.com). Research was performed by observing them in the natural setting of the class conduction for the duration of three weeks. With observation methods and questionnaires, we aim to answer the following research question:

Does collaborative problem solving without formal structure and facilitation in the social media environment stimulate the self-management of the group?

2 Methodology

The research took place in the 'natural environment' of a Computer Systems and Communication class. The class was comprised of 45 school hours (45 minutes each) of lectures (3 weeks), followed by 30 hours of practical training in the computer classroom (two weeks). Twenty-four undergraduate students of the class, aged between 20 and 23 years from the Faculty of Organizational Sciences, University of Maribor, participated in the study. At the beginning of the last week of lectures, students were presented a study task (a research topic) that they had to research and present at the end of the two weeks of practical training, thereby giving them three weeks of time (one week of lectures plus two weeks of practical training). Their work on the topic was not limited to the classroom; they were free to cooperate at the time of their own choosing. They were asked to form three groups with a maximum of 10 members per group was allowed. During the study, one transition was made from Group 1 to Group 3 due to conflicts within the group, thus forming two groups of 9 and one of 6 members (n_1=9, n_2=9, n_3=6). For the purpose of keeping the 'natural environment' intact, they were not told they were participating in a study. The role of the teacher (part of the research team) was to observe their work without interfering or facilitating it. The students were able to use the computer classrooms, but were also allowed to work from home or any facility and at time of their choice. Their task was to create a presentation of the research on topic selected by an individual group. Groups were given four topics from the class curriculum to choose from: 1) cloud computing, 2) collective problem solving, 3) information security, and 4) virtualization. The three groups selected the first three research topics.

Students received simple written and oral guidance for their assignment, explaining that they had to create groups that would research the selected topics, using the social collaboration service Flowr (www.theflowr.com). The instructions included instructions on how to use the Flowr service, and a description of the problem and the task. The task was part of the class curriculum; the topics are changed yearly according to the state of the art in the ICT field. The only new factor for the students was the use of a previously non-familiar social service.

Flowr is a web-based social media service addressing the professional communities. It offers collaboration tools, communication (microblogging, commenting, creating knowledge bases), sharing files, videos, integrating Google Apps (Gmail, Google Docs, Google Calendar), and offering tools like Bookmarklet, the Flowr Mobile App, sharing from email, multilingual support and built-in analytics. The use of Flowr basic for small groups is free of charge. Their initial task was to register at the Flowr site, form groups and start using the solution. As stated, they were free to use Flowr in any way they wanted, bearing in mind the goal: to create a critical presentation of the selected research topic. The role of the teacher (researcher) was to follow the progress of the groups (only one group reported problems within the group during the study), to evaluate their tasks and to collect their feedback at the end of the study, using the questionnaire. Students had to prepare the presentations of their assignments using an online collaborative tool, Prezi, whose education licence is free of charge.

2.1 Instrument

After three weeks of collaborative work, students presented their work and reported their opinions through an anonymous questionnaire. The questionnaire had three parts: first there was general demographic information (gender, region, school, internet access); the second part was devoted to the use of social media in general, and the third part was on the collaborative work. Statements formed key variables (constructs) researched in the study: general experiment quality, motivation, self-management of the group, trust, conflicts, absence of formal facilitation and structure, group satisfaction, and user experience, and agreement to the statements were measured on a five-point Likert scale ranging from 1-strongly disagree, 2-disagree, 3-non decisive, 4-agree, to 5-strongly agree. The reliability of the instrument was examined by analysing internal consistency and the correlation matrix. Two basic constructs, self-management of the group and the absence of structure and facilitation, and their association to motivation, trust and conflicts within the group will be analyzed in the following text.

<u>(C1) Self-management of the group</u> was measured by four statements and their reliability (a=.815). Self-management of the group is directly connected to the basic assumption of the paper: groups form freely, are more coherent and the work load delegation is equal among members. A score of 1 means that members strongly disagree that the group effectively managed itself, and a score of 5 means that members strongly agree that the group was able to organize itself.

S1: We have immediately assigned roles in the group.
S2: We have assigned the leader of the group with consensus.
S3: The group was coherent.
S4: The work was delegated equally between the group members.

<u>(C2) Formal structure and facilitation</u> was measured by three statements. Reliability was measured by Cronbach's alpha (a=.794).

Statements were calculated into a new variable where Score 1 on the scale means that respondents strongly disagree that the formal structure and facilitation helps the group work and Score 5 means that respondents strongly agree that formal structure and facilitation would have helped the group work.

S5: Facilitation and guidance of the group would contribute to better work of the group.
S6: Formally enforced structure and roles within the group would help the group work more efficiently.
S7: I missed formal structure, rules and facilitation.

(C3) Motivation
S8: I was motivated for problem solving.

(C4) Trust

S9: I believed that my colleagues would complete their part of the assignments.

(C5) Conflicts
S10: There were conflicts within the group during the experiment.

(C6) General experiment quality

S11: The experiment was well prepared.
S12: Time for problem solving was appropriate.

(C7) Group satisfaction
S13: Group work contributed to effective research of the problem.
S14: The group performed better than everyone would by his/her self.

(C8) User experience
S15: Virtual environment contributed to personal involvement.
S16: Virtual environment contributed to problem solving.
S17: The experiment attributed to better quality of the course.

2.2 Hypotheses

Our assumptions were based on the idea that in the social media environment the group efficiently organizes itself and that members feel no discomfort from the absence of facilitation and formal structure. Therefore, the stated hypotheses aim to test the associations between the perceived role of formal structure and facilitation in group work to self-management of the group and to motivation, trust, and conflicts. Furthermore, the association between self-management of the group to motivation and trust are being evaluated. Based on the theoretical background we designed the following hypotheses:

(H1) Formal structure and facilitation in collaborative problem solving is associated to self-management of the group.
(H2) Motivation and self-management of the group are positively associated.
(H3) Trust is positively associated with self-management of the group.
(H4) Trust is positively associated with formal structure and facilitation.
(H5) Conflicts within the group are associated to formal structure and facilitation.

To test the stated hypotheses, we performed basic descriptive and correlation analysis in SPSS. Hypotheses were tested on a $p < .05$ level of confidence.

3 Findings

There were 24 subjects aged between 20 and 23 (78.3% male and 21.7% female) participating in the study. Nineteen students came from the Gorenjska region, three from the central Slovenia region, one from the Koroška region, and one from Serbia. Sixteen of the students finished technical secondary school, three of them academic secondary school and three of them healthcare secondary school. All except one have their own computer or laptop, and all except one had broadband access to the internet. The majority of the students (83%) reported having access the internet via their mobile phone. On average, they have more than one e-mail addresses.

The second part of the questionnaire addresses the social media usage among subjects. The results show that 29% of

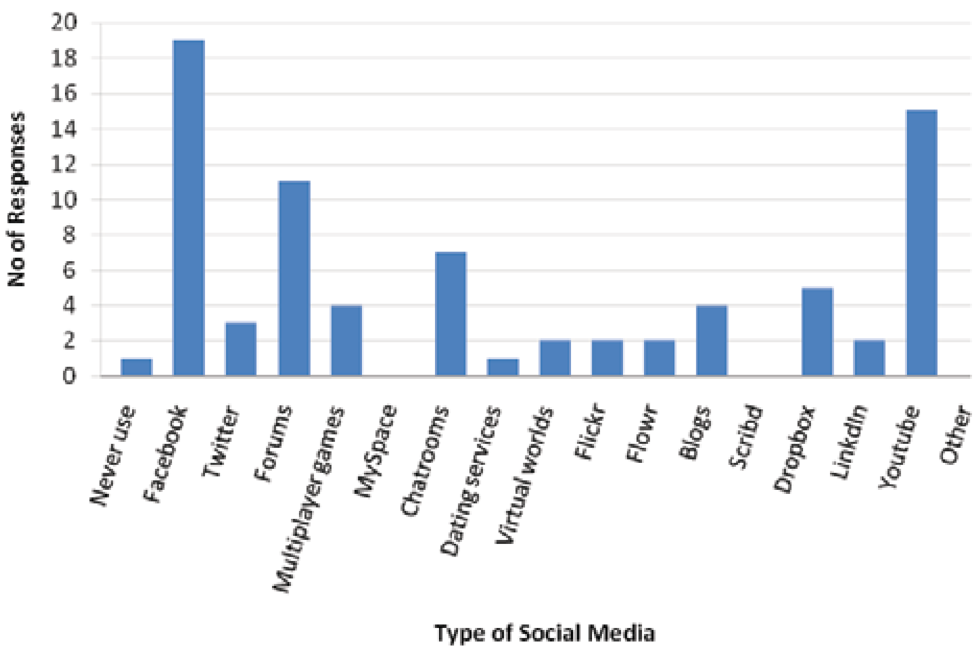

Figure 1: The use of Social Media among respondents

the respondents browse the internet up to one hour per day, 25% reported browsing up to two hours daily and almost 42% browse more than two hours per day; A total of 25% of the respondents reported to 'not think about' the issues of trust in relation to the social media use; 37% reported being 'cautious', almost 17% reported to 'trust people, not services', and almost 21% 'don't trust' these services at all. Among respondents, 12.5% reported to use the web for studies 'moderately' (in half of the courses), 37.5% reported to use the web for studying 'frequently' in more than half courses, and 50% of the respondents stated that they always use web resources.

In Figure 1, we present the reported use of various Social Media by the study participants. From Figure 1, we can observe that Facebook and YouTube, followed by the forums, are predominantly used by students. Very few reported using Twitter, Flickr, Scribd, LinkedIn, which are considered to cover more professional and specialized contents. When asked what they expect of an e-learning environment, the majority of respondents stated that a forum was a first priority, followed by chat rooms (with the possibility of chatting to professors), online examination, literature repository, and at the end of priority list were the wikis, blogs, and interactive and animated contents, which are considered to enhance the collaborative and reflective learning.

Further, only two of the respondents reported having known about the social service Flowr prior to this study. On average, respondents reported the usefulness of Flowr to be average ($M = 2.71$, $SD = 0.99$) and the ease of use to be average ($M = 3.29$, $SD = 1.19$). They also reported some issues with the service operation (problems in group communication, multiple posting of comments, problems with group assigning – repeated group authentications).

The third part of the questionnaire was devoted to study the participants' opinion about collaborative learning in the social media environment. The subjects opinion on eight sets of variables were examined: (C1) self-management of the group, (C2) formal structure and facilitation, (C3) motivation, (C4) trust, (C5) conflicts, (C6) experiment quality, (C7) group satisfaction and (C8) user experience.

Table 1 presents the frequencies of subjects responses in percentages of respondents' level of agreement (from 1 – strongly disagree to 5 – strongly agree) grouped into eight variables (C1–C8), which were computed from subsets of questions, along with the basic descriptive statistics (M and SD).

From Table 1, we present eight variables that were derived from the statements described in Section 2.1. The majority of respondents agreed that the general quality of the experiment was good. They agreed (reported four or more points on the 5-point scale) that they were motivated for the work (60.87%). More than 80% agreed that group had sufficiently self organized, i.e. members assigned roles, leadership and workload easily. Agreement on trust among members was assessed as good by more than 80% of respondents, while 66.67% of the respondents stated there were no conflicts in the group. Only 4.17% reported strong agreement and 16.67% reported agreement to the statement that there were conflicts within the group. This corresponds to the reports of conflicts within one group during the experiment, which led to the one group member transition to another group. A mere 8.33% strongly agreed and 37.5% agreed that facilitation and structure would contribute to better group work; 45.83% were neutral on this and only 8.34% disagreed on this. The vast majority of the respondents (more than 88%) reported that they were satisfied with the work of the group. Further, as seen in Table 1, 45.83% of respondents reported neutral opinions about the user experience, half of them agreed to having had good user experience, while none reported negative user experiences.

3.1 Hypotheses testing

(H1) Formal structure and facilitation in collaborative problem solving is associated to self-management of the group. ($r_S \neq 0$).

Table 1: Subjects responses on 8 variables (N=24)

	1	2	3	4	5	Total	M	SD
C1		4.17	12.50	33.33	50.00	100	4.10	0.89
C2	4.17	4.17	45.83	37.50	8.33	100	3.42	0.88
C3		8.70	30.43	43.48	17.39	100	3.70	0.88
C4	4.17		12.50	37.50	45.83	100	4.21	0.98
C5	66.67	4.17	8.33	4.17	16.67	100	2.00	1.55
C6		4.17	20.83	45.83	29.17	100	3.75	0.71
C7		4.17	8.33	50.00	37.50	100	4.00	0.82
C8			45.83	50.00	4.17	100	3.64	0.51

**Scores on a 1-5 point Likert scale*

A Spearman rank order correlation was calculated to assess the relationship between the amount of formal structure and roles and the ability of the group to self-manage. The results revealed that there is moderate negative correlation between the formal structure and facilitation and self-management of the group (r_S = - .483, p = .017). In other words, less facilitation and structure is associated with greater ability to self-manage.

(H2) Motivation and self-management of the group are positively associated. ($r_S \neq 0$).

A Spearman test was performed and the results revealed that there is significant positive correlation between motivation and self-management of the group (r_S = .555, p = .006). Increase in motivation is associated with an increase in the ability of the group members to effectively self-organize.

(H3) Trust is positively associated to self-management of the group. ($r_S \neq 0$).

A Spearman test was performed and the results revealed that there is significant positive correlation between trust and self-management of the group (r_S = .455, p = .026). A higher sense of trust is positively associated with an increase in the ability of the group members to effectively self-organize.

(H4) Trust is positively associated with formal structure and facilitation. ($r_S \neq 0$). The Spearman rank order was calculated to assess the association between trust and formal structure and facilitation. The results revealed that there is no correlation between trust and formal structure and facilitation (r_S = .177, p = .408). Findings suggest that perceived trust is not related the amount of formal structure and facilitation.

(H5) Conflicts within the group are associated to formal structure and facilitation. ($r_S \neq 0$). A Spearman test was performed and the results revealed that there is significant moderate negative correlation between conflicts and formal structure and facilitation (r_S = -.474, p = .019). An increase of conflicts within group is associated with the decrease in the amount of formal structure and facilitation.

4 Discussion and conclusion

The results of the study suggest that formal structure and facilitation is negatively associated with the self-management of the group, which encompasses the assigning of roles, leadership, and coherency of the group and workload delegation (H1). Less facilitation and structure is associated with a greater ability to self-manage. This implies that the rule-free and unstructured environment with no guidance foster conditions in which participants are more willing to self organize. However, we should be careful with this conclusion for two reasons. Firstly, the number of participants was very small and secondly, according to the descriptive statistics, 45% of the respondents reported neutral opinions about the role of facilitation and structure in the collaborative work.

Furthermore, self-management of the group is associated to both trust and motivation (H2, H3), which is in line with many studies stating that trust and motivation are essential in self organizations of the groups in the social media environment (Rosen, 2007, Hafkesbrink & Evers, 2010). However, trust is very complex and can be studied from various perspectives (interpersonal, philosophical, and organizational). In this study, we have only studied trust as perceived by individual group members. The results that suggest that trust is not associated with formal structure and facilitation are somewhat surprising (H4). This means that the absence of guidance, structure and rules would not affect how group members perceive trust or vice versa. What influences the perceived trust in the collaborative environment of a social media would need to further research. Furthermore, examining how conflicts are related to formal structure and facilitation, the results suggests that with the increase of conflicts within group the formal structure and facilitation decreases. This implies that guidance and structure are regarded as not being helpful in a conflict situation.

Some insight in the student's readiness to use the social media is provided in the second part of the questionnaire. Respondents reported they still perceive forums and chat rooms to be more important than knowledge creation tools, such as wikis and micro blogs, in terms of the virtual learning environment. Although students have reported that the social media approach in this study contributed to the course execution and to positive learning experience, they identify the possibility of chatting with the teacher as one of the priorities in an on-line learning environment. This supports the findings of Kim (2010), who suggested that the teacher in fact assumes the role of a facilitator. The inability of the students to identify other services as having learning potential promotes the still greater role of the teacher. Therefore, special attention should be put on teaching about the use of social media tools in the virtual learning environments.

This study has explored and described the potential of social media for educational purposes and especially in collaborative problem solving and reflective learning support. Classic in-class and virtual learning environments can be effectively enhanced with the use of social media, bearing in mind factors like process facilitation, a well-prepared assignment that not only motivates the students but also enhances their group experience. The drawback of this research lies in the small number of subjects. Future research on collaborative problem solving should be focused on rigorous experimental design for studying the participants' behaviour and performance. The results of this study show some promising directions for further studies on how people use social media in self organizing groups for problem solving, especially in education where the research approach is more of relevance and the rigor is usually lagging behind.

