NBE2005

Teaching-Studying-Learning (TSL) Processes and Mobile Technologies – Multi-, Inter-, and Transdisciplinary (MIT) Research Approaches

Proceedings of the 12th International Network-Based Education (NBE) Conference (Former PEG) 2005

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Heli Ruokamo, Pirkko Hyvönen, Miika Lehtonen and Seppo Tella (Eds.)

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Edited by

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Preface

Dear NBE 2005 Conference Participants

We are pleased to welcome you all to the NBE 2005 international conference at Rovaniemi, Finland.

The international NBE 2005 conference continues the tradition of the PEG conferences that were organised every two years. For over a decade, the PEG/NBE international conferences have explored ideas at the cutting edge of developments in the fields of artificial intelligence, epistemology, psychology and education in relation to the interaction between teacher, learner, researcher, curriculum, culture and technology.

This will be the 12th time, and we have chosen to upgrade the name of the conference to better highlight our central theme which is Network-Based Education (NBE). We are sure that this way we can respect the tradition and yet create an even more promising future.

Let us, however, remind you of the history of PEG. Originally established in 1985, PEG aimed at linking Logic Programming and Education. Gradually, its focus expanded to encompass all elements of intelligent computer technologies as well as information and communication technologies (ICTs), and, most recently, mobile technologies and applications intended for teachers, students of all ages, as well as designers and researchers. Thanks to this broadened interest, PEG is now known as NBE, Network-Based Education.

NBE aims to grow into an informal and friendly conference which experts and specialists like to attend regularly to exchange ideas and information. NBE is a consortium of all those interested in the relationships between information, knowledge, information and communication technologies (ICTs), mobile technologies, teaching, studying and learning, and multi-, inter- and transdisciplinary (MIT) research approaches.

For this conference, we received 34 submissions, out of which 56 % will be presented. We take this opportunity to thank all reviewers who helped us make this conference even better qualitatively.

The conference presentations cover a high number of themes and topics relating to the thematic groups of the conference. Let us mention the most central domains: Knowledge Construction and Hypermedia, Playfulness and Game-Based Learning, New Pedagogical Models, Emotionality in TSL Processes, Design and Development, New Media and Online Video Clips, Narrativity in TSL Processes, and ICT Tools for Teaching and Learning.

We are very grateful to all the members of the Programme Committee for their altruistic contributions to the success of our conference. Our gratitude also goes to Ms Marja-Leena Porsanger, Congress Secretary, for excellent general logistics of the organisation, to Ms Annakaisa Kultima for all graphics design and conference web pages, and to Mr Mauno Hernetkoski for attending to the conference publication and the CD-ROM.

The venue of this NBE 2005 conference is unique. Rovaniemi is generally considered as the Gateway to Finnish Lapland. She has always been at the crossroads of cultural and technological achievement and civilisation. Our conference is hosted by the University of Lapland, the northernmost of all universities of the European Union. This will guarantee us a splendid setting to meet, to share and to feel at home.

Looking forward to meeting you all at Rovaniemi in September 2005!

For the Organising Committee

Professor Heli Ruokamo, Chair

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Keynotes

Semantic Web versus Data Mining

Advancing Education in Virtual and Real Worlds by Meta- Innovations

Semantic Web versus Data Mining

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The fields of semantic web and datamining are currently emerging and creating lots of scientific and commercial interest. The two fields are typically analyzed in isolation from each other. This paper represents an effort to treat them as two different approaches to the same final goal, and to treat them comparatively. In addition, it explains the essential issues of the two approaches, and gives some predictions about the future development trends.

1 Introduction

A major goal of both datamining and semantic web is efficient retrieval of knowledge from large databases (single or distributed) or the Internet. In this context, the knowledge is treated through a synergistic interaction of information (data) and their relationships (links within a typical relational database or links on the web). Synergistic interaction implies also the cases in which the meaning of data differs from the cases when data is represented in isolation, to the cases when data is linked with other data, which is a special challenge for research efforts aimed at efficient knowledge retrieval.

If datamining and semantic web are compared from the point of view of how they facilitate retrieval of knowledge, a major difference is in the placement of complexity. In the case of datamining, complexity is (conditionally speaking) placed at run time and retrieval time. In the case of semantic web, complexity is (conditionally speaking) placed at compile time and design time.

In the case of datamining, data and knowledge are represented with simple mechanisms (typically based on HTML) and typically without metadata (data about data). Consequently, relatively complex algorithms have to be used, which means that complexity is migrated to the retrieval request time. In return, there is no complexity at system design time – one uses well developed algorithms and their standard implementations.

In the case of semantic web, data and knowledge are represented with complex mechanisms (typically based on XML), and with plenty of metadata (sometimes, a byte of data – a name – may be accompanied with a megabyte of data – descriptive information related to that name). Consequently, relatively simple algorithms can be used for data retrieval, which means that complexity placed at the data retrieval time is minimal. However, large and sometimes relatively sophisticated metadata have to be created at system design time – one has to invest large efforts into the metadata design, preprocessing, postprocessing, and general maintenance.

Major knowledge retrieval algorithms used with datamining are neural networks, decision trees, rule induction, memory based reasoning, and many others. Consequently, the stress in the datamining review part of this paper is on algorithms.

Major metadata design, processing, and maintenance tools used in semantic web are XML, RDF, and ontology languages. The ongoing research concentrates on issues like logic, proof, and trust. Consequently, the stress in the semantic web review part of this paper is on tools.

The rest of this paper is divided into three parts: an overview of datamining, an overview of semantic web, and conclusions that include trend predictions. With this final issue in mind (trend predictions), the two overview parts stress the point to be elaborated in the trends prediction part.

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2 Datamining

This section contains a condensed overview. A detailed overview can be found in [1], which is a tutorial. That tutorial can be found on the web site of the author, and was presented many times at conferences, in house for industry, or as a university course, worldwide. Primarily, the issues are stressed which represent either the important bottlenecks of the approach or the potential solutions for the general problem of recognition of semantics in cases when data may change its meaning from one context to the other.

There are three major differences between datamining and database engineering: (a) Uncovering the hidden knowledge, (b) Treating the huge n-p complete search space, and (c) Implementing a multidimensional interface to the user.

With databases, one can do only the data retrievals conceptualized at the database design time. If a query is placed which is planed at the database design time, the database will deliver the requested information. However, if a query is made which is not predefined, the database will deliver a question mark! On the other hand, a datamine is supposed to be able to deliver answers even in such cases. This means that a major difference is in layers of intelligence that have to be placed on the top of a database, to create a datamine.

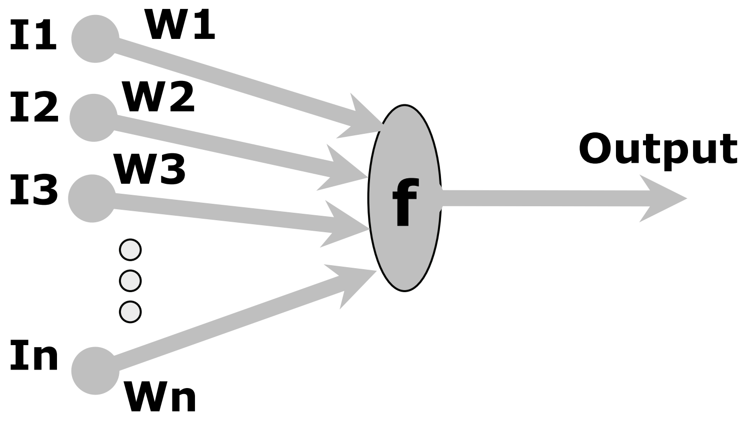
Next, traditional databases are typically much smaller compared to datamines, especially if datamining is done in the context of the entire Internet. This extra-large size means that linear search algorithms (sometimes used in the database environments) are absolutely useless in datamining environments.