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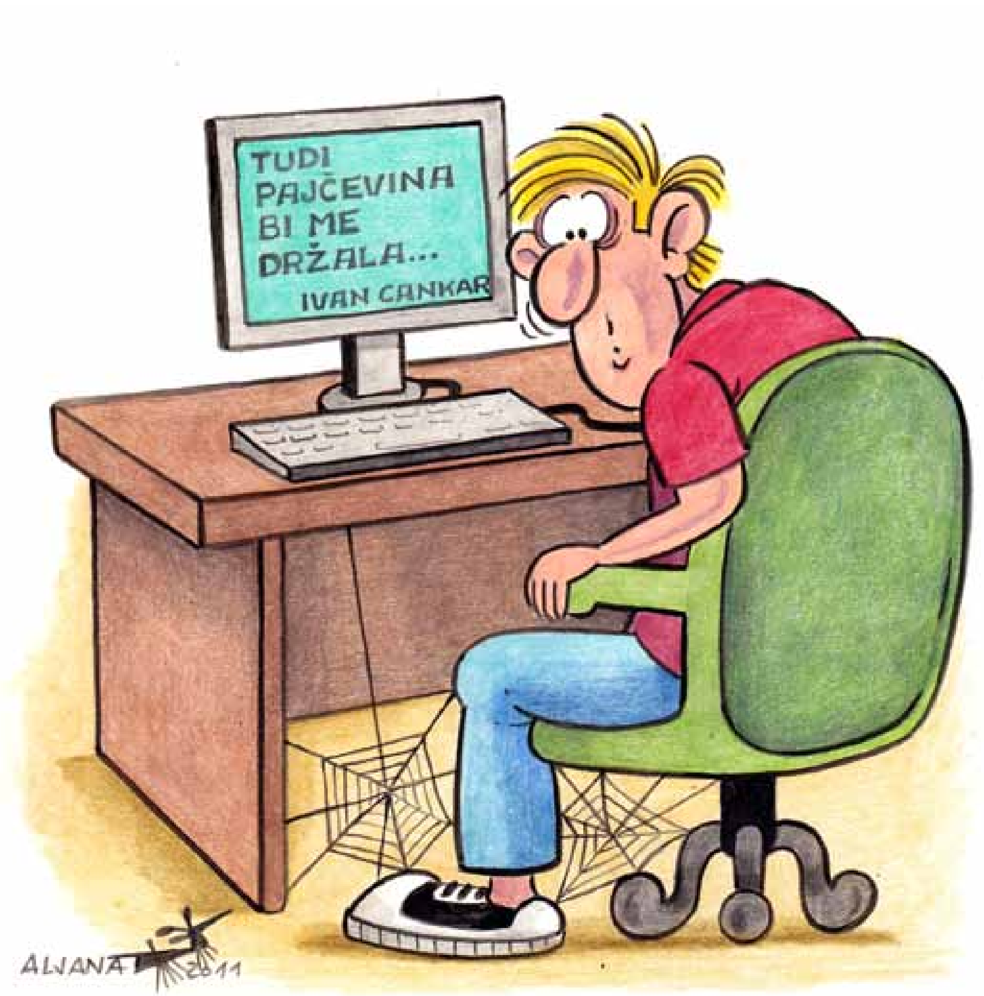
Prispevek k razumevanju sodelovalnega učenja v okolju družabnih omrežij

Družabna omrežja, Splet 2.0, sodelovalno učenje in uporabniško soustvarjanje so le nekateri pojmi, ki opisujejo spremembo vloge informacijske in komunikacijske tehnologije (IKT) v poslovnem svetu, privatnem življenju in družbi. Spremembe v IKT so dokončno oblikovale, že dolgo tako poimenovano, informacijsko družbo in so pomembno vplivale tudi na mnoga raziskovalna področja, na primer na sodelovalno reševanje problemov. O učinkovitosti sistemov za podporo skupinskemu delu se je v preteklosti že razpravljalo. Večinoma je bila pripisana sistematično organiziranemu in vodenemu procesu, čeravno rezultati niso vedno govorili v prid skupine. Za razliko od dobro organiziranih sistemov za podporo skupinskemu delu, je okolje družabnih omrežij nestrukturirano, brez pravil in celo kaotično. V prispevku raziskujemo možnosti za pridobivanje znanja skupine v procesu sodelovalnega učenja z uporabo družabnih omrežij. V ta namen smo analizirali tri tedne trajajočo študijo, v kateri je sodelovalo 24 študentov, razdeljenih v tri skupine. Njihova naloga je bila raziskati postavljen problem s pomočjo njim nepoznanega družabnega omrežja in predstaviti izsledke raziskave. Študenti so nalogo opravljali v naravnem študijskem okolju (v učilnici, na spletu in doma). Njihova mnenja, o sodelovalnem reševanju problema s pomočjo družabnega omrežja, so bila zbrana s pomočjo vprašalnika. Rezultati kažejo, da nestrukturirano okolje brez vodenja stimulira samo-organiziranost udeležencev. Pridobili smo nova spoznanja o zaupanju, motivaciji in konfliktih v sodelovalnem reševanju problemov.

Ključne besede: družabna omrežja, sodelovalno reševanje problemov, učenje



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Virtual Laboratory in Chemistry – Experimental Study of Understanding, Reproduction and Application of Acquired Knowledge of Subject's Chemical Content

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Traditional teaching does not often allow very active involvement of pupils in class. In chemistry and natural sciences in general experimental and laboratory work is one of the most effective methods for acquiring knowledge. Experimental work can also be exercised using virtual world. Virtual laboratory offers some important advantages. Understanding chemistry involves the ability of cognitive comprehension on three levels: the macroscopic level, the symbolic level and the level of particles where the virtual laboratory can be an effective tool. On this basis a didactic experiment was performed in order to verify the effectiveness of virtual laboratory from pupils' knowledge point of view. The experiment involved seventh grade pupils (N = 38). Furthermore, we tried to answer the question whether the learning results of pupils, according to the experimental design of classes using a virtual laboratory, are better than results gained through teaching classical science classes without visualization tools. The research of the didactic experiment carried out on a relatively small, pilot sample of pupils has shown that acquiring knowledge is more effective when using the virtual laboratory instead of classical teaching (in the case when classical approach does not include visualization elements crucial for learning and understanding chemistry).

Key words: virtual laboratory, science, chemical and visual literacy, knowledge

1 Introduction

In teaching science teachers often proceed from the fact that nature is the best source of information. The basic and at the same time the most effective method in gaining chemistry related knowledge is experimental and laboratory work. Basic science concepts are introduced by experiments. In a dynamic social environment like today's traditional forms of education and training do not suffice. Information and communication technology (ICT) opens up a new world of creativity for students and teachers. The understanding of chemical concepts and processes can be increased if we provide the development of chemical visual literacy. Key elements of chemical visual literacy are perception and the ability to describe changes at the macroscopic level and the correct perception of the natural partition structure of matter at the submicroscopic level. We use molecular and crystal models. In school laboratory experiments can be carried out in a realistic or virtual manner. With virtual experiments the experiments are carried out using computer simulations or animations. One of the advantages of virtual laboratory, among other things, is that it allows the portrayal of matter's model structure which is a prerequisite for proper understanding of the natural partition structure of matter.

2 Learning science concepts

Teaching scientific concepts should be firstly based on the observation of a particular science process which means that the natural process is perceived through perception or senses. At the second stage it is necessary to explain the observations with theories based on the partition structure of matter that are at a given time and on a certain level of education scientifically indisputable. At the third level is the understanding of a chemical concept. The submicroscopic level is translated into the appropriate symbols which include chemical symbols, formulas and equations, mathematical equations, different

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schematic and graphical presentations and more. This level permits an easier interpretation of the situation and mutual communication between those who are acquainted with the symbolic language. Science education particularly seen from the symbolic level without integrating it with the previous two, can lead to the creation or strengthening of already established misunderstandings if these symbols are not correctly interpreted and integrated into the existing network of knowledge (Devetak et al., 2009).

In chemistry and natural sciences in general, the experimental and laboratory work is one of the most effective methods for acquiring knowledge. The detection of concept world of matter, phenomena and processes is characteristic for chemistry at the macroscopic level. For interpreting and forecasting we must use the language of the submicroscopic world. While learning chemistry it is important that students understand and can connect concepts on all three conceptual levels (macroscopic, submicroscopic and symbolic) which is difficult for many of them. The gap between the three conceptual levels can be, to the great extent, overcome by the use of visualization elements. Thus the ability to use models in teaching and learning chemistry is among the key chemical elements of visual literacy (Vrtačnik et al., 2003).

2.1 ICT and science

In a dynamic social, production and service environment such an environment as today's traditional forms of education and training no longer suffice. Electronic interactive media allows us to take a look at the micro-world of living or inanimate nature, fly between planets of the solar system or take a look at how a real laboratory experiment should be performed in a classroom. Information and communication technology (ICT) opens up a new educational world of creativity for students and teachers. ICT plays an important role in planning lessons and in their management (Grimaldi and Rapuano, 2009). The use of ICT could be divided into two groups: in the first group a computer is used as a tool for finding information, communication and multimedia and in the second group the computer is a scientific tool such as a virtual laboratory, interactive simulation, computer-assisted laboratory work (Šorgo et al., 2007).

The use of computers in science subjects, particularly chemistry, has some specific advantages. Cognitive psychologists assume that the understanding of chemistry includes the ability to think on three levels: the macroscopic level, the symbolic level and the level of particles (Johnstone, 1991). Pupils and students have the most difficulties in understanding the submicroscopic level - the level of particles because it reaches beyond their experience. In these cases the interactive multimedia can be used as an effective tool. Multimedia demonstration of experiments must not replace other methods of work in teaching chemistry. Virtual laboratory can eliminate uninteresting and boring parts of the experiments. It helps students understand higher cognitive levels of analysis, synthesis and evaluation (Kirscher and Huisman, 1998). The use of multimedia and virtual laboratories for teaching chemistry improves teaching because it allows the integration of the three levels of understanding of chemistry, visualization and simulation of processes.

2.2 Experimental work and virtual laboratory

In chemistry and natural sciences in general the experimental laboratory work is one of the most effective methods for acquiring knowledge. From a didactic point of view the experimental work is of the utmost importance because it sometimes discontinues the monotonous teaching of theory with practical work. Experimental work can be divided into real and virtual. Classical experimental work is the best known method of practical work and is most commonly used in teaching science and chemistry in elementary school. For students who choose the subject. Experiments in chemistry are a fundamental and predominant form of work. Students train their manual skills, develop the ability to describe chemical changes, learn about physical and chemical properties of matter, develop safety at work abilities in the school laboratory, they strengthen and complement knowledge, abilities and skills, develop an experimental approach as a form of research work.

The experimental work allows them to develop and deepen their science literacy, basics of scientific work, complex thinking and linking theory with practice. As proved, the students want to elevate the frequency of laboratory work covered in traditional classes (Šorgo and Špernjak, 2007).

Virtual laboratory exercises are held in the virtual world. Virtual lab brings many advantages. We can perform dangerous experiments without endangering ourselves or others. Simulations are affordable. Once developed, they can be done at no extra costs as many times as we want. The results are always the same.

The main disadvantage of a virtual laboratory is the alienation from nature and from what is real. Therefore simulations are mostly a good supplement and not a substitute for practical experimental work (Puhek 2009, p. 6-7).

In Table 1 we compare the classical and virtual laboratory. The "+" sign represents the advantages of laboratory, the "-" sign the disadvantage of the same laboratory.

Interactive 3D virtual environments have great educational potential because they enable the active participation of students, research and management of virtual objects. Virtual laboratories reproduce the conditions of a real chemical laboratory and enable learning through an interactive simulation and are a valuable tool for distance learning and lifelong learning of chemistry. Virtual laboratories allow the execution of experiments without teacher's presence; therefore students have a major role in their learning process. Studies have shown that virtual laboratory is an appropriate tool with which chemistry students prepare for practical work (Dalgarno et al., 2010, Georgio et al., 2008, Rajendran et al., 2010).

2.3 Program Crocodile Clips Chemistry

Scottish enterprise Crocodile Clips Ltd develops educational software for primary and secondary schools. Crocodile Clips products are recommended by teachers worldwide as an innovative approach to learning. A new generation of educational tools of the same enterprise is called Yenka. Yenka can be used at home or in schools with an interactive blackboard. It is free software as far its purpose is domestic use.

Table 1: Advantages and disadvantages of classical and virtual laboratory

Classical experimental work	Virtual laboratory
+ training manual skills	+ learning about the scientific approach to work
+ learning about the scientific approach to work	+ the results are always the same
+ following instructions	+ a large range of chemicals and accessories
- preliminary preparation	+ an easy implementation of dangerous, expensive, harmful to health experiments or experiments in specific conditions
- dangerous or harmful to health chemicals	+ inexpensive
- difficult, too long or too expensive experiments	+ visualization features are included
- there are variations	- alienation from nature and from reality
	- it can be only a supplement and not a replacement of practical work

Virtual Chemical Laboratory Crocodile Clips Chemistry is a sophisticated, user-friendly interactive simulation program for teaching and for independent student work. The program provides a clear and simple display of phenomena on the following themes: energy, water and water solutions, alkalis, salts, acids, metals, materials and much more...

They may also use gadgets, glassware and chemicals to compose an experiment by themselves. The program has the ability to modify the already existing experiments.

Students or teachers can adapt the existing experiment by changing different parameters such as temperature, mass, concentration. In the book of elements we find an abundant amount of equipment found in chemical laboratories and more than a hundred different chemicals with which we can also carry out any kind of experiments that are too dangerous for the school laboratory. Animations can be seen on the submicroscopic level with relevant displays of atoms or molecule.

Topics of this program were properly connected to the chemical content that students learn at science in the seventh grade of elementary school.

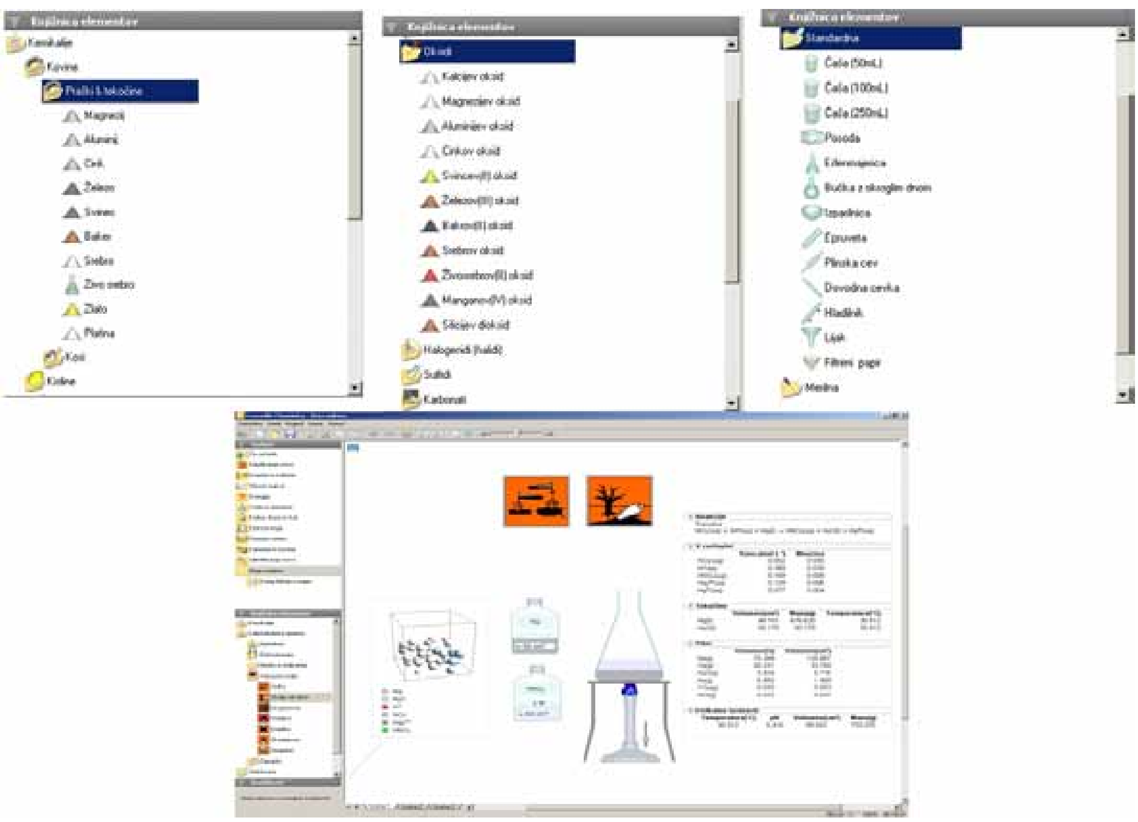


Figure 1: A book of elements featuring selected glassware and chemicals

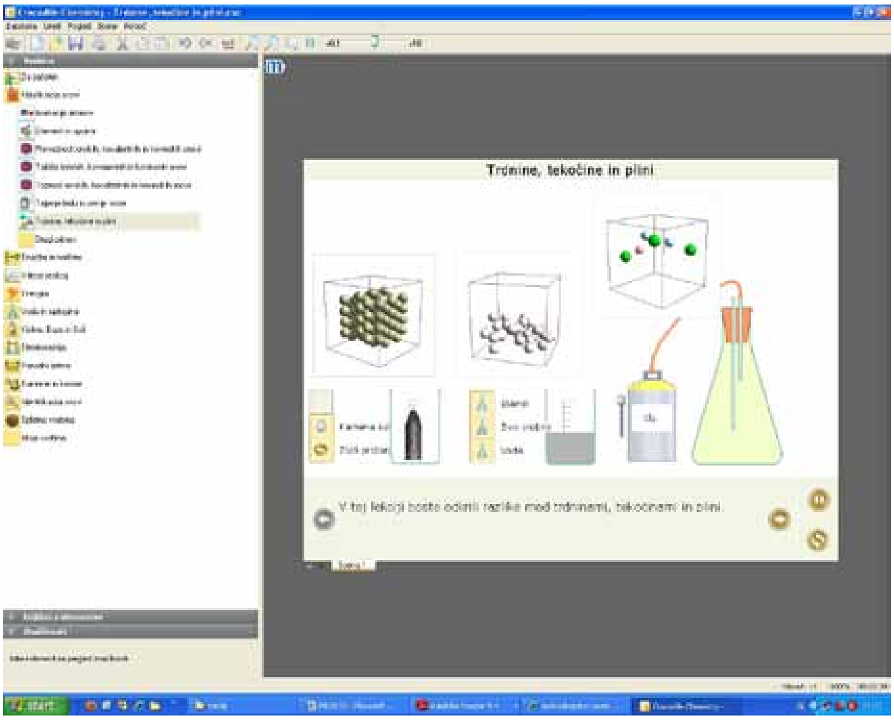


Figure 2: Solid, liquid and gaseous physical state - an example of the content that we used in class with the experimental group.

3 Methodology

3.1 Purpose of the research and methodology

In this study we wanted to determine the effect of chemistry lessons executed in a virtual laboratory in the seventh class of primary school. To study the impact of lessons performed by a virtual laboratory we used an experimental method of the traditional empirical-analytical educational research. Research was conducted in the experimental (EG) and control (CG) group. In the virtual laboratory classroom we used the program Crocodile Clips Chemistry. Lessons with a virtual laboratory were performed in the experimental group. In the control group the teacher taught according to a conventional teaching approach which is used in the classroom. We were therefore interested in the effect on students' knowledge taught by the lessons carried out with a virtual laboratory. Knowledge is reflected on three levels: reproduction, comprehension and application of knowledge. The educational experiment covered chemical contents:

1. substances, their properties and changes,
2. pure substances and mixtures.

3.2 Experimental model

We designed a one factor experiment with two classes as the comparing groups. Research was conducted in the experimental (EG) and the control group (CG). In a virtual laboratory classroom we used the program Crocodile Clips Chemistry. Virtual laboratory classes were performed in the experimental group. The experimental factor had two modalities:

- teaching science according to the standardized curriculum with the traditional approaches used by a teacher in a classroom; describing changes at the macroscopic level and illustrating the reactions with symbols and formulas (symbolic level) (CG),
- teaching science according to the standardized curriculum where the teacher includes a virtual laboratory in the traditional approach that allows to view changes and processes on the submicroscopic level (EG).

To ensure content validity (thorough identification and verification of actual achievements), we studied the effectiveness of the experiment after teaching students the themes *Substances, their properties and changes* and *Pure substances and mixtures* in terms of science knowledge (chemical part), expressed as:

- the total score of numbers on the examination,
- the result of the examination at three levels of Bloom's cognitive taxonomy: knowledge, understanding and application.

3.3 Defining the sample

The didactic experiment involved 38 students (n = 38) of Primary School Ormož. Students attended the 7th class and were eleven or twelve years old.