Finally, the retrieved knowledge (in the case of datamine search) has to be presented to the user in a way which is easy to comprehend, especially in situations when the meaning is dependent on the context. This requires complex graphical interfaces. On the other hand, in the case of database search, information is comprehensible even if presented in the form of tables or histograms or similar.

One possible definition of datamining implies that it represents automated extraction of predictive information from memory (large databases or the Internet), or communication lines (cell phones or data channels in general). With this in mind, the rest of this section concentrates on datamining problem types, algorithms, models, as well as some available software.

One can talk about a number of different problem types in datamining (data description and summarization, segmentation, classification, concept description, prediction, and dependency analysis), but in real systems, most of the time, one can recognize a combination of several problem types. This is important to know, because some of the algorithms (to be elaborated later) work better for one problem types, while other algorithms work better for other problem types. Consequently, if we have a combination of problem types, we have to use a combination of algorithms. As it will be seen later, especially in the case of less complex and less expensive tools, one tool supports one type of algorithm. So, treating a problem with various algorithms typically implies the usage of several tools.

One widely used class of algorithms is neural networks. These algorithms are especially useful if the nature of the problem is not well defined, and it is difficult to determine an exact explicitly defined algorithm for problem treatment. The approach uses an analogy with biological neurons and utilizes the so called artificial neurons, as indicated in Figure 1.



$$Output = f (W1*I1, W2*I2, ..., Wn*In)$$

Figure 1: An artificial neuron. Legend: Inputs (I) are combined with weights (W), propagated through an interconnection network of some topology (N), and treated by the built-in function (f), to create an output (O). This output represents the result (e.g., a decision to make, an action to initiate, etc.). Explanation: Neurons are typically interconnected, to form a network, and the network can be applied to a problem, only after it has been properly trained. Network is trained iteratively, by comparing the network generated answer to the problem, and the beforehand known answer to the problem. The difference of the two answers is fed back into the system, the major parameters of the system are modified (weights W or topology N or function f), and such iterations last till the difference between the known and the created becomes acceptably small. The major bottleneck of neural networks is their training, because the training process can take huge time (during that time, processor time is being spent, without any advancement in the approaching to the final problem solution).

Another widely used algorithm is decision trees. This algorithm is especially useful if all decision making parameters and conditions are well defined, and precise processing rules can be created. The approach uses if-then-else and case structures, to define all relevant rules, as indicated in Figure 2.

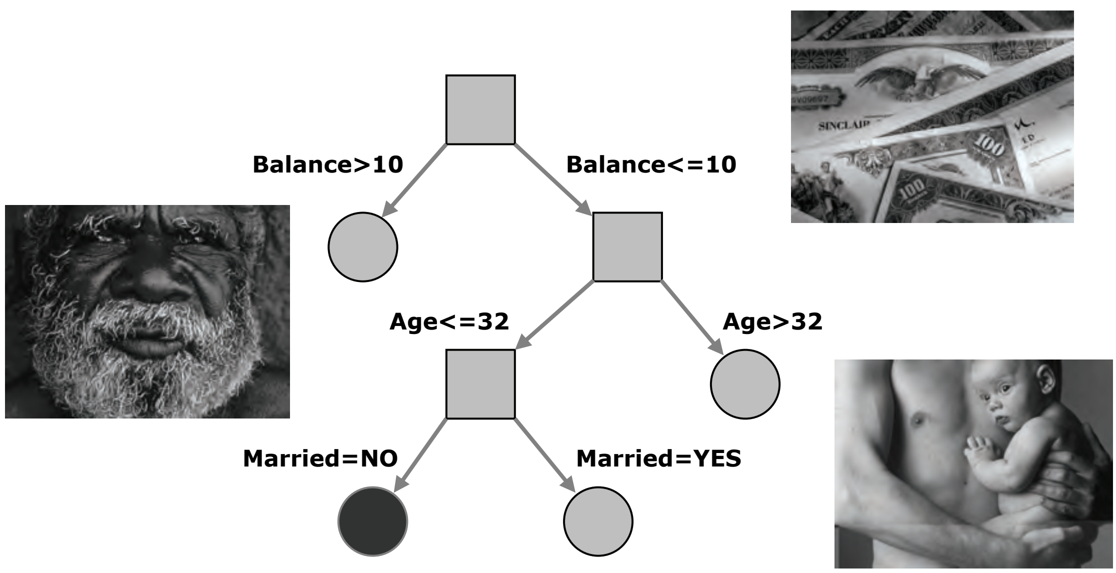


Figure 2: A decision tree. Legend: Arcs represent conditions, and leaves represent the actions to take. Explanation: In this specific example, the problem is who to give a bank loan, based on financial standing, age, and marriage status. The major bottleneck of decision trees is how to represent cases with meanings that depend on the context.

Still another widely used algorithm is rule induction. This algorithm is used in situations when various opinion creators/leaders have different opinions, and it is not possible to set precise rules. Instead, a statistical set of rules is created, and it is allowed that various rules of the set contradict with each other. The approach uses rule definitions with specifications of confidence levels and weights, as indicated in Figure 3.

If balance>100.000
then confidence=HIGH & weight=1.7

If balance>25.000 and
status=married
then confidence=HIGH & weight=2.3

If balance<40.000
then confidence=LOW & weight=1.9

Figure 3: A rule induction specifier set. Legend: Confidence can be HIGH or LOW; balances and weights are real numbers. Explanation: Note that higher balances can result in lower confidence (compare rules 1 and 2), and rules can contradict with each other (compare rules 1 and 3). The major bottleneck of the approach is related to the treatment of cases with small probability but a huge impact.

The memory based reasoning approach is used much more widely than in datamining alone; it is used also in court practices, etc. This algorithm is used in situations when we have to reduce the problem size, in order to be able to apply more sophisticated algorithms only to a subset of cases that can not be resolved with memory based reasoning. The approach uses the concept of history size and majority logic, as indicated in Figure 4.