A select group of students represents, in the context of statistical hypothesis testing, a simple coincidental sample out of a hypothetical population.

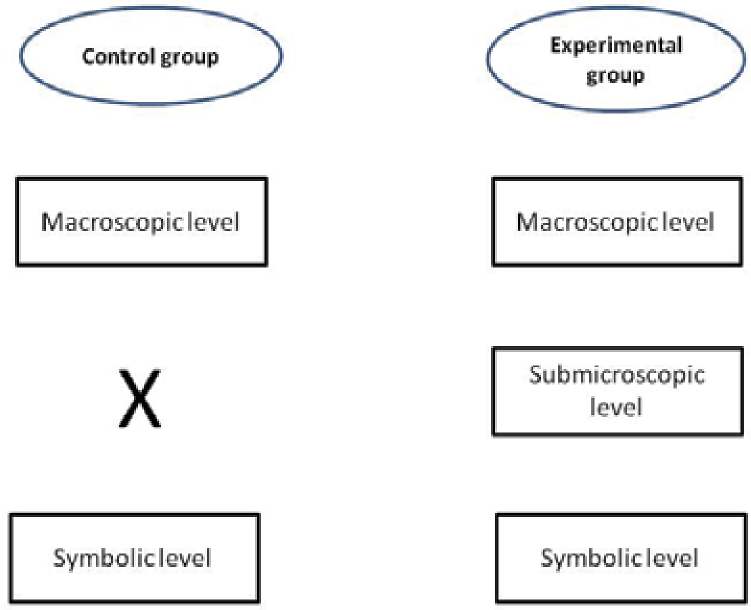


Figure 3: Schematic diagram of the implementation of research in the classroom

Table 2: Number (f) and percentage (f%) of participating students in the experimental (EG) and control (CG) group.

GROUP	f	f%
EG	20	52,6
CG	18	47,4
TOTAL	38	100

3.4 Data collection procedures

Data were collected by testing students' knowledge after lessons. Furthermore we carried out a rational and empirical validation of tests. Rational validation is based on assessing the appropriateness of content and design of the test. For empirical validation we used factor analysis solution, namely the percentage of explained variation by the first common factor (% ex. var. $_{F1}$). Given that the first factor explains 24.5% of the variance and is above the limit of the criterion for the lower limit (20%), we estimate that the examination is valid. To determine the reliability of the examination we used Cronbach's alpha coefficient ($\alpha = 0.832$). This confirms that it is a reliable instrument for assessing knowledge after the experiment. Objectivity of knowledge testing was provided by detailed instructions. Many questions on the test were closed-ended question. The results in both groups were evaluated by the same teacher according to the criteria.

In February 2011 we defined the experimental and control group and by that we gained the necessary information prior to the initiation of the experiment. In both groups (EG and CG) we verified the background knowledge with a test.

In March we carried out a didactic experiment that lasted a month. Following the completion of the didactic experiment we wanted to once again test students' knowledge to diagnose their progress on learning and to compare one group to the other. Knowledge testing after the experiment consisted of 14 tasks (42 possible points). The examination had tasks based on three levels of difficulty:

- knowledge testing tasks (17 points),
- understanding testing tasks (12 points),
- application of knowledge testing tasks (13 points).

Performance evaluation was conducted according to criteria and a scale of possible points.

3.5 Data processing procedures

The data were processed using the SPSS program, treated at the level of descriptive and inference statistics. We used one-factor analysis of covariance for examining differences in the arithmetic mean of scored points on the knowledge testing after the experiment based on the equivalence of the groups at the beginning.

4 Results

Before carrying out the experiment we analyzed the total score on the knowledge testing prior to the experiment.

The assumption of homogeneity of variance, on which the use of the t-test is based, is justified ($F = 0.430$, $P = 0.516$).

As shown by the outcome of the t-test according to knowledge before the experiment there were no statistically significant differences ($t = 0.749$, $P = 0.635$) among students.

Table 3: Results of the t-test of differences in the total score on the knowledge testing among students of the experimental (EG) and control group (CG) group prior to the experiment

GROUP	Numerous n	Arithmetic mean $\overline{x}$	Standard deviation	Test of homogeneity of variances		Test of the arithmetic mean difference	
EG	22	37,23	6,76	F	P	t	P
CG	17	36,18	7,68	0,430	0,516	0,749	0,635

Table 4: Results of one-factor analysis of covariance of differences between the experimental (EG) and control group (CG) of the total score of the knowledge testing after the experiment as a CRITERION VARIABLE with testing their knowledge prior to the experiment

GROUP	Numerous n	Arithmetic mean $\overline{x}$	Standard deviation	Test of homogeneity of variances		Test of homogeneity of regression coefficients		Test of the arithmetic mean difference	
EG	20	32,65	4,88	F	P	F	P	F	P
CG	17	27,29	6,79	1,706	0,200	2,003	0,166	7,718	0,009

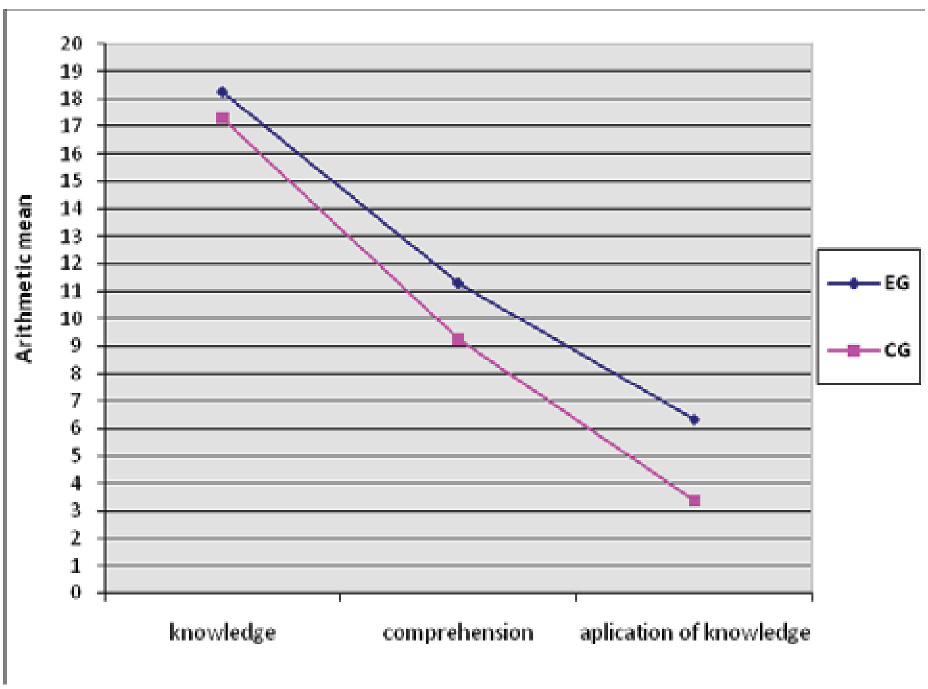
4.1 Knowledge after executing the didactical experiment

After executing the experiment we used a written test for evaluating their knowledge. We analyzed the joint result and the score of all scores achieved on the written test.

Assumptions on the homogeneity of variances (F = 1.706 P = 0.200) and on the homogeneity of regression coefficients (F = 2.003, P = 0.166) were eligible.

The difference between the adjusted arithmetic mean of students' test scores in experimental and control group was statistically significant (F = 7.718, P = 0.009).

Students in the experimental group ($\overline{x}$ = 32.65) were better in knowledge testing after the experiment than students in the control group ($\overline{x}$ = 27.29). According to knowledge the experimental group's students who learned about the chemical contents with a virtual laboratory had the advantage over the control group where traditional lessons were carried out.



Graph 1: The arithmetic mean of students' acomplishments (EG and CG) on the various levels of tasks testing chemical content after the experiment.

4.2 Analysis of differences between experimental and control group on the various levels of knowledge

Knowledge testing consisted of three levels of tasks according to Bloom's taxonomy of objectives for cognitive area: knowledge, comprehension and application of knowledge. The chart below shows the arithmetic mean of individual levels of knowledge when testing knowledge.

The graphical display shows that the line of the experimental group (EG) is above the line of the control group (CG). The score line of the test decreases because the most tasks required students' knowledge, the number of tasks based on understanding and application of knowledge were smaller in number and the score line does not fall because the students were less successful in these tasks. Students of the experimental group scored more points in all three types of tasks compared to the control group of students. Distinct differences are visible in comprehension and application of knowledge. Results in table 5 show whether the detected differences are statistically significant.

a) Achievements on knowledge testing tasks

The results show that the assumption of homogeneity of variance is justified (F = 0.002, P = 0.962) as well as the assumption of homogeneity of the level regression coefficients (F = 0.915, P = 0.346). The difference between the adjusted arithmetic mean of the students' test scores between experimental and control groups was not statistically significant (F = 0.712, P = 0.405). Experimental group's students ($\bar{x}$ = 18.25) were slightly better than students in the control group ($\bar{x}$ = 17.29) considering knowledge testing after the implementation of the experiment. In the reproduction of knowledge the experimental group students did not have the advantage over the control group students.

b) Achievements on comprehension testing tasks

Assumption of homogeneity of variances (F = 2.428, P = 0.128) and homogeneity level of regression coefficients (F = 2.012, P = 0.165) were eligible. Although there is no statistically significant difference among EG and CG students' knowledge after the experiment, there is a statistically significant difference in solving the tasks that were checking students' understanding (F = 6.987, P = 0.012). The acquired knowledge of the students who learned the prescribed content in class using the virtual laboratory ($\bar{x}$ = 11.30) is statistically better than the control group ($\bar{x}$ = 9.25). At the level of concept understanding the students in the experimental group had an advantage over the control group's students.

c) Achievements on application of knowledge testing tasks

Table 5 shows that the assumption of homogeneity of variances of the coefficients (F = 0.090, P = 0.766) and the assumption of homogeneity level of regression coefficients (F = 1.875, P = 0.180) are justified. Results of the overall F-test show that there is a statistically significant difference between the two adjusted arithmetic means (F = 26.096, P = 0.000). Experimental group's students ($\bar{x}$ = 6.35) were exceptionally successful at tasks that required the use of knowledge in comparison to the control group ($\bar{x}$ = 3.76). In terms of application

Table 5: Results of one-factor analysis of covariance of differences between the experimental (EG) and control group (CG) in acomplishments with knowledge, comprehension and application of knowledge tasks as a CRITERION VARIABLE with testing their knowledge prior to the experiment

	GROUP	Numerous n	Arithmetic mean $\bar{x}$	Standard deviation	Test of homogeneity of variances		Test of homogeneity of regression coefficients		Test of the arithmetic mean difference	
KNOWLEDGE	ES	20	18,25	3,21	F	P	F	P	F	P
	KS	17	17,29	3,64	0,002	0,962	0,915	0,346	0,712	0,405
COMPREHENSION	ES	20	11,30	1,92	F	P	F	P	F	P
	KS	17	9,25	2,75	2,428	0,128	2,012	0,165	6,987	0,012
APPLICATION OF KNOWLEDGE	ES	20	6,35	1,71	F	P	F	P	F	P
	KS	17	3,76	2,04	0,090	0,766	1,875	0,180	26,096	0,000

of knowledge the experimental group's students also have the advantage over the control group's students.

5 Discussion

The virtual chemical laboratory gives students and teachers potential educational tools that allow them to introduce new strategies to support higher-level skills: communication and information literacy, self-management knowledge skills, problem solving, independent learning, cooperative learning and the like.

In this study we identified statistically positive impacts in the field of chemical content's knowledge of the experimental group. Experimental group's better results may be justified with the use of virtual laboratory. Students of the experimental group were given the explanation of the phenomena at all three levels: the macroscopic level, the symbolic level and submicroscopic level. The gap between the three levels can largely be overcome by the use of visualization elements (Barke and Wirbs, 2002). Students have the most difficulties in understanding the submicroscopic level - the level of particles. This crucial element was experienced by the experimental group by the use of the virtual laboratory. The advantages of using a virtual laboratory were also demonstrated by the research that took place in the study of analytical chemistry (Zimmerer et al., 2003).

Students of the control group were given classes following the well established curriculum with the traditional approach used by a teacher in the classroom. The changes were shown on the macroscopic and symbolic level including the use of ICT. ICT plays an important role in planning lessons and in their management (Grimaldi and Rapuano, 2009) and allows the introduction of more active forms of learning. Using a virtual laboratory represents an upgrade of the traditional teaching (Chin, 1999) and from this point of view experimental group's students had an advantage over the control group's students. Better designed laboratories on the basis of educational theory can lead to better learning outcomes (Abdulwahed and Nagy, 2009). The study on the effectiveness of the virtual laboratory in e-learning (Rajendran et al., 2010) showed that students prefer to learn using computer aided tools comapred to textbooks. The fact that students prefer to use online virtual labs rather than just reading textbooks was confirmed by the study of authors Sun, Lin and Yu from 2008. On the basis of this research the measured better results of students' knowledge of the experimental group were due to the use of virtual laboratory and therefore greater self-initiative of experimental group's students.

By using the virtual laboratory Crocodile Clips Chemistry we presented the experimental group's students changes on the submicroscopic level and so overcame the gap between the three presentation levels in chemistry. However, this program also has its shortcomings that were not important at this level of education. The basic matter constituents are presented in the form of spheres regardless it is a molecule of water or for example a two-atom element. At this point it is important that the teacher chooses the appropriate tool for students out of a multitude of learning tools. She should choose the tool that is adapted for students, their learning style and abilities in accordance with the curriculum. Many laboratories are merely technological substitutes for the real laboratories where we have computer-based demonstrations of experiments. With such laboratories we are losing the basic elements of the science methodology.

6 Conclusion

We studied lessons with the virtual laboratory as a method of teaching and learning science. Lessons were carried out using the Crocodile Clips Chemistry program. The program offers a large range of different experiments that can be repeated when consolidating and testing knowledge. We can change reaction conditions and examine the course of the reaction on the submicroscopic level. With this we included visualization elements that are crucial for learning and understanding chemistry. Research has shown that even very successful students in solving mathematical - chemical concepts often do not know how to explain what is happening at the level of particles.

The effectiveness of lessons carried out with a virtual laboratory was examined from knowledge's point of view at three levels: knowledge, comprehension and application of knowledge. The statistical tests of differences between experimental group of students who used the virtual laboratory and the control group of students who were taught according to the traditional way of teaching, confirmed three hypotheses and rejected one hypothesis. The unjustified hypothesis was the one concerning the reproduction of the experimental group students' knowledge. The basic empirical findings are:

- We identified statistically significant positive impact on science and knowledge at a higher level of knowledge of the experimental group which was taught the themes *Substances, their properties and changes* and *Pure substances and mixtures* using a virtual laboratory.
- With the reproduction of knowledge the difference between the adjusted arithmetic mean of the students' test scores of experimental and control group was not statistically significant ($F = 0.712$, $P = 0.405$).
- In measuring the comprehension of knowledge we found the experimental group students' performance was better than of control group students' performance. The difference between the adjusted arithmetic mean is statistically significant ($F = 6.987$, $P = 0.012$).
- It turned out that in the application of knowledge that the experimental group gained more knowledge in comparison to the control group as there is a statistically significant difference between the adjusted arithmetic mean ($F = 26.096$, $P = 0.000$).

Virtual laboratory facilitates laboratory work which sometimes cannot be implemented due to physical or other reasons. Using ICT makes science popular among young people. Retaining knowledge through virtual laboratory has proved to be effective in comparison to traditional lessons in terms of knowledge.

The didactic experiment results based on a relatively small, pilot sample of students have confirmed that the method of using a virtual laboratory potentially has efficient and positive impact on students' knowledge. The results encouraged us to upgrade the research in the future with (1) bigger sample across several schools, (2) methodology that will diminish the effect of the teacher/researcher on the knowledge of the pupils and (3) potential international verification.

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Virtualni laboratorij pri pouku kemije – eksperimentalna študija razumevanja, reprodukcije in uporabe osvojenega znanja

Tradicionalni pouk pogosto ne omogoča aktivnejše vloge učenca pri pouku. V kemiji in naravoslovnih vedah nasploh je eksperimentalno in laboratorijsko delo eno izmed najučinkovitejših metod za pridobivanje znanja. Eksperimentalno delo lahko izvajamo tudi v virtualnem svetu. Virtualni laboratorij prinaša nekatere pomembne prednosti. Razumevanje kemije vključuje sposobnost razmišljanja na treh nivojih: makroskopskem nivoju, simbolnem nivoju in nivoju delcev, kjer kot učinkovito orodje lahko uporabimo virtualni laboratorij. Na tej osnovi smo izvedli didaktični eksperiment, da bi preverili učinkovitost uporabe virtualnega laboratorija, in sicer z vidika znanja učencev. V eksperiment so bili vključeni učenci 7. razreda (N = 38). Ob tem smo si zastavili vprašanje, ali so učni rezultati učencev po eksperimentalni zasnovi pouka z virtualnim laboratorijem boljši kot pouk naravoslovja brez vizualizacijskih elementov. Rezultati didaktičnega eksperimenta so pokazali, da je z vidika osvajanja znanja uporaba virtualnega laboratorija učinkovitejša kot pouk, kjer niso vključeni vizualizacijski elementi, ki so ključni pri učenju in razumevanju kemije.

Ključne besede: virtualni laboratorij, naravoslovje, kemijska vizualna pismenost, znanje

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Solving Complex Problems with Help of Experiential Learning

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This paper presents the impact of experiential learning on solving complex problems. Analyzed are methods and techniques of experiential learning as an active form of learning. Presented are the results of research in which we examine whether the systematic approach of problem solving differs between the genders, if the perception of experience as a source of knowledge depends on the level of education, and examine a correlation between searching of all possible ways for successful problems solving and perception of experience as a source of knowledge.

Keywords: complex problem, human resource, training, experiential learning

1 Introduction

Everyday tasks in the workplace require suitably qualified individual who either brought his knowledge with him to the organization or have obtained it during the employment. In the first case, the school system is responsible for appropriate educational programs covering a wide range of knowledge, in the second case, the organization is the one that should take care to meet the individuals' needs of a specific knowledge. We could say that the continuing education and organization's development are directly linked with each other. This means that systematic approach is needed to the process of training, acquisition of knowledge and skills required to achieve the objectives of organization and its development. However, at this point it also must be emphasized that each individual is responsible for both their education and career planning.

By entering the information society the accessibility of information has increased and with it the possibility of using different ways of staff training. Active forms of learning are increasingly replacing the traditional passive forms, by which the use of technology enables interactivity between individuals and learning content. The individual is the one who can choose the time, learning speed and the way that is suitable for him and his needs. Lack of time and the saturation of the individual with information can lead to frustration and consequently to the failure in achieving the set goals. To avoid that a systematic approach is needed to solve both simple and complex problems. That means first of all the identification of the detected problem, the possibility of its solving and search of information that we lack for adequate problem solving. In doing so, organizations use different methods of staff training with the aim of employees' capability to solve complex problems they face at workplace constructively and effectively.

The main aim of this paper is therefore to determine how in general individuals solve problems in their lives, and whether they use previous experiences as help in solving the problems.

2 Theoretical background

2.1 Defining complex problems

Complex problems characterized the problem situation of many different, strongly linked influential quantities of which interaction will be further changing. The main feature of complex problems is therefore the dynamic, the appearance of always new patterns and their mutual relationships (Rosi and Mulej, 2006).

One of the main characteristics of complex problems is their dimensions, which require for their solution the integration of several players with different skills. Complex problems rarely occur quickly and also the available time that the decision makers have for decision is usually longer than for solving simple problems. Therefore, solving complex problems often takes place in groups, teams, because it frequently happens that the current solution turns out to be a new problem. Interconnection of variables within a complex problem can

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also be so extensive, that that the problem in specific time shows to be unsolvable.

The process of complex problem solving must be a process of integration of qualitative analysis and quantitative analysis (Chen and Ding, 2010). The solution is based on qualitative and quantitative knowledge of the decision maker. Qualitative knowledge includes problem knowledge, meanwhile quantitative knowledge includes the model knowledge.

Furthermore, Tuan (2003) argues, that a complex problem consists of two parts: human's incapacity of mental power and human's cognitive dissonance. The complexity is in the observer's mind. The disparate mental activities and the limitations of human's mental power are the sources that lead to dissonance and conflict.

2.2 Methods of solving complex problems

Solving complex problems is a logical process that begins by determination of the problem, continues with analysis what led to unwanted results, noting the individual causes and ends with the decision, an action needs to be done to solve the problem, which is the undesirable situation. We can say that the problem remains, if the resulting state differs significantly from the established state. In other words, if the current situation deviates substantially from what it should be. It is necessary to determine the event or cause that led to the current situation. Just appropriate actions based on an accurate definition of the causes are likely to lead to the goals, improvements.

What exactly we do when we analyze and solve complex problems? In fact, we evaluate previous work and outline the way ahead. We ask ourselves questions that would lead us to the findings and way forward. This requires considerable data and all the correlated information, particularly those that show us the cause of the problem and those that exclude the cause of the problem.

Ability to identify the causes of occurring state is particularly important if we are under pressure of time and work. Then it happens often that we quickly search for a solution and we believe to the first reason, just to get rid of the problem, but usually then find ourselves in a new, more complex problem. It is therefore important to know the appropriate work method. We also have to beat least generally familiar with our work and we have to know where our place is. On this basis we than know what information is relevant (correlated) for us, as well as which we are missing and we have to obtain.

One way of the complex problem solving is reinforcement learning, which is important mechanism in machine learning. Usually solutions involve multiple steps and actions which mean that number of possibilities grows. Reinforcement approaches define problems in a compatible way using algorithms concepts such as states, actions, goals, constraints, costs and distances (Dandurand, Shultz, Rivest, 2007).

We could say that generally in the process of solving complex problems, we distinguish two parts, namely, analyzing problems and making decisions. In both parts we have more levels, which are interconnected. Analysis of problems includes the following steps:

1. First it is necessary to determine what should be achieved; that is an expected standard and then compares it with the actual progress.
2. The problem, which is the deviation from the expected standard, should be precisely defined in terms of content, location, timing and distribution.
3. The cause of the problem is always an event; change, the conditions that led to the unwanted situation. It is necessary to identify and distinguish between what is related to the problem and what is not related to the problem.
4. It is necessary to determine possible causes, consider them according to the information and credibility and gradually move towards the most probable cause.
5. The most likely cause is the one that for the most part explain all the facts and data concerning the occurrence of a specific problem.

Once we define and analyze complex problems, we yet have to adopt a suitable solution to address the problem. Decision-making includes the following steps:

1. Based on the identified situation and the causes, it is necessary to set a goal, decision or action that is in this context.
2. We define a goal regarding of what we have to and what we can achieve.
3. It is necessary to determine possible ways, and alternative actions, that could lead to the goal.
4. We compare possible ways, an alternative action, to each other and evaluated those regarding set goals in light of what we must and can do within an existing organization.
5. Choose the most appropriate way, an action, which is the decision. The most appropriate decision is the one that contains the least undesirable consequences.

Because complex problems cover a number of interrelated changing events, systematically approach to address them is necessary. That means that we have to use appropriate methods, such as experiential learning which is described below.

The complex problem solving can be found in many research fields. It can be used for educational purpose as case studies (Leppävirta, Kettunen and Sihvola, 2011), design engineering (Cavallucci and Eltzer, 2011), cognitivity (Kim, 2012; Dandurand, Shultz and Rey, 2012), decision support system (Klashner and Sabet, 2007) as in many others research fields.

One of them is individual's ability to learn and solve problems. The connection between learning and problem solving can influence the employee performance (Tews, Michel and Noe, 2011). Organizations tend to have strong employee performance to achieve strategically goals. One parameter of employee performance is efficiency of complex problem solving.

2.3 Human resource learning and complex problem

Daily employees face problems which they have to solve in the workplace. Problem solving is on one hand related to decision-making and setting goals of the organization, and on the other hand is related with education and competence of individuals to solve problems. The transformations taking place in society and in organizations require an increasing participation of the individual, an ability to innovate and solve problem, a capacity to learn and opportunity to continue with learning (Žnidaršič and Jereb, 2011).

Organizations need and expect a successful employee, who is every day gaining new knowledge, on the one hand, from practice, from experiences of solving (past) problems, and on the other hand, from theoretical finding and generalization or even others' experiences. Often it turns out that the actual practice is often ahead of theoretical knowledge and so individuals are trained on the basis of informal knowledge obtained with experiences, and not on the basis of knowledge acquired through formal education or theoretical knowledge (Možina, 1991). Even better is that theoretical and practical knowledge are connected, in this case we talk about active learning.

Numerous studies have confirmed that the learning which integrate individual, mentally and emotionally activate him and is personally meaningful and integrated into real life situations, is more effective. Moreover, such learning will give sustainable knowledge that will also be useful in new situations (Marentič Požarnik, 2000). And such learning is active learning. Chickering and Gamson (1987) point out that students with a passive form of learning where they just listen and try to remember the content do not learn much, therefore, they propose that students should be more actively involved in the learning process. About learned they have to talk, write, discuss, and integrate what they have learned with past experiences and they also have to be involved in solving problems. Bonwell and Eison (1991) further add that students should be involved in complex mental processes such as analysis, synthesis and evaluation.

The traditional concept of education that encourages passive forms of learning is no longer adequate or sufficient, especially for education of adults, who already have some practical experience gained with working at particular workplace. Nuissl (2006) points out that the adults in the educational process today more than in the past expect from teachers to take in account their already acquired knowledge and their ability to articulate and communicate it. Adults in the educational process require active learning, which allow them greater understanding and preservation of information that can then be used in different situations and at solving problems in the future.

Active learning includes all learning methods, where student participates actively (Keyser, 2000). One of the common methods of active learning is an experiential learning.

2.4 Methods and techniques of experiential learning

Jarvis (2003) defines experiential learning as a process by which individuals either create or attempt to create meaning on the basis of situations that they are aware of, and then pursue to remember that and transform or integrate results into their life experience.

Experiential learning is therefore on the experience based learning of theory (Fowler, 2007). It is a bridge between theoretical and practical knowledge, or with other words, it links skills gained from literature and lectures with knowledge based on experiences gained through the real life. For experiential learning is important an active involvement in the overall experience, for example, in group events, and at the same time thinking, reflection on experience. The basic assumption of experiential learning is that we learn best if we do something. A central role plays the comprehensive personal experience (Marentič Požarnik, 2000).

Erzar Metelko (1999) says that an experiential learning is a quality and an integrated process of further learning, training and personal growth. Analysis of the experiential learning concept shows that the product of reflection based on experience, including the nature of reflection and quality of experience, is important for general education (Fowler, 2007).

Kolb (summarized from Erzar Metelko, 1999) argues that experiential learning consists of four stages: concrete experience, reflective observation and reflection, the formation of concepts and abstract generalization, and testing of new recognition and generalization to new situations. These rates are repeating and linking in the process of experiential learning. As Kolb argue, the experiential learning is therefore a process in which occurs a creation of knowledge based on changes of experiences and changes in thinking and direct and considered perception of experience (summarized from Erzar Metelko, 1999).

There are many methods of experiential learning. Walter and Marks (1981, summarized from Erzar Metelko, 1999) divide them into the central methods (group interaction, simulation method, the role-play method, brainstorming, etc..), support methods (guided imagination, use of audio-visual means, the process observation) and classical methods (lecture, work with text, writing, case study). But we have to point out that there are stated also some methods that today are no longer classified as experiential learning (eg, lecture).

Marentič Požarnik (2000) divides experiential learning methods into the central methods (simulations, role playing and social games, structured games, group interaction and physical exercise, and relaxation), and support methods (process observation, the time for consideration, fantasy and visualization, terrain experience, excursion, case method, project method and the use of audiovisual means).

The teacher has an important role in implementing and planning experiential learning, and that requires great skills. Teacher must be able to empathize in participants, have to ask himself which areas in participants would like to touch, what are the aims and purposes, but also have to take into account the circumstances - what they are, on which they can influence and on which they cannot (Marentič Požarnik, 2000). One way of achieving these goals is using problem – based learning (PBL) theory, which offers a strong framework that allows all participants to learn real-world, and globally competitive problem solving skills (Pierrakos et al., 2010).

3 Methodology

3.1 Hypotheses

Through the research we wanted to test next hypothesis:

H1: There are no differences in the average of systematic approach to problem solving between the genders

H2: Perception of experience as a source of knowledge varies depending on the level of education

H3: There is positive correlation between searching of all possible ways for successful decision and positive experience with solving problems

H4: There is positive correlation between perception of experience as a source of knowledge and positive experience with solving problems

3.2 Instrument and variables

We tested our hypotheses through a questionnaire. The study was conducted in November 2011. The questionnaire was of the closed type and anonymous.

The questionnaire comprised 31 questions relating to (1) data on the respondent (gender, age and education), (2) factors relating to analyzing problems, (3) factors relating to using experience in solving the problem and (4) factors relating to decision-making.

Variables used in our research are the following:

1. General data
   - S1 Gender
   - S2 Age
   - S3 Education
2. Problems analyzing
   - S4 I can notice a serious problem
   - S5 I confront the problem
   - S6 I approach to the problem systematically
   - S7 The problem upsets me
   - S8 The problem is a challenge for me
   - S9 I take time to explore causes of the problem
   - S10 I analyze causes of the problem by relevance
   - S11 I analyze consequences of the unresolved problem
   - S12 I consult with colleagues about the causes of the problem
   - S13 I am not bothered with others' problems
3. Using experience in solving problems
   - S14 At the problem I am looking of parallels with similar problems in the past
   - S15 Experience with solving problems in the past personally enriching me
   - S16 I had positive experience with solving problems in the past
   - S17 I solve problems with help of associates' experience
   - S18 I forget the problem and its solution in the past
   - S19 Experiences are a source of my knowledge
   - S20 I keep going back to the to the analysis of past problems
   - S21 I doubt in my previous decisions
4. Decision making
   - S22 Before deciding I set myself the goal that I want to achieve
   - S23 I analyze situations that I can avoid at decision-making
   - S24 I search for all possible ways for successful decision
   - S25 I analyze ways and evaluate them in terms of performance for successful decision
   - S26 Of all the ways leading to the decision to decide for the fastest
   - S27 Of all the ways leading to the decision to decide for the least harmful
   - S28 I search for new information before decision-making
   - S29 When I decide I do not think anymore about the decision
   - S30 I take time for decision-making
   - S31 Before I decide I discuss with associates

Respondent's perceptions (questions S4 to S31) were measured on a scale ranging from 1 to 5 where: 1 – never, 2 – rarely, 3 – sometimes, 4 – often, 5 – always.

For questions 4 to 28 the Cronbach's alpha coefficient was calculated. The value was 0.684 which indicates good reliability of measurement. With regard to the composition and characteristics of the sample, we believe that it is representative.

3.3 Sample

Participants in this study were employees from different sectors (industry, service and educational institutions). They were selected randomly and participation was voluntary. The sample consisted of 26 (52%) women and 24 (48%) men (N=50). The age range of respondents was between 20 and 60 years, where 17 respondents were below 21 years old (34%), 12 between 21 and 30 years (24%), 11 between 31 and 40 years (11%), 8 between 41 and 50 (8%) and 2 respondents were more than 51 years old (2%). The education of respondents was from secondary education to PhD.

3.4 Results

We begin by constructing the frequency tables (Table 1) for the variables we have used in our research.

The first set of statements referred to the problems analyzing. Respondents' answers were fairly different. Answers varied the most at the question of whether they consult with colleagues about the cause of the problem (S9). The arithmetic mean at this question is 3.26 with a standard deviation of .986. Most alike were respondents at the first argument (S1), if they can detect a serious problem. At that question they only answered the questions with answers sometimes, often and always (Mean=3.92, Std. Deviation .528).

The second set of statements referred to the using experience in solving the problem. Again the answers were quite spread. Most responses have differed on the question if experiences with problem solving in the past personally enrich-

Table 1: Frequency tables for the variables

	N		Mean	Median	Std. Deviation	Minimum	Maximum
	Valid	Missing					
Analyzing problem							
S4	50	0	3,92	3,91[a]	,528	3	5
S5	50	0	3,98	4,00[a]	,654	2	5
S6	50	0	3,66	3,61[a]	,772	2	5
S7	50	0	2,84	2,80[a]	,792	1	5
S8	50	0	3,20	3,21[a]	,857	1	5
S9	50	0	3,34	3,38[a]	,848	1	5
S10	50	0	2,96	2,94[a]	,880	1	5
S11	50	0	3,26	3,31[a]	,965	1	5
S12	50	0	3,26	3,31[a]	,986	1	5
S13	50	0	3,04	3,06[a]	,903	1	5
Using experience in solving the problem							
S14	50	0	3,72	3,75[a]	,882	2	5
S15	50	0	3,94	4,05[a]	,913	2	5
S16	50	0	3,52	3,53[a]	,614	2	5
S17	50	0	3,08	3,12[a]	,829	1	5
S18	50	0	2,52	2,47[a]	,909	1	4
S19	50	0	3,98	4,06[a]	,892	2	5
S20	50	0	2,54	2,55[a]	,813	1	4
S21	50	0	2,40	2,40[a]	,756	1	4
Decision making							
S22	50	0	3,90	3,91[a]	,839	2	5
S23	50	0	3,46	3,50[a]	,813	1	5
S24	50	0	3,72	3,74[a]	,809	2	5
S25	50	0	3,10	3,17[a]	,763	1	4
S26	50	0	3,14	3,15[a]	,969	1	5
S27	50	0	3,72	3,73[a]	,757	2	5
S28	50	0	3,76	3,84[a]	,894	1	5
S29	50	0	3,24	3,21[a]	,916	2	5
S30	50	0	3,60	3,62[a]	,756	2	5
S31	50	0	3,04	3,11[a]	,880	1	5

a. Calculated from grouped data.

Table 2: T test for hypothesis one

Independent Samples Test								
		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
S6	Equal variances assumed	,006	,940	-,671	48	,506	-,147	,220
	Equal variances not assumed			-,671	47,701	,506	-,147	,220

ing them (S12), although none of the respondents answered this question with never. Mean at this question is 3.94, Std. Deviation is .913. The most common responses were at the question of whether they have positive experience with solving problems in the past, where also none of the respondents answer with the answer never (Mean is 3.52, Std. Deviation is .614).

The last set of statements referred to the decision-making. Most responses have differed on the question of whether of all of the ways leading to the decision they choose the fastest. Here the Std. Deviation is .969, Mean 3.14. For none of the question in this set the respondents have not been uniform.

In our research we assumed that there are no differences in the average of systematic approach to problem solving between the genders (H1). To test this hypothesis we used Independent-Samples T Test. As we can see in Table 2 there are no statistically significant differences between genders regarding systematic approach to problem solving.

Further we assumed that perception of experience as a source of knowledge varies depending on the level of education (H2). One-Way ANOVA was used to test this hypothesis. As we can see in Table 3 perception of experience as a source of knowledge differed significantly between education levels, F (5, 44) = 7.075, p = .000.

In our research we also assumed that there is a positive correlation between searching all possible ways for successful decision and positive experience with solving problems (H3). We tested hypotheses with Pearson's correlation coefficient and confirmed the correlation at 0,01 level (r=318).

In the last hypotheses we assumed that there is positive correlation between perception of experience as a source of knowledge and positive experience with solving problems (H4). We tested hypotheses with Pearson's correlation coefficient and confirmed the correlation at 0,01 level (r=318).

4 Discussion

Our research shows that most respondents can detect a serious problem and they have faced with the problem. They also mainly believe that their experiences in solving problems personally enrich them and that experiences are source of their knowledge. Before decision-making they set a goal they want to achieve.

First we tried to find out if there is any difference in systematic approach to problem solving between women and men. From our research and data collected in our survey we have found out that there is no statistically significant difference between genders regarding systematic approach to problem solving. Through Independent Sample T Test we verified our first hypothesis.

Our second assumption was that perception of experience as a source of knowledge varies depending on the level of education. We tested this hypothesis through One-Way ANOVA and learn that perception of experience as a source of knowledge differed significantly between education levels. The significance value comparing the groups was .000 so we confirmed our second hypothesis.

Further we tried to find out if there is a positive correlation between searching all possible ways for successful decision and positive experience with solving problems (H3) and between perception of experience as a source of knowledge and positive experience with solving problems (H4). We tested our last two hypotheses with Pearson's correlation coefficient. Based on our research and data collection we can argue that

Table 3: One-Way ANOVA for hypothesis two

Experience are source of my knowledge					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	17,373	5	3,475	7,075	,000
Within Groups	21,607	44	,491		
Total	38,980	49			

Table 4: Pearson's correlation coefficient for hypothesis three

		I try to find all possible ways for successful decision	I had positive experiences with solving the problems in past
I try to find all possible ways for successful decision	Pearson Correlation	1	,381**
	Sig. (2-tailed)		,006
	N	50	50
I had positive experiences with solving the problems in past	Pearson Correlation	,381**	1
	Sig. (2-tailed)	,006	
	N	50	50

*** Correlation is significant at the 0.01 level (2-tailed).*

Table 5: Pearson's correlation coefficient for hypothesis four

		Experience are source of my knowledge	I had positive experiences with solving the problems in past
Experience are source of my knowledge	Pearson Correlation	1	,429**
	Sig. (2-tailed)		,002
	N	50	50
I had positive experiences with solving the problems in past	Pearson Correlation	,429**	1
	Sig. (2-tailed)	,002	
	N	50	50

*** Correlation is significant at the 0.01 level (2-tailed).*

there is a positive correlation between searching all possible ways for successful decision and positive experience with solving problems as well as between perception of experience as a source of knowledge and positive experience with solving problems. Both correlations were confirmed at the 0,01 level.