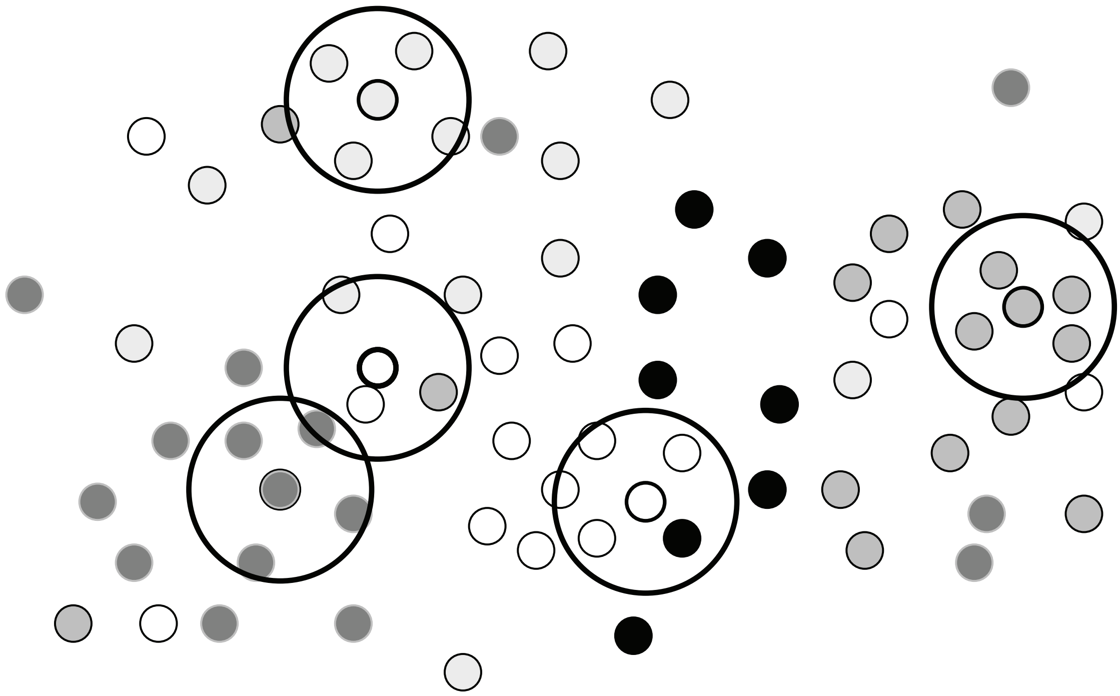


Figure 4: A case for memory based reasoning. Legend: Small circles represent the events and large circles represent the limits of the history to be taken into consideration. Explanation: Note that in some cases we have clear situations and in other cases ambiguous situations inside the history limits. The major bottleneck of this approach is how to determine the history size for efficient treatment of a given problem.

Other algorithms of interest include logistic regression, discriminant analysis, generalized adaptive models, genetic algorithms, simulated annealing algorithms, etc. For research results of the author, in the domains of these algorithms, the interested reader is directed to the web site of the author [3].

The major datamining model (framework for the application of above mentioned algorithms) is the CRISP model which tries to decompose each problem into six different stages, and to apply the relevant algorithms to each stage separately (divide and conquer), as indicated in Figure 5.