Data collected from the sample of 50 respondents confirmed all four hypotheses set up on reviewed literature. Based on the reviewed literature and results from our research we can conclude that analyzing problems and use of experiences contribute to successful problem solving and decision.

Before conclusion several limitations of this study need to be considered. First, we used small representative sample and second, the discussed findings were obtained from single study, therefore generalizing the results should be done with caution. Also, important to point out is that respondents in the questionnaire evaluate themselves, which means that answers are their subjective opinion and it might depend on current circumstances and well-being. For further research it would also validate to use the research model of this paper on a bigger and diverse sample as well as restrict the samples to specific group and do a comparative analysis between the groups.

7 Conclusion

The main aim of this paper was to determine how in general individuals solve problems in their lives, and whether they use previous experiences as help in solving their problems. With the analysis we also tried to determine to what extent experience assist individuals in decision making process. Our research shows that individuals mainly believe that their experiences in solving problems personally enrich them and that experiences are source of their knowledge. Before decision-making they set a goal they want to achieve. Our research also shows that analyzing problems and use of experiences contribute to successful problem solving and decision. Therefore it is important to stress the role of experience and experiential learning in solving problems, which is the main emphasis of this paper.

To conclude, individuals are daily facing problem-solving. Despite that, the nature of the problems changed over the decades to a certain extent, mainly due to access to information and development of humanity itself. Individuals today are often not able to solve complex problems occurring in the workplace; therefore it is necessary to train them appropriately. Solving complex problems requires cooperation between various participants with different skills and with the aim of taking appropriate decisions. In this context, participants use different learning methods and techniques to solve complex problems, which assist individual in resolving work-related tasks and their related problems.

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Reševanje kompleksnih problemov s pomočjo izkustvenega učenja

V prispevku je predstavljen vpliv izkustvenega učenja na reševanje kompleksnih problemov. Analizirane so metode in tehnike izkustvenega učenja kot aktivne oblike učenja. Predstavljeni so rezultati raziskave v kateri smo ugotavljali ali se sistematični pristop reševanja problemov razlikuje med spoloma, ali je dojemanje izkušenj kot vira znanja odvisno od stopnje izobrazbe, ter ugotavljali povezavo med iskanjem vseh možnih poti za uspešno reševanje kompleknih problemov in dojemanjem izkušenj kot vira znanja.

Ključne besede: kompleksni problem, kader, usposabljanje, izkustveno učenje

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Using the 3D Virtual Environments for Teaching: Report from the Field

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Virtual worlds represent a powerful media for instruction, offering a wide scope of tools for social interaction and innovation in learning that encourages student participation. Supported by the AVATAR course, teachers were able to productively create teaching and learning environments that support the needs of learners of diverse linguistic, cultural and economic backgrounds, all within a safe virtual environment. This paper outlines the AVATAR course structure, delivery, experiences, and post course reflections on teaching within a 3D virtual world.

Key words: e-learning, 3D virtual environment, course structure, experience

1 Introduction

Despite being in the age of computers, the use of Information and Communication Technology (ICT) in teaching is still lacking, and this has become a predominant issue in secondary schools throughout Europe and around the world. Even with the educational benefits and social learning opportunities that ICT promotes, the application of computing, and more specifically digital game activities, are mostly introduced by individual teachers and related to their increased efforts in preparing lessons. Magnussen, (2007) argues that game like activities are highly engaging for the students, but the role of the teacher as facilitator is paramount to the success of the learning outcomes. Pivec and Pivec (2011) further emphasize that the advantages of using digital games and innovative ways of teaching can only be realized if the games and game like activities are designed correctly, are used in the appropriate environment, and employ a suitable pedagogical framework.

Research results from many European funded projects suggest that either video games or the interactive environment that they create can enhance the learning process (AVALON, ENGAGE 2012, Games in Schools 2012, IMAGINE 2010, MUVEnation). Digital games, Virtual Worlds, and their appropriate use for education vary considerably. Commercial educational games such as Ludwig, physics adventure game, have the quality of recreational games and include defined learning outcomes. These games employ an interface very similar to the popular commercial adventure game "*Myst*" from the game publisher UbiSoft (2007), and provide an interactive storyline that transports the player into a virtual world of fantasy and creates an immersive environment. Reese (2007) suggests that these virtual worlds have the potential to create player immersion (Pivec & Pivec, 2007) and cites the concept of flow from Czikszentmihalyi (1990). Reese advocates that virtual worlds should be used as an alternate space for learning because of this immersive quality.

However, the uptake of this technology in the classroom has been slow with the major barriers being a lack of knowledge by the teacher in how to use the resource, a lack of time to prepare in adapting the game for the curriculum, and a lack of adequate technology, as outlined in Pivec (2011). Educators and especially teachers, are trained in traditional methods of delivering lesson plans that do not usually include the use of digital games and interactive technology in the curriculum. They cannot be expected to know how to integrate digital games or other 3D virtual worlds into their lessons to achieve the desired learning outcomes.

The AVATAR project (2011) was aimed at enhancing the level of ICT use in education and provided teachers with relatively new methodological and pedagogical tools. In the early stage of the project, research and comparative analysis on existing virtual world platforms were conducted, assessing the quality of teaching/learning features and functions, as well as compiling best practice cases and interviews with experts. Subsequently, a course on teaching and learning in virtual worlds was designed and piloted in-world with approximately 120 secondary school teachers from 6 EU countries. It was offered to teachers from secondary schools in Austria, Bulgaria, Denmark, Italy, Spain and the United Kingdom. The course and related activities were developed to increase the

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motivation of teachers (and students) by creating interdisciplinary and international network of teachers developing and exchanging teaching material and practice, thus improving the quality of teaching.

The pedagogical perspective of the course was built around self-directed learning and tutorials, in combination with group activities in e-learning and activities in a 3D virtual world (v-learning) environment. Activities were designed to facilitate informal and formal learning, encouraging participants to reflect on their own learning experiences, sharing their findings with the international community of teachers, and enabling them to set and pursue personal learning goals. The practical work made it possible to explore virtual worlds and gain first-hand knowledge of their potentials and pitfalls.

Quantitative and qualitative evaluation methods were applied during and after the course. During the course, an ongoing evaluation of module contents was carried out by means of feedback questionnaires and self-reflection phase at the end of each module. With the aim to gather more detailed information on didactic methodology, quality of content, and users satisfaction, an online post course survey was carried out. In addition, national focus groups and user interviews were conducted to get more detailed information as well as to explore the transferability of the AVATAR course to other segments of formal or informal learning.

In the next chapter, the AVATAR course structure, aims, learning objectives, timeline, and method of delivery are outlined. In the last chapter of this paper, a collection of post course reflections on teaching within a 3D virtual world outlines the appropriateness of such an environment for teaching and added value for the learning experience. With the intention to highlight some doubts and challenges that course participants were facing, interview excerpts are also included in the paper. The paper concludes outlining the success factors for teaching within virtual worlds.

2 AVATAR course

The course offered support for teachers integrating ICT based pedagogy and included approximately 100 hours of learning activities broken down into group activities, individual study, planning and carrying out the project work with students. The course was delivered through both an e-Learning and a v-Learning platform comprising of a mix of tutorials, individual and group activities, and practical tasks. The 3D virtual world of Second Life (SL) was used for the course delivery for the participating teachers. National groups of teachers were moderated by national moderators (virtual world experts), who communicated in their native languages. Participants also partook in transnational activities and reflection in English.

During the four months, the course covered educational design of virtual world teaching, the management and construction of virtual objects, and learning environments and examples of learning activities within virtual worlds. During this time, teachers developed project work and used it directly in the classroom with their students. The project work incorporated a practical application of knowledge and skills gained during the course with regards to the creation of a virtual world learning environment and learning activities for a specific subject.

The overall learning objectives of the AVATAR course were for the participants to:

- develop skills and confidence in using various social internet resources as well as massively multi-user online worlds such as Second Life
- develop a deeper understanding of these environments and their uses with regard to learning scenarios
- gain knowledge of teaching methods, best practices and educational design usable in virtual worlds
- identify and reflect upon the efficacy of the outcomes of different learning activities carried out in-world
- design strategies, activities and resources for learning different subjects in virtual worlds
- integrate virtual worlds as an innovative means in their daily teaching
- experience virtual worlds with their students
- evaluate the educational use of virtual worlds in their classrooms

To achieve these objectives, the course was offered in nine modules with activities as follows:

Module 1 Introduction Module; Access to the E-learning platform and course overview

Module 2 E-Learning Platform Introduction Module; Socialisation and getting to know the functions of the E-learning platform

Module 3 V-Learning Platform Introduction Module; Accessing Second Life, acquiring basic skills, accessing Second Life support resources

Module 4 V-Learning Intermediate Module; Search for resources, building groups and communication in Second Life

Module 5 V-learning Advanced Module; Basics of object creation in Second Life

Module 6 V-Learning Advanced Module; Advanced course for object creation in Second Life

Module 7 V-Learning Educational Design Module; Introduction to different teaching methods in Virtual Worlds

Module 8 Ongoing V-Learning Seminar; Discussion with experts on different teaching methods in Virtual Worlds

Module 9 V-Learning Project Work; Designing and piloting a lesson plan with class of students

As depicted in the Figure 1, in the timetable of the course each of the modules 1-6 lasted for one week, during this week the participants were expected to spend about 5 hours per module. Modules 7 and 8 run for five weeks, in parallel to modules 3 – 6. There was one activity per week and per module planned, in total 5 activities per module. Participants were expected to invest 3 hours per week to accomplish one activity, i.e. 6 hours per week for activities of both modules.

The delivery form of these modules was based on knowledge exchange and sharing experiences via e-learning and v-learning platforms, in a mix of provided resources, invited presentations of use cases, and discussions. Resources encompassed several book titles, uploaded articles and web-articles,

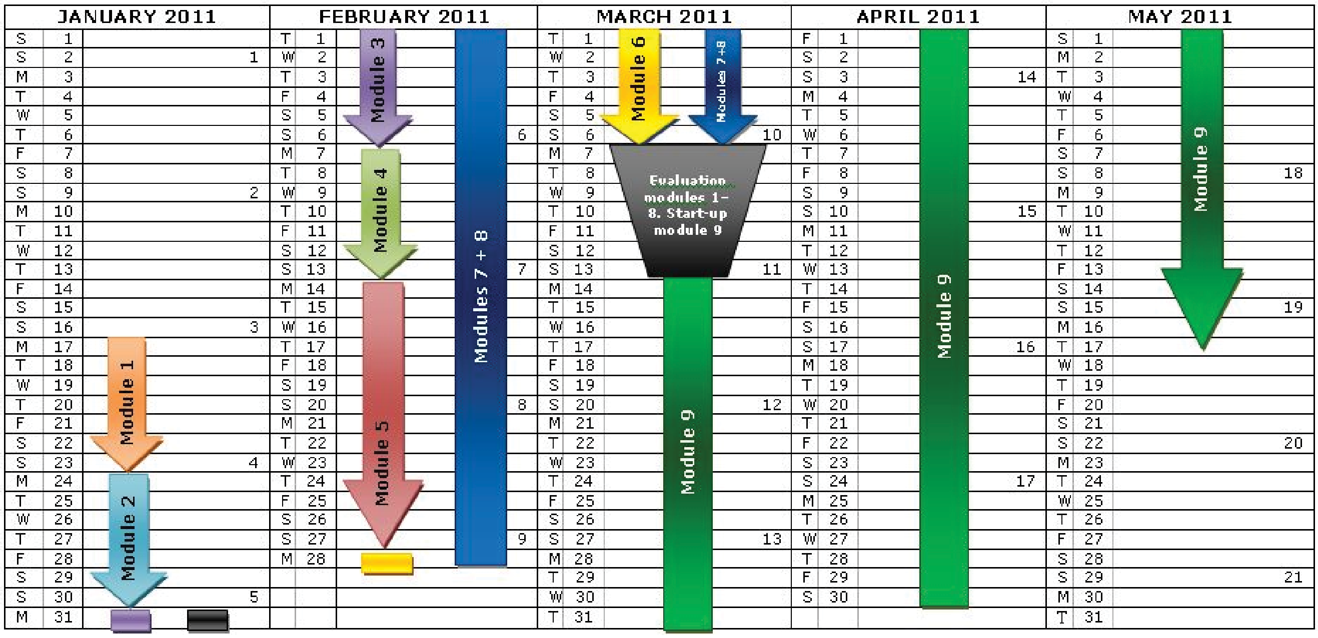

Figure 1: Timetable of the AVATAR course

guides for teaching in SL (Second Life), videos and links covering teaching practices in different disciplines using SL, from science, art, history to demonstrations of physical phenomenon, museum exhibitions, to language learning. Within SL there was an AVATAR estate Retrieved , offering quick start guides in several languages, science and art guided tours in SL, two theaters for exchange of experience and socializing, "shopping alley" with smorgasbord of building resources, and sand box estates for teachers to prepare their classes.

The aim of modules 7 and 8 was to provide more understanding of what Virtual Worlds and Massively Multiuser Online Games and worlds are, and how they are used for teaching and learning. The focus was in particular on Second Life, its culture and how it has and can be used in educational contexts.

As part of the activities of Module 8, there were three synchronous sessions with experts carried out within SL. The sessions were in form of presentations of good practice, which ended with a guided field trip exploring teaching resources. During the first session an expert from Denmark provided hints and basic building skills on how to create your own learning objects and environments for teaching English. The second session was guided by an Austrian expert on language learning in SL, followed by another Danish expert who named her session "Making history come alive".

Although the Module 8 was optional, 20 – 25 teachers participated at each of the sessions. Some of the sessions were also recorded and videos were uploaded to the forum as a resource. SL sessions with experts were very well accepted and provided an ideal opportunity to benefit from more experienced users, to get ideas and practical instructions of what works, and to ask for advice related to one's own ideas. Some resources that were demonstrated at these sessions were later incorporated by participants when creating their own lessons, e.g. using the Robin Hood Quest which is available in Second Life at the British Council Isle, as part of SL activities in the subject of teaching English as the second language. See Pivec et al. (2011) for more details on the practical work with students and their results.

Module 9 V-Learning Project Work was carried out during the last two months of the course. The purpose of the project work was to support teachers in designing their virtual world course or lesson, and subsequently piloting it with their students. Teachers had to structure their ideas by filling out a template. Besides the description of class and level, subject and learning goals, they had to consider how many students they plan to have within the class, the technical requirements and support, as well as plan for v-objects and other resources they might need. Teachers shared their plans with other participants in the forum, where other colleagues commented on their ideas and helped with hints on tools that they had discovered.

3 Reports from the field

After the end of the AVATAR course, an online survey on didactic methodology, quality of content, and user's satisfaction was carried out by an independent external evaluator, as outlined in the AVATAR course (2011). In total, 36 teachers responded to the post course online survey.

According to the official project figures, 123 teachers enrolled in the AVATAR course, 65 teachers attended the training, 55 dropped out and 3 acted as observers. The reasons for dropping out as stated by the course attendees via different communication channels included, i.e. personal e-mails, forum postings, module feedback questionnaires or final course survey, can be grouped into four categories: lack of interest, lack of time, technical problems, and lack of support.

More than half of the participants answering the post course online questionnaire (61,1%) underlined the difficulties of finding time to follow the course. Out of 65 attending teachers 26 completed the course, including carrying out the project work with their students.

Several questions were asked to evaluate why teachers would consider the application of SL for teaching. From 35 participants answering the survey, 82% shared the opinion that SL is an appropriate environment for teaching, and state:

- SL is an appropriate training environment, because it provides quick and easy access to different places and events which in real life can hardly be seen or visited.
- SL is useful if you have students who live far away and cannot come to school each day.
- It supports to learn foreign languages but the speed of the PC has to be efficient to enable collaboration classes from other countries.
- Part of the teaching today should also take place in virtual worlds. The young people know virtual words through their online computer gaming and can bring their competences into the learning scenario.
- Valuable teaching activities that supplement real life teaching can also take place in Second Life, especially international collaboration projects between countries.
- In the case of teaching English you have a unique opportunity to work in real time if you find collaboration partners.
- SL is the best tool for simulations; virtual tours are suitable for everything.
- SL offers an interactive way, more in line with how students interact in the modern world. Teaching in SL enables students to have the benefits of active learning.

Furthermore, many of the teachers outlined various ways of interaction that increase motivation, explorative learning, and pro-active behavior of students as added value for teaching in Second Life. Some of these explanatory statements are:

- Using SL as a teaching method makes learning easier and fun for students. It improves communication skills as well as negotiation skills of the participants/students.
- The interactivity offered in SL is a new way of teaching. You can visit or view places far away or impossible to visit.
- Looking for other ways to make my teaching subject more exciting to students.
- Teaching in SL gives better visualization of the subject for better understanding of the matter.
- It gives the opportunity to engage in a new way of learning. It increases the motivation and interest for the subject.
- Via their avatar the students become more liberated - especially in language teaching, they dare to do more without feeling exposed.
- Students can act by themselves and solve problems in groups more easily than in face-to-face teaching.
- It provides an environment where students can play, cooperate, help each other and meet with students from other countries.
- They can see the world, fly, play music, perform, change appearance, have fun and forget that they are actually learning new skills, and English by participating.
- The possibility to integrate the real life teaching with activities which aren't always possible in a traditional lesson, i.e. virtual travels in distant places, experiments, meeting and talking to native people etc.
- The added value is related to the way students can improve their competences in the use of ICT tools and in the foreign language. (This is true for my project work. Students can improve their competences in many other subjects, obviously.)

However, eighteen percent of surveyed teachers disagreed, and further explained why they do not consider SL as appropriate teaching environment: These statements were:

- Maybe in some teaching subjects like architecture SL is useful, but not in general.
- It takes too much time to establish the environment.
- It is one of the possible ways but it is not "exhaustive", i.e. not all can be done in, it does not cover everything.
- You can hide your person - teaching needs personal contact.
- It is too complicated and school ICT is too slow to cope with it.

Parallel to the online post course survey and to collect more in-depth feedback on the course, focus groups and interviews with participating teachers were carried out in each partner country. Findings from these focus groups are presented in form of factors to success for teaching in the virtual worlds, are tabled at the end of this chapter. In addition, a personal reflection on the course experience and observations from piloting phase from an Austrian teacher of mathematics in the secondary school is enclosed as an individual case study. This teacher was very pro-active and had a high personal motivation and interest in teaching with technology.

Which were the most surprising aspects of the Avatar course?

That the other people that I met in-world were very supportive and trough Second Life (SL) I found a lot of mathematicians in America – there was active exchange and support from them for my problems and class experiment design.

One pupil from my group, otherwise performing rather poorly, really profited from the course. He resolved all the tasks without any help and performed in the test for couple of grades better.

Which were the most disappointing aspects of the Avatar course?

That the participating teachers in the AVATAR course were not establishing projects together (on international bases)! Several times I contacted other teachers teaching similar subjects, but there was no response.

Did you do anything differently as a result of the course?

When teaching in SL one needs to teach differently. The pupils can actively experiment and experience things – that is the bases of the teaching approach in SL.

Did you develop new interests as a result of the course?

At the beginning I was very skeptical regarding the SL (has often bad image and bad publicity with topics as children porno, marketing…), but the experience of the SL was positive, there are a lot of possibilities what one can do there. One of the American professors has developed in Open Sim classes for math and invited me also to co-use the facilities.

However in Europe the distances are not such a problem, therefore people are mainly at campuses and sitting in the classrooms together, and do not recognize or see the advantages of using SL for learning.

After the project work with students, teachers from the AVATAR course outlined several factors to success for teaching in the virtual worlds. These practical advices can be further expanded by activities and hints how to manage various situations, catalogued in the Design Patterns for Teaching in Virtual Worlds (MUVENATION, 2011).

- Introduce the students to netiquette, so that they can interact with other avatars in the virtual world without causing offence.
- Support the students in-world by offering note cards with SLURLs, instructions etc.
- Provide a framework of modules that explain the task and related completion deadlines.
- Ask a colleague to help you with the students at the beginning of the in-world lessons, e.g. to give them support and guidance in case of technical problems or difficulties to find the class location, so you can focus on planed activities.
- Virtual worlds add an international dimension to language teaching as well as they provide interaction that motivates students to learn foreign languages.
- The AVATAR course proved to be virtual competence development for the participating teachers.
- Inform colleagues (teachers) and your didactic manager of the activities that you will carry out in-world; they will contribute to motivating the students.
- Involve the technical staff in your school at an early stage of your project, they will help you with all the technical problems (open Firewalls, install Viewer, etc).
- Valorize the work of your students.

4 Conclusions

Based on course results and collected feedback, the AVATAR course was well accepted by teachers and helped them to introduce new practices in their teaching. Teachers appreciated the on-line support by national moderators as well as discussions within international forums. Furthermore, the provided video tutorials on how to build in SL, textures and building blocs, and SL (Second Life) expert help were very important to overcome personal and technical barriers at the beginning of the course. Novice users of SL needed a lot of time for first steps and to practice basics. Participation in the SL part of the course required good equipment and a good Internet connection to be provided by the institutions.

Teachers reported on higher motivation and involvement of students due to the virtual classes, often taking the initiative and even volunteering to support their colleagues or create parts of practical lessons. In several cases students used the competences acquired in SL at other school projects to create added value thus achieving better results.

SL as learning and teaching environment can be also applied in other areas e.g. higher education students can access many available resources for exploratory learning with age limitations. Due to in-world the interactions with avatars, SL is very appropriate for learning communication skills and practicing languages. In general SL can motivate people to socialize, speak other languages, explore historic sites – it can be very inspiring in many different areas.

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Uporaba 3D virtualnih okolij za učenje: poročilo iz prakse

Virtualni svetovi so interaktivni medij z velikim potencijalom za pouk, ki ponuja širok obseg orodij za vzpodbujanje socialnih interakcij. Z inovativnimi pristopi k učenju motivirajo aktivno sodelovanje študentov. S pomočjo projekta AVATAR in ponujenega dodatnega izobraževanja, so bili učitelji sposobni ustvariti produktivno učno okolje in izvesti učne vsebine iz različnih področij v varnem virtualnem okolju. V članku je opisana struktura in izvedba AVATAR izobraževalnih modulov, ter podane izkušnje in razmišljanja učiteljev o poučevanju v 3D virtualnem svetu.

Ključne besede: e-učenje, 3D virtualni svet, struktura izobraževanja, izkušnje

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Trends in ICT and Multimedia Supported Education

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The formal educational system is facing different problems regarding adaptation towards the needs of a modern knowledge society. In the article, two important and comprehensive challenges to today's formal educational system are discussed and commented upon. The first problem is the incoherence between the needs of the labor market and formal education system outcomes in terms of graduated students. Another problem is the distancing between the prevailing traditional pedagogical methods within formal educational institutions and the ways in which students acquire information and knowledge outside of the schools as they are becoming less and less interested in traditional lectures. It is argued that specific information and communication system technologies (ICT) supported mechanisms, such as social learning and virtual communities may address these challenges. Theories of communities and social learning that may be useful for implementation in the education system are explained and practical implementation is proposed.

Keywords: ICT supported education, social learning, virtual communities, credibility gap, multimedia education, e-learning

1 Introduction

The transition towards a post-industrial or knowledge-based society brought many changes in the daily lives of individuals, as well as organizations and corporate environments. These changes were rapid and accompanied by a large amount of information to be accepted, processed and understood. One of the areas affected by changes is education.

The authors of the article have already been contributing to the introduction of modern ICT into the formal education system of the Republic of Slovenia for more then ten years. Their e-learning system E-CHO (http://www.e-gradiva.si), along with multimedia courses are being used in elementary and secondary schools with more then 15000 regular users (teachers as well as students). The authors of the article are also studying the ongoing work of other projects and commercial providers in this field. In recent years there have been large financial investments, as well as organizational and implementation efforts of policy makers, experts and providers involved. However, when compared to the total number of students and learning practitioners, as well as to the variety of options provided by modern technologies, the success of introduction and use of ICT in schools in Slovenia are still not satisfactory. Students use ICT outside of schools to much greater extent then within the educational process. The majority of learning practitioners use ICT only to present their learning materials to students in a traditional way.

Based on the experience and an overview of the current situation, the authors identified two crucial challenges which have not yet been addressed, in order to increase the use of modern ICT in schools and to adapt the formal education system to the new era. The first challenge is to overcome the increasing credibility gap between the outcomes of the formal education system and expectations of the knowledge society employers. The second challenge is to adjust the knowledge transfer methods of the formal education systems to the most common information and knowledge acquisition manners of today's youth. Both challenges are addressed in this article. Possible solutions are provided, discussed and commented upon.

The hypothesis presented in the article is, that specific modern ICT concepts derived from virtual communities and social networks may couple the schools with the industry environment and bring the formal educational environment nearer to today's pupils and students without having to perform any complex structural changes to the education system itself.

1.1 Formal educational system today and tomorrow

The current formal educational system was first established in the mid 19^{th} century. As industrial society was under development, the system delivered only basic knowledge and

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skills. It was mostly oriented towards forming the working force. Knowledge needed at the work place included repetitive activities only and didn't change within the life time of an individual.

Since then, the basic concept of the formal educational system hasn't changed much. In the 20th century quantity of knowledge transferred from educational practitioners to learners expanded; however it was still designed according to the principle of "one size fits all". All learners were treated the same, given the same content and the same didactical methods.

Today we are becoming more and more aware that individuals have different talents, characters and different interests related to our work and education, yet the formal education system has not adapted. The formal curricula still mostly consists of repetitive knowledge/skills and does not adapt to the needs of the modern society, i.e. to the needs of the industry environment or take into account the future work places on any positions. Thus, **the credibility gap** is expanding as expectations and demands of the employers vary from the actual knowledge and skills acquired by current and future employees (Howie, 1996).

The credibility gap is occurring due to a lack of cooperation between the corporate environments and formal education system. The path towards the solution to this problem may be in **establishing some sort of community between both environments**. Communities can be formed in different manners, as explained in the later chapters of the article. ICT can foster creation as well as maintenance of such community.

The gap explained is not the only gap arising in recent years in the educational field. Existing and prevailing methods of knowledge transfer in formal educational institutions (a classical one way method - teacher to large group of students) are becoming more and more different from the informal methods of information and knowledge acquisition, most common to today's youth. As digital natives they live in the digital world from their birth, meaning that they use modern technologies to understand the world, communicate, play and learn, the same way older generations used pens and paper. Thus, they don't accept the knowledge gained from formal education the same way as they accept information from their daily lives. Modern ICT can answer this challenge as well, by means of social learning and the establishment of virtual communities.

1.2 ICT and multimedia in education

Until now, we have mentioned social learning and virtual communities as drivers of change in the formal education of the future. Both are thoroughly explained in the subsequent chapters of the article. There are also other ICT supported concepts that simplify and foster social learning, such as user-generated content and mobility.

Users with virtually no technical skills are able to produce rich multimedia digital content themselves. This puts them in the position of creators, unlike in the past, when they only accepted provided knowledge. Educators can become moderators or intermediaries instead of being the prevalent source of knowledge. Modern ICT therefore fosters learner-centered education with all its advantages.

Another evolutionary moment in education occurred with the appearance of simple to use, wide spread, powerful mobile ICT terminals, such as broadband connected tablet PC's or smart phones. These terminals gave mobility its real meaning as they replaced a variety of previously used devices and even school bags and provide high interactivity with peers, teachers or the digital content itself.

The described concepts of modern ICT are of crucial importance as they enable overcoming of past obstacles in order to introduce social learning into the formal education system.

2 Methodology

Tailored to the scope of the article, the methodology adopted seeks to address possible solutions to the presented problems of the formal education system through a bottom-up approach with the use of ICT. The bottom-up approach is the opposite of the analysis and proposal of structural changes in the formal education system, which is a set of complex, interdisciplinary tasks that should be coordinated by policy makers. The aim of the authors was for specific stakeholders, primarily learning practitioners and students, to embrace necessary changes in practice, during thelearning process itself, by means of modern ICT.

A multi source information gathering method was used in order to provide an initial robust solution that will cater to the stakeholders mentioned above and being able to satisfy their requirement as well as withstanding the test of time. The research sources are numerous and varied, in order to increase the information basis and diversify it. During preparation of the article, authors have carried out:

- Analysis of their own previous e-learning projects, pilot deliveries and implementations for elementary and secondary schools
- Formal and informal conversations, meetings and brainstorming with external experts and policy makers
- Desktop research and analysis of relevant literature on communities theory and social learning aspects.
- Initial design of the social learning management system, derived from the their own existing learning software E-CHO, which is already being used in elementary and secondary schools.

Findings from e-learning projects and implementations carried out in the past were used to define problems described in the introductory section of the article. Analysis of the relevant literature and desktop research was performed in order to clarify which conceptual types of the virtual communities existing in practice or theory would aid the establishment of social learning network and ties between the industry and formal education environments. The findings are presented in the following chapters about virtual communities and communities for management of knowledge.

Finally, the proposed solution is presented and discussed in the last chapters of the article.

3 Communities

In the following chapter communities - as the most important mechanism to answer previously explained problems of the formal education system - are explained.

A community is a group of two or more people who have been able to accept and transcend their differences regardless of the diversity of their backgrounds (social, spiritual, educational, ethnic, economic, political, etc). This enables them to communicate effectively and openly and to work together toward goals identified as being for their common good (Hampton, 2005).

Generally, communities can be divided into seven typologies (Costa and Kahn, 2000):

- Practice communities
- Relations communities
- Learning communities
- Transaction communities
- Interest communities
- Fantasy communities
- Circumstance communities

In the following chapters we will focus on the types of communities which relate to educational activities. Mainly, these are communities of practice, which can be used to connect the corporate environment and formal educational institutions, as well as learning and interest communities.

3.1 Practice communities

Communities of practice are represented by a group of people who share a common interest and, through continuous interactions, solve problems relating to a common theme of interest, deepen their knowledge and experience (Wenger et al., 1999).

Communities of practice are social learning systems that combine individual learning and collective learning, where the contribution of the individual, in terms of creativity and experience, becomes part of the collective heritage of the community.

The shared knowledge is not static, but a repertoire of knowledge and knowledge subject to continuous revision based on the experience of individual members.

Communities of practice are the place where you activate the learning process, in which the generation of new knowledge is inseparable from practice (Sedita and Paiola, 2009).

Participants are often professionals and there are no hierarchical differences, but all are equally important because the work of each one is of benefit to the entire community (comsonet.org). With regards to employees' participation in communities of practice, it is important to attract as many people as possible because you can not know in advance who, within the community, may possess the knowledge that is needed at a given time (Ponassi, 2004).

Ponassi (2004) identifies two difficulties as regards practice communities.

The first is the resistance from the participants to share information and ideas in their possession. It may, in fact, develop forms of opportunistic behavior that exploits the communities without ever offering any help. A push for participation is given by:

- the intention to increase its visibility around the professional and create a positive image;
- an incentive system, e.g. establishing a prize for anyone who can give a valid contribution.

The second problem is the validation of the information found within the community of practice. The evaluation process is not generally based on criteria of response to objective truth, because the knowledge that communities elaborate is dynamic, emerging from constantly changing processes, and therefore does not allow definitive stabilization of the content to be discussed. A solution to this problem might be to nominate some people who are particularly aware and informed as leaders of each community of practice.

Wenger et al., (1999) define a community of practice as a combination of three fundamental elements:

- Domain, or thematic area, is the purpose for which a community exists, identifies the object around which the community is concentrated, creating a common ground and a sense of shared identity among members.
- Community creates the social fabric for learning. A strong community enables easier iterations at the base of the transmission of information and then knowledge.
- Practice is the specific knowledge the community develops, shares among members and keeps up-to-date with the evolution of techniques and knowledge.

Communities of practice can exist in different forms (Wenger, 2010):

Small or large. The small ones foster a feeling of familiarity and involve only a few specialists, while the large ones are made up of hundreds of people and are usually broken down by geographic region or joint issues in order to ensure that all members actively participate.

Long or short existence. Practice appears to be essential for the development of a community that has been stable for centuries thanks to the passage of knowledge from generation to generation (examples: the major automakers in Detroit, or the technology firms located in Silicon Valley). There are communities that might not last many years, because their presence is related to a project that when finished will cause the death of the community associated with it.

Within or distributed in space. One of the characteristics of a community is the continuous interaction between its members, for this reason communities usually begin among people working in or living near the same place who can easily interact. In any case, thanks to current technologies and Web 2.0, information sharing can also occur among people distant from each other, thus generating a very large community in terms of geographical areas.

Homogeneous or heterogeneous. Homogeneous communities are communities whose members have areas of common interest, they participate in the same discipline (woodworking, iron working, practice of the same sport, etc) or function (worker, manager, foreman, etc). On the other hand, heterogeneous communities rather bring together people with different backgrounds.

Within or cross borders. Communities within borders are those that develop within the same company, department, or team. Communities that cross borders are those that affect multiple departments in the same company or several companies in the same organization, or even more different organizations.

Spontaneous or intentional. Many communities are born without intervention from an organization. In these cases, the participants spontaneously come together because they need each other as equals and partners in the learning process. In other cases, organizations have developed specific communities in order to manage the strategic areas of competence.

Another classification of communities of practice comes from (Pavlin 2006), in the article “Community of practice in a small research institute”. In this classification, communities are:

- Informal
- Structured
- Supported

Informal communities are self-managed, as they do not have any organization that manages them, have a very large workforce and their training takes place in a natural way. There are discussion forums where creation and sharing of knowledge take place, which is then used by members in the workplace. Structured and supported communities instead develop under the attention of organizations, and community objectives are aligned with the objectives of the organization that manages and finances these communities.

3.2 Learning communities

Communities are involved in a learning experience and share a common path of discovery and growth (Scotti and Sica, 2007). People who are part of a learning community work, set themselves goals and divide tasks and responsibilitie in order to try to make a product or a common project.

Generally, learning communities have a boundary in time and space, linked to the end of the life span of the learning goal achievement (comsonet.org).

According to Briano et al., (1997) learning is a process by which we are enabled to belong to a community (e.g. at the end of university a student is able to work in the community of engineers). The membership about learning is also the ability to continue as part of the community in which our participation is recognized as a skill.

Learning communities are of particular interest in education today, as there has been a change in the concept of learning. It is no longer understood as a mere passive storage of contents, but with the aim to generate actions and solutions in various contexts in which the concepts are applied (Pozzi et al. 2007, Manca 2008).

3.3 Interest communities

Interest communities are places where people gather for the same interests, for the sheer purpose of sharing these inclinations and obtaining information with other not-for-purchase or other type (Ponassi, 2004).

People who are part of these communities have a shared interest or passion, like the fans of a football team, or fans of a band (comsonet.org).

3.4 Circumstance communities/ Relation communities

The community of circumstance unlike the community of practice, are not based on a shared interest, but their presence is based on circumstances and experiences, which have a strongly temporary character (Scotti and Sica 2007).

Typical examples are news groups that connect people with particular diseases, the passengers of an airplane, a ship or a train, which can be classified among the communities of circumstance (comsonet.org).

3.5 Social networking

Social networks are currently among the most popular phenomena of the Web (e.g. Msn.com, MySpace, Facebook, Orkut, etc). These are communities in which users, based on personal affinities or professional reasons, identify the people that can enter into a relationship, communicate, share information and digital content (Scotti and Sica 2007). These popular online tools have more then 800 million users worldwide and enable different types of interactions among users (Qualman, 2011. Social networks users tend to spend a lot of time online using social networks environment only. More then 50% of users use them on a daily basis and more then 20% spend more than a quarter of their time online within the most popular environments.

Social network concepts are important as they enable formal representation of social learning scenarios (Figure 1). Furthermore, social networks users are familiar with the concepts of social interactions. This means that no specific instructions are needed in order to perform the social learning activities.

4 Communities for Knowledge Management

The communities described so far are used for the management of knowledge (knowledge management).

From Figure 1 we can see how the community of practice in some way includes all other types of communities (the community of learning is also a community of practice, while the opposite is not always true).

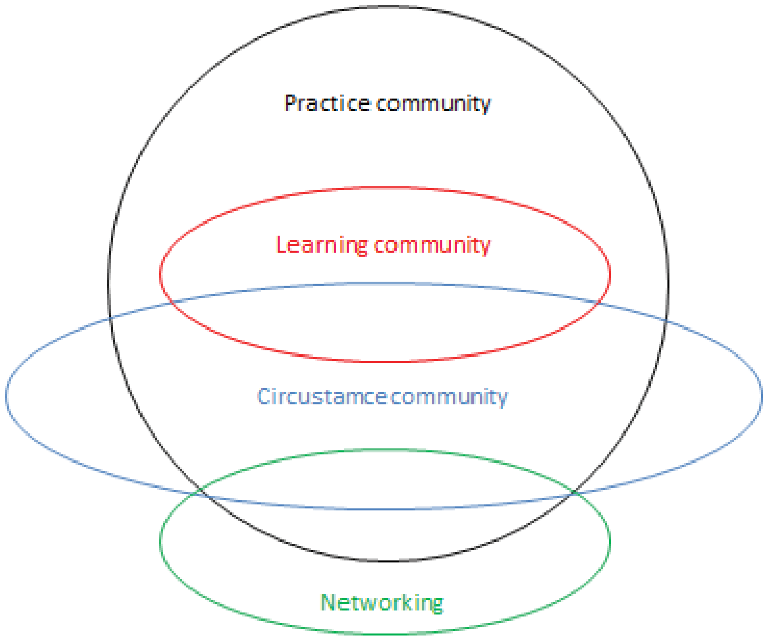

Figure 1. Communities for knowledge management (Sica and Scotti, 2007: 59)

5 Implementation proposal in the formal education system

From a functionalities point of view, the formal education system would require two types of communities. The **community that connects the corporate environments field and educational institution** would be predominantly a community of practice. **The community to be used within the core of the education process** would be a learning community.

In the implementation proposal, both communities are based on the existing Learning Management System (LMS) E-CHO, developed by the authors of the article. The reason for this is that LMS represent important mechanism in the ICT supported educational process. Commonly within the e-learning process, specific digital content has to be learned and understood or sets of activities have to be completed. LMS represent the environment to access the content and perform activities. Personalization features of LMS, along with the need to monitor the learning progress, remain important even in the social learning domain. The E-CHO LMS will therefore be upgraded to become a social learning environment.

Initial research and implementation in the field of so called Social LMS resulted in the delivery of several products, such as Knoodle (http://www.knoodle.com/), Topyx (http://interactyx.com) and Sclipo (www.sclipo.com), all of which were launched in 2010. These systems are built from scratch, provide only simple LMS functionalities and are focused on a specific domain of use, such as innovative approaches to presenting multimedia content or simple social interactions (Figure 2a).

Another approach is to connect existing LMS to the most popular social networks such as Facebook (Figure 2b). For

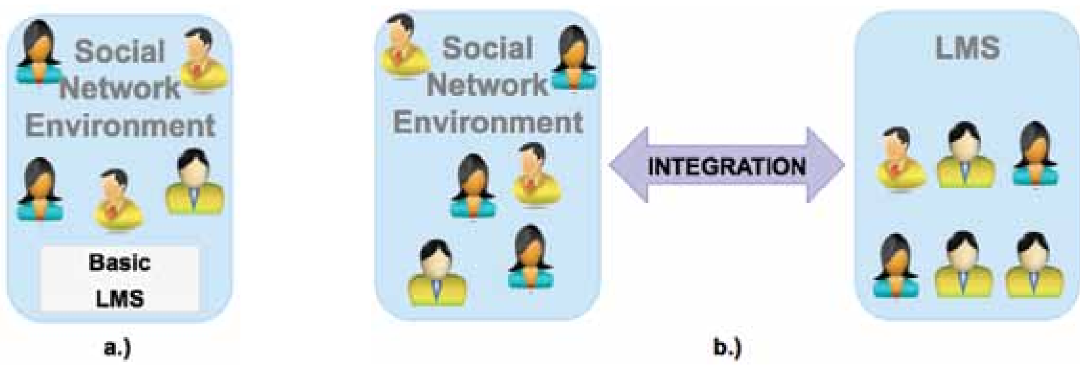

Figure 2. Existing social LMS scenarios: a.) Social Learning Platforms; b.) Integration of existing LMS with social network environment

example, developers might launch an LMS as a Facebook application e.g. Udutu, Appfusion, E-CHO (Wing, 2011).. However, it is still not an ideal solution as the interactions occur either within the social network environment or LMS itself. A Facebook application can not provide all the LMS features necessary for the learning process entirely within the social network environment. Therefore, such initiatives usually result in the social network environment being another channel for delivering learning information or in some cases learning content.

LMS are generally systematically structured and rigid from the organizational point of view, as they reflect a formal educational environment. Students are organized into groups, depending on their age, school or class and have teachers tutoring them. The most popular social networks on the other hand tend to be established and self-organized by end users. Integration of both concepts, according to figure 2b may result in a chaotic learning environment.

In the case of the E-CHO social learning environment implementation proposal, the concept, presented in Figure 2a will be used. The only difference is that the solution will not be developed from scratch, but will be based on existing cloud based LMS, which covers important e-learning areas of interest, such as content delivery, knowledge assessment, progress tracking, users and content management, and e-portfolios. Social interaction components are therefore being built over the existing LMS components.

Social learning functionalities will be provided to the users of E-CHO LMS as an added option. The students will be able to access their learning experience in two different ways. The traditional way of access is through standard E-CHO sections: the classroom, progress tracking, content development or user management sections. The new option will allow accessing through the E-CHO social learning environment. Both access options will be equivalent in order to test whether the users will embrace the new social learning environment themselves. This community should be gradually introduced, because of the real threat of abuse and security risks of existing social communities.

Features that will distinguish this social learning environment from classical LMS can be divided into two main areas fostering social interaction:

- social collaboration features (including communication tools as well),
- features regarding motivation and incentives for participation in the learning process.

Social collaboration features will consist of:

- **Chat** service, interconnected with learning objects with integrated awareness of relations among users.
- **Messaging**, used for general communication and administrative purposes.
- **Commenting** - comments must be linked with learning objects encouraging users' communication focused on the target learning object.
- **Recommending** (rating) of learning objects.
- **Posting** different kinds of multimedia material (user statuses or learning objects)
- **Sharing** of learning materials or other multimedia objects generated during social learning experience.
- **Buddies** selected by users, as arbitrary peers in the learning process, independently of established organization within the E-CHO LMS.

The community of practice used to foster cooperation with industry will encompass end users directly. Participants and contributors of such communities will be:

- experts, employees from corporate environments,

Figure 3: E-CHO Social Learning Environment implementation proposal

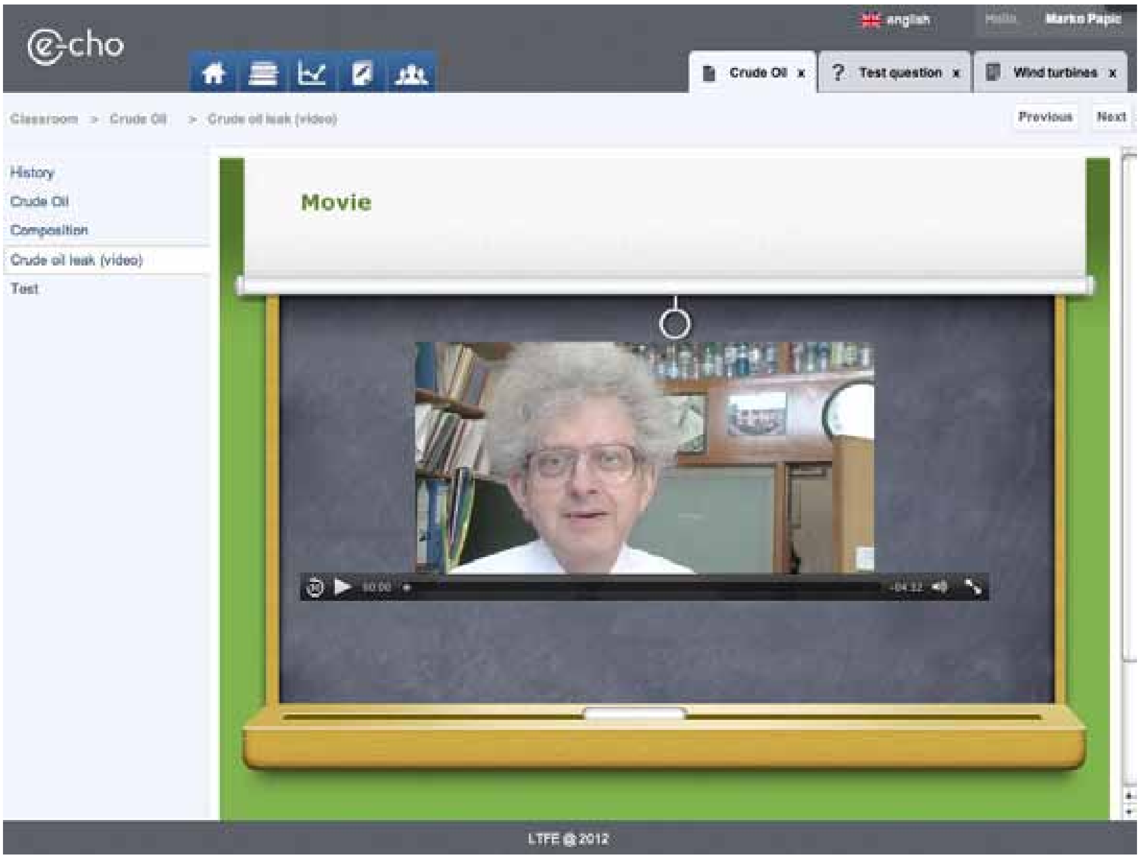

Figure 4: The E-CHO learning environment

- students, pupils from educational institutions and
- learning practitioners (teachers) as moderators.

The main aim of such a community will be for corporate environments to publish specific problems, related to their field of work and search for solutions from students and their teachers. These problems could be formed as minor projects, supported by documentation and other digital learning material (Tseng et al, 2006).

Such a community should have specific attributes, according to Wenger. It should be a large, heterogeneous community of long existence. Its establishment will of course be intentional. However, specific topics of interest will be spontaneous, on an as needed basis. Therefore it will combine features of communities of practice as well as circumstance communities.

Incentives for participation are especially important in the case of communities connecting the corporate environment and educational institutions. These will be derived from already implemented, commercially available, web-based collaboration platforms, such as Hypios (www.hypios.com) or Ponoko (www.ponoko.com). Related research was performed by various authors, such as Nof (2003) and Lakhani et al.,(2007). Motivation will incorporate intrinsic and extrinsic mechanisms. Extrinsic mechanisms are relatively easy to define. In the educational field active participation of students and learning practitioners will be acknowledged with rewards provided by participating corporate environments. By participating, students will collect reputation points, which could be then used to measure their activity or replaced for other benefits. Intrinsic motivation would come from students themselves. To achieve this, problems and projects originating from the corporate environment should be formed in a playing mode or competition mode. Intrinsic factors prove to be even more relevant then extrinsic factor in communities of practice (Venkatesh and Ramesh, 2006, Atanasijević-Kunc, et al., 2011).

Motivation for participation of corporate environments would be completely different. Their main interest would be to identify potential future human resources and to follow them with relatively little time consuming effort (Baba et al, 2009).

6 Discussion

The gap between students and the formal education system is increasing, due mainly to the prevalence of classical lecturing methods at a time when students work with information and knowledge in a completely different manner. Changes to education system will have to occur, not because of ICT, but in order to increase the active participation of students in the learning process.

Modern ICT may provide an answer to this problem, as well as to the rising of credibility gap, however it is yet to be seen whether the adoption of new technologies, as explained in the article, would be sufficient for the formal education system to better encompass labor market needs.

Both communities will have to be gradually introduced as the social learning community brings the threat of abuse and certain questions will have to be answered. What is the most appropriate age at which students should begin using such communities? What will the boundaries of such communities be and how will they be managed at a high level? Providing and assuring privacy or intellectual property rights is a challenge even for the largest and most developed popular communities at present. In the case of the formal education environment, the target group is sensitive and management (control) will have to be provided. After initial testing on a limited group of users, the social learning environment will gradually be added to students and teachers already using the E-CHO e-learning LMS. Analysis of their use will be performed in order to gather enough information to perform further user experience testing and analysis.

Based on previous experience of introducing e-learning (as ICT based education) supported by LMS, digital content and variety of ICT tools, the desired changes within the formal educational system will not happen instantly. Existing ICT in education, introduced since the beginning of Internet, did not bring about desired changes and did not revolutionize the system as many anticipated.

In order to address the challenges of formal education systems, ICT can represent a path towards the solution and bring about initial success, however, complex structural and institutional changes will be required, independently of the introduction of ICT in the educational system.

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Trendi v multimedijskem in IKT podprtem izobraževanju

Formalni izobraževalni sistemi se v današnjem času srečujejo z različnimi izzivi prilagajanja sodobni družbi znanja. Prispevek obravnava dva ključna izziva, na katera lahko odgovorijo sodobne Informacijske in komunikacijske tehnologije (IKT). Prvi problem je neusklajenost med potrebami današnjega trga dela in formiranimi kadri izobraževalnega sistema. Drugim obravnavani problem predstavlja razkorak med še vedno prevladujočimi frontalnimi metodami podajanja znanja v šolah in načini na katere mladi pridobivajo znanje izven formalnega šolskega sistema, saj se šole srečujejo z težavami v zvezi z motiviranostjo učencev, dijakov in študentov. V prispevku je predstavljena teza, da je oba problema možno nasloviti s smiselno uporabo IKT, predvsem v obliki metod socialnega učenja in z njimi povezanih spletnih skupnosti. Na osnovi teorije spletnih skupnosti in socialnega učenja so v prispevku povzeti mehanizmi in značilnosti, ki so uporabni v formalnem izobraževalnem sistemu, hkrati pa je podan tudi predlog implementacije spletne skupnosti, ki povezuje šolski sektor in poslovni svet, kot tudi izobraževalne skupnosti, namenjene izvedbi učnega procesa v okviru šol ter izven šolskega prostora.

Ključne besede: IKT podprto izobraževanje, socialno učenje, spletne skupnosti, digitalni razkorak, trg dela, e-izobraževanje, multimedija, spletni izobraževalni sistemi

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The Conceptual Learning of Physics in Slovenian Secondary Schools

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In the last decade, educational researchers have been intensively searching for new, innovative teaching approaches. Information and Communication Technology (ICT) has a great didactic potential and project COLOS (Conceptual Learning of Science) encourages the use of ICT in the contemporary educational process. In this paper we present the conceptual learning of Physics. With experimental research we investigated the effectiveness of such learning in Slovenian secondary school. Two groups of third-year students who were enrolled in an introductory Physics course participated in the study. In the experimental group students were taught through the conceptual learning and in the control group a traditional expository instruction was used. We examined the knowledge of students after carrying out lessons specifically on the topic of Electricity. Five thinking processes were assessed – Knowledge (Recall), Analysis, Comparison, Inference and Evaluation. We found that the conceptual learning was more effective than the traditional instruction.

Key words: traditional instruction, conceptual learning of Physics, Information and Communication Technology (ICT), simulations, physlets.

1 Introduction

In the last two decades many researchers have been searching for new, innovative approaches in teaching Physics. Some of them have systematically collected and put in order previous researches by specific domains. The articles by McDermott and Redish (1999) and Thacker (2003) include more than 500 researches and projects about the innovative teaching approaches. Many of previous studies include the investigation on the potential of computer simulations in the contemporary Physics teaching (Podolefsky, Perkins and Adams, 2010; Sadaghiani, 2011; Lee, Guo & Ho, 2008; Wieman, 2007).

For example, Wieman (2007) noted that computer simulations are new, very powerful ways to engage students in educational activities. To exploit the great potential of Information and Communication Technology was one of the key goals of the COLOS (Conceptual Learning of Science) project (Härtel, 1995). With the rapid progress of the computer technology in recent years, the conceptual learning is fast becoming a very promising teaching approach, also in the field of Physics.

2 The conceptual learning of Physics

Motivation is one of the key problems in Natural and Technical Sciences Education. In Education, particularly by the teaching and learning of Physics, the motivation and active knowledge of the students is of paramount importance. Passive, unmotivated students, a template of pattern solving principles and minimal creativity learning have no future in contemporary education. Computers and ICT have a didactic potential because of their ability to incorporate motivation and research problem solving approach into Education. Active involvement and problem solving are important characteristics of the conceptual learning of science, which has been promoted by members of the COLOS group. Project COLOS was founded in 1988 by Zvonko Fazarinc, a professor at Stanford University (Muller et al., 1995). The main goals of the project were to improve teaching and learning, also with the help of ICT, and to stimulate the production and use of software for education.

2.1 The role of Physlets in the conceptual learning

The conceptual learning of Physics often uses models, animations and simulations for problem solving approaches (Christian et al., 2006). In the beginning simulations required an expensive graphics workstation (e.g. SUN, HP, Silicon Graphics ...) but the advances in personal computer hardware and especially platform independent software, such as Flash

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and Java, have provided tremendous new capabilities. The World Wide Web makes it possible that, if a simulation is written in a language such as Flash or Java, it can be run through a standard browser anywhere in the world. This capability brings many opportunities to improve educational processes. In the last decade we started using java programs – applets; when an applet is orientated on a small, specific domain of physics, we talk about physlets (Christian et al., 2006).

The question how to effectively support the conceptual learning has captured many researchers` attention (Cheng, 1999). Physlets could effectively support such learning because of their special characteristics. In the first place, Physlets are interactive materials, where processes happen at certain intervals and there is an interaction between the model and the student. Students have the possibility of changing the conditions and immediately observing the impact. In addition, Physlets enable us, when dealing with new physical phenomena, to change relevant parameters and immediately see the consequences of our actions. Consequently, that could help students to understand the main concepts of the phenomenon.

In the didactical sense there are three different types of Physlets:

- **Illustrations:** we use them for the presentation of the phenomena,
- **Explorations:** physlets for the exploration of specific physical phenomena,
- **Problems:** they are useful for examining the knowledge that students have acquired.

Figure 1 shows a Physlet for the exploration of the simple harmonic motion.

Physlets can be used as simulation models in numerous learning web applications. They can be used as an element of almost any curriculum with almost any teaching approach, so they could also play an important role in the conceptual learning of Physics.

2. 2 The practical application of conceptual learning

The basic and primary goal of conceptual learning of Physics for the students is to experience the phenomena before receiving its theoretical and mathematical background (Gerlič, 2006). Students should become familiar with the concepts of phenomenon or law and equations can be introduced later if needed, presenting them as they really are – a model trying to present reality (Muller et al., 1995).

Following the main goals of the conceptual learning of Physics, in this study the teacher had quite a different role through the conceptual learning than through the traditional lessons. He was not that of the authoritative fount of all knowledge, but that of the initiator, organizer, adviser and connector of the whole process. The big emphasis was on the understanding of the basic concepts of the particular phenomenon. Communication was vertical and horizontal, so teacher immediately got feedback from students about their understanding of the task or phenomenon. There was a bit more noise in the classroom because the students worked in pairs. Each lesson contained following main stages:

- The starting-point of the lesson was checking the pre-knowledge of the students, usually through the discussion with the students.
- Motivating students through exposing them to a physical example of the particular topic, usually involving a demonstrational experiment.
- Researching the phenomenon with the help of the conceptual based interactive materials (learning of the topic).
- Checking of the deepness of knowledge and understanding of phenomena, nature law, conceptions etc. in new problem based situations, also with the conceptual based interactive materials.

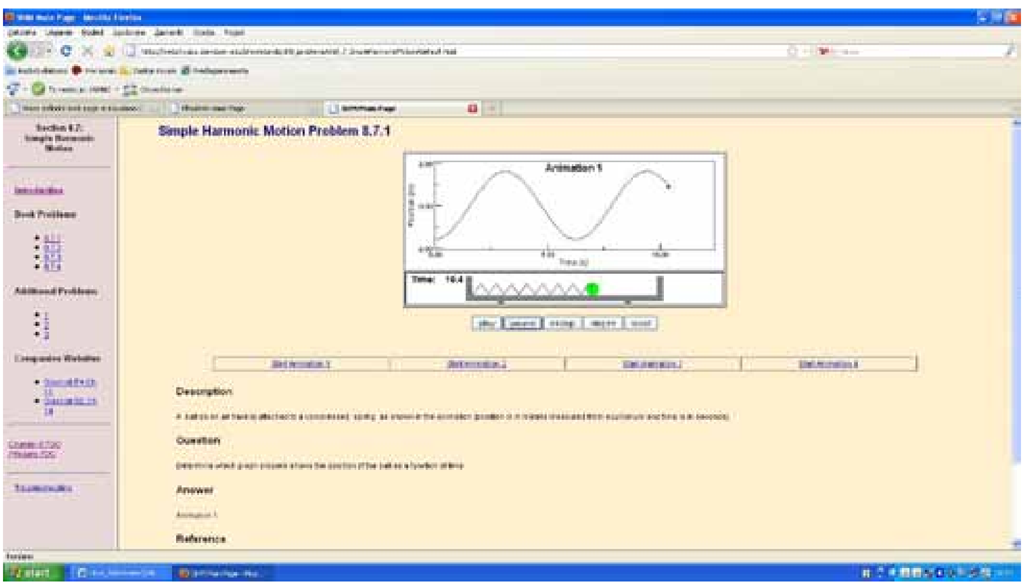


Figure 1: Simple Harmonic Motion Problem (Christian et al., 2006).

3 Purpose of the study

The main goal of the study was to investigate the effects of the conceptual learning of Physics in comparison to the traditional expository instruction when teaching the topics in the field of Electricity, in the third class of Slovenian 4-Year High School.

Methodology

We carried out the One Factory Experiment with classes as comparison groups. The same teacher was teaching two groups of students, covering the following topics: Electric field, Coulombs` law, Force on the charge in the plane and Electric fluid. Each lesson was carried out with the two different teaching approaches: one group was taught through the conceptual learning and the other group was taught through the traditional expository instruction. All lessons were prepared with consideration of the curriculum for Slovenian Secondary Schools (Ministry of Education and Sport, 2008). The traditional instruction was supported with standard didactical material – textbooks; for the conceptual learning we prepared interactive worksheets with appropriate Physlets.

Research sample

The research sample consisted of the third grade students, of which one group presented the experimental group (N = 33), and the other group (N = 33) functioning as the control group.

Data collection procedure

The research took place in Secondary School "Gimnazija Franca Miklošiča Ljutomer" and was carried out in October and November in the academic year 2011/2012. We were especially interested in the effectiveness of the conceptual learning in the field of five thinking processes- *Knowledge*, *Analyse, Compare, Infer and Evaluate* (Phye, 1997):

- *Knowledge* is the lower thinking process and involves just interpretation of memorized data.
- *Analysis* involves dividing a whole into its distinctive elements and understanding the relationship of the parts to the whole.
- *Comparison* involves identifying similarities and differences and understanding their overall significance.
- *Inference and interpretation* involve use of various forms of inductive and deductive reasoning.
- *Evaluation* involves making judgments about what to believe on explicit criteria and supporting evidence.

We tested students' knowledge before the experiment (pre-test) and after the experiment (post-test). To see the structure of the test, the sample question is provided in Figure 2 bellow.

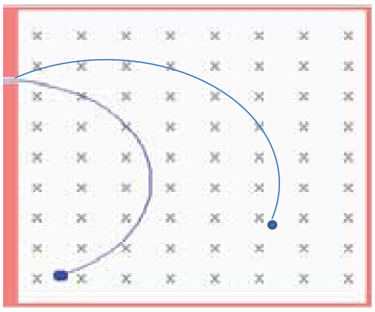
4 Results

The results of descriptive statistics are presented in Figure 3; there are the pre-test and post-test results.

As seen in Figure 3 (a), there were no major differences in the pre-test results between the experimental and the control group across every taxonomic level of knowledge. It could be concluded that students from the experimental and the control group were comparable enough in their pre-knowledge, before starting the lectures.

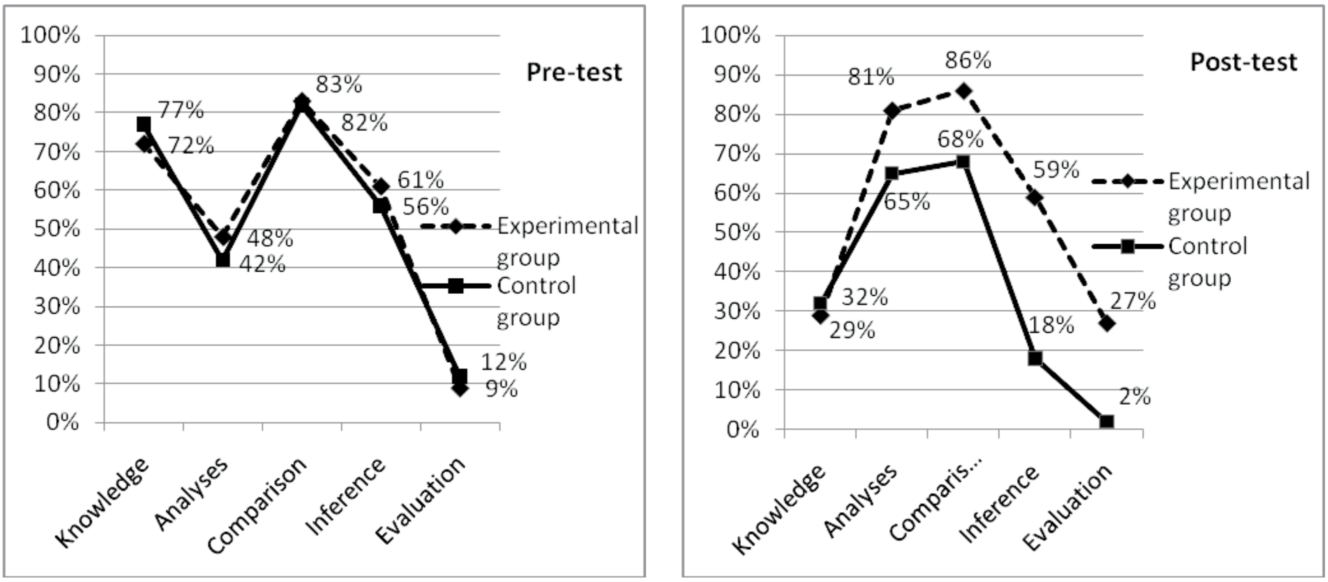
However, after carrying out lessons, there were major differences between the results of students, who were taught in the conceptual way (experimental group) and the results

The speed of proton 1 in the magnetic field is two times slower than the speed of proton 2 and at the same time the magnetic field that proton 1 is entering, is two times larger than the magnetic field, when proton 2 is entering (see picture on the left). Which of the following statements best describes the movement of these two charged particles in the magnetic fields?



A. The radius of the circulation of proton 1 is smaller than the radius of proton 2.
B. The radius of the circulation of proton 1 is larger than the radius of proton 2.
C. The radius of the circulation of proton 1 is equal to the radius of proton 2.
D. The radius of the circulation of proton 1 is two times larger than the radius of proton 2.

Figure 2: An example of the task at the level of Evaluation.



(a) (b)

Figure 3: (a) Pre-test results on the single thinking process; (b) Post-test results on the single thinking process.

of students, who were taught traditionally (control group). As seen in Figure 3 (b), students in the experimental group achieved better results than those in the control group on each higher thinking process (Analysis, Comparison, Inference and Evaluation). At the Analysis and the Comparison the differences were 16% and 18% and at the Inference and the Evaluation there were the biggest advantages of students from the experimental group (41% and 25%).

5 Conclusions

The principal role of the conceptual learning of Physics is the empirical experience of a naturalistic law, rather than its mathematical background. In this study we have investigated the effectiveness of such a learning approach in Slovenian Secondary School. We compared the post-test results of students who were taught through the conceptual learning, with the emphasis on the usage of computers and autonomous researching (experimental group), with the results of students who were taught through the expository instruction (control group). The results of this study indicate that the conceptual learning enables students a better understanding of physical concepts and consequently, enhanced students` learning outcomes.

The new generation of students and the rapid development of modern technology are encouraging the educational researchers to keep searching for new, appropriate teaching approaches. This study confirms that ICT can effectively support the use of innovative methods of teaching and can help to improve the existing teaching approaches. On the other hand, using ICT does not mean that teachers should forget and neglect the experiment as the basic instrument in Physics teaching; however, they should take the advantages of the modern technology in the educational process wherever this is possible and reasonable.

In conclusion, the results of this study indicate that the conceptual learning of Physics could be, in the selected didactical cases, the alternative or the completion to the existing approaches in Physics teaching. In light of the results of this study, teachers who use just traditional methods in their programmes because of time constraints but want to improve the effectiveness of their instruction may review the potential benefits of Physlets and the conceptual learning of Physics.

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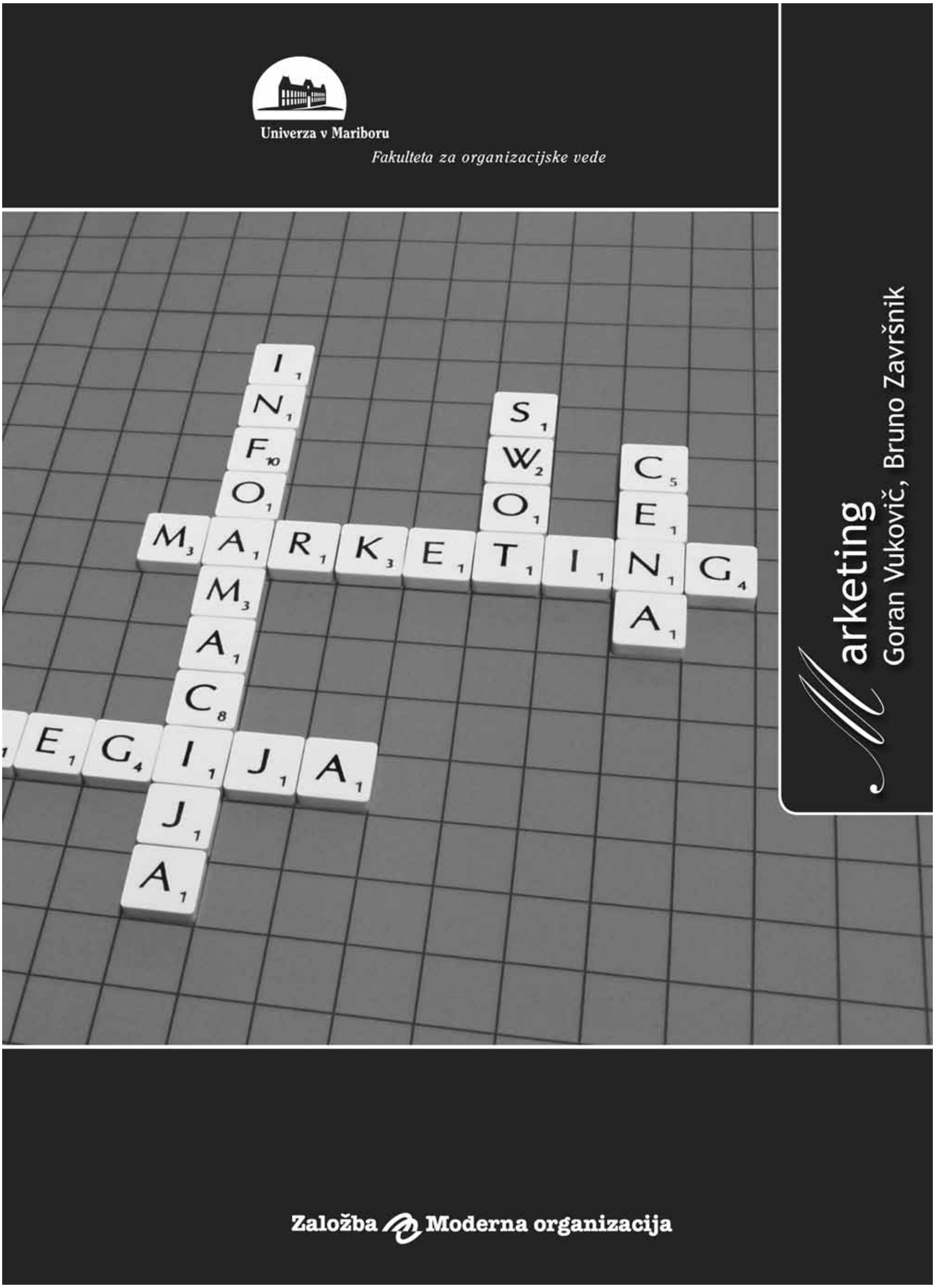
Konceptualni pouk fizike v slovenski srednji šoli

V zadnjem desetletju številni raziskovalci na področju izobraževanja iščejo nove, inovativne pristope v poučevanju in učenju, take, ki bodo primernejši za nove generacije dijakov v današnjih šolah. Informacijsko komunikacijska tehnologija (IKT) ima ogromen didaktični potencial in projekt COLOS (Conceptual Learning Of Science) spodbuja uporabo IKT v sodobnem izobraževalnem procesu. V prispevku predstavljamo konceptualno učenje fizike. S pedagoškim eksperimentom smo raziskali učinkovitost takega pouka v slovenski srednji šoli. V raziskavi sta, v okviru učnih ur fizike, sodelovali dve skupini dijakov tretjega letnika gimnazije. Eksperimentalno skupino dijakov smo poučevali skozi konceptualno učenje, v kontrolni skupini dijakov smo uporabili tradicionalne metode poučevanja. Po izvedbi učnih ur, katerih vsebine so zajemale področje Elektrike, smo znanje dijakov ocenili. Preverjali smo pet miselnih procesov dijakov – poznavanje, analizo, sklepanje, primerjavo in ovrednotenje. Ugotovili smo, da je bilo konceptualno učenje učinkovitejše od tradicionalnega pouka.

Ključne besede: tradicionalni pouk, konceptualno učenje fizike, Informacijsko komunikacijska tehnologija (IKT), simulacije, fizleti.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OBČINA RADOVLJICA
Gorenjska cesta 19, 4240 RADOVLJICA

Opravljanje del z gradbeno mehanizacijo MARJAN RAZPOTNIK s.p.
Krače 8, 1411 IZLAKE

OPTIMA - Podjetje za inženiring in trgovino d.o.o.
Ulica 15. maja 21, 6000 KOPER

PALOMA SLADKOGORSKA - Tovarna papirja d.d.
Sladki vrh 1, 2214 SLADKI VRH

PIVOVARNA UNION d.d.
Pivovarniška ulica 2, 1001 LJUBLJANA

POSLOVNI SISTEM MERCATOR d.d.
Dunajska cesta 107, 1000 LJUBLJANA

POSLOVNI SISTEM - ŽITO LJUBLJANA d.d.
Šmartinska cesta 154, 1000 LJUBLJANA

POSLOVNO PRIREDITVENI CENTER - GORENJSKI SEJEM Kranj d.d.
Stara cesta 25, 4000 KRANJ

POŠTA SLOVENIJE d.o.o.
Slomškov trg 10, 2000 MARIBOR

PRIMORJE d.d.
Vipavska cesta 3, 5270 AJDOVŠČINA

REGIONALNI CENTER ZA RAZVOJ d.o.o.
Cesta zmage 35, 1410 ZAGORJE OB SAVI

SATURNUS - AVTOOPREMA d.d.
Letališka c. 17, 1001 LJUBLJANA

SAVA - Gumarska in kemična industrija d.d.
Škofjeloška 6, 4502 KRANJ

SIEMENS d.o.o.
Dunajska cesta 22, 1000 LJUBLJANA

SLOBODNIK JOŽE
Generalni častni konzul RS v Kanadi

SLOVENIJALES PRODAJNI CENTRI
Dunajska cesta 22, 1000 LJUBLJANA

SLOVENSKE ŽELEZNICE d.d.
Kolodvorska ulica 11, 1000 LJUBLJANA

SVEA LESNA INDUSTRIJA d.d.
Cesta 20. julij 23, 1410 ZAGORJE OB SAVI

SUROVINA d.d. MARIBOR
Pobreška cesta 20, 2000 MARIBOR

TELEKOM SLOVENIJE d.d.
Cigaletova 15, 1000 LJUBLJANA

TERME MARIBOR Zdravstvo, turizem, rekreacija d.d.
Ul. heroja Šlandra 10, 2000 MARIBOR

TERMO d.d. - Industrija termičnih izolacij
Trata 32, 4220 ŠKOFJA LOKA

TERMOELEKTRARNA TOPLARNA Ljubljana d.o.o.
Toplarniška 19, 1000 LJUBLJANA

TOVARNA KLOBUKOV ŠEŠIR d.d.
Kidričeva 57, 4220 ŠKOFJA LOKA

TRIMO Inženiring in proizvodnja montažnih objektov d.d.
Prijateljeva 12, 8210 TREBNJE

UNITAS - Tovarna armatur d.d.
Celovška cesta 224, 1107 LJUBLJANA

USTANOVA SLOVENSKA ZNANSTVENA FUNDACIJA
Štefanova 15, 1000 LJUBLJANA

ZAVAROVALNICA TRIGLAV, d.d.
Miklošičeva cesta 19, 1000 LJUBLJANA

ZVEZA RAČUNOVODIJ, FINANČNIKOV IN REVIZORJEV SLOVENIJE
Dunajska cesta 106, 1000 LJUBLJANA

ŽIVILA KRANJ - Trgovina in gostinstvo d.d.
Cesta na Okroglo 3, 4202 NAKLO

ŽITO GORENJKA d.d.
Rožna dolina 8, 4248 LESCE


UNIVERZA V MARIBORU - FAKULTETA ZA ORGANIZACIJSKE VEDE
Skripta
ZAPOSLIMO
Ustvarjalne
Komunikativne
Samozavestne
Kadrovanje
VESNA NOVAK
Založba Moderna organizacija