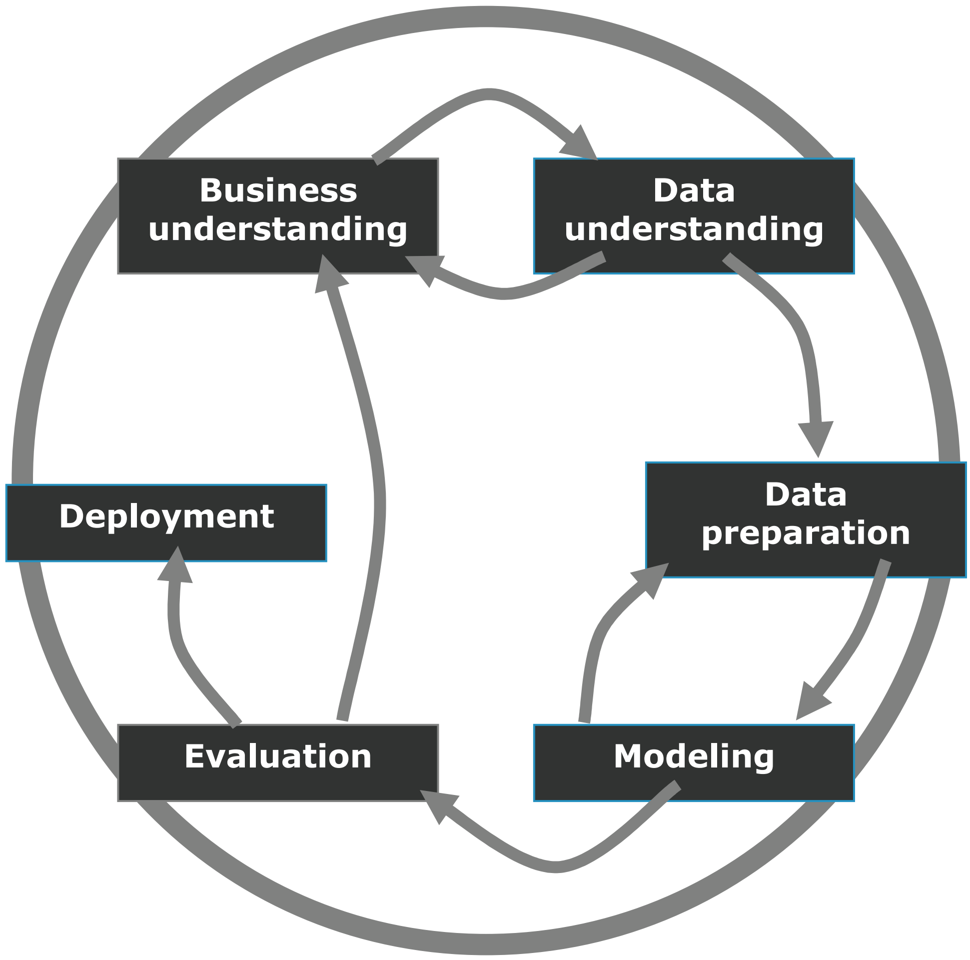


Figure 5: The CRISP model. Legend: Functions of the stages are self-explanatory. Explanation: The CRISP model was developed through a joint effort of three important companies: SPSS, NCR, and DaimlerCrysler.

A comparison of 14 different tools is given in Figure 6. Each tool supports a different algorithm, and their cost (at the time of our research) spans the range of three orders of magnitude, which is a clear indication of the fact that the field is still in its development stages.

Technology	Tool	Capability	Learnability/ Usability	Interoperability	Flexibility	Accuracy	Overall (equal weights)	Price (US$)
Tree	**CART**	+	✓	-	✓+	+	✓+	995
	Scenario	✓-	+	+	-	--	✓	695
	See5	✓	✓-	✓	✓-	+	✓	440
	S-Plus	+	✓-	++	+	+	+	1,795
	Tree Average*	✓	✓	✓+	✓	✓+	✓+	Median = 845
Rule	**WizWhy**	✓	✓+	✓	✓-	-	✓	4,000
	DataMind	✓+	++	+	✓-	✓	✓+	25,000
	DMSK	-	--	✓-	-	+	-	75
	Rule Average*	✓	✓	✓+	-	✓	✓	Median = 4,000
Neural	**NeuroShell 2**	-	✓	-	-	++	✓-	395
	PcOLPARS	✓-	-	-	✓-	✓	✓-	495
	PRW	✓+	+	++	✓	++	+	10,000
	Neural Average*	✓-	✓	✓	✓-	+	✓-	Median = 495
Poly Net	**MQ Expert**	+	✓	✓	✓+	+	✓+	5,950
	NeuroShell 2	✓-	✓	✓	✓	+	✓	495
	Gnosis	✓-	✓	--	✓-	++	✓-	4,900
	KnowledgeMiner	-	-	-	✓-	+	-	100
	Poly Net Average*	✓-	✓-	-	✓	+	✓-	Median = 2,698
	Overall Average*	✓	✓	✓	✓-	✓+	✓	Median = 845

Figure 6: Evaluation of 14 difference datamining tools. Legend: Plus indicates that a feature is extremely well supported, checkmark indicates that the feature is correctly supported, and minus indicates that the feature is not supported. Explanation: A good exercise for an interested reader is to make an effort to compare the latest versions of the given tools (only those that survived till the time of reading of this paper), from the following viewpoints: Ease of use, data visualization, depth of algorithms, file I/O, etc.).

An important research issue in this emerging field is how to combine different algorithms, models, and tools, for maximal performance, especially in cases when the meaning of the required knowledge depends on the context.

3 Semantic Web

This section contains a condensed overview. A detailed overview can be found in [2], which is a tutorial. That tutorial can be found on the web site of the author, and was presented many times at conferences, in house for industry, or as a university course, worldwide. Primarily, the issues are stressed which represent either the important bottlenecks or the potential solutions for the general problem of recognition of semantics in cases when information changes the meaning from one context to the other.

Figure 7 gives a definition of web today. The central elements are the information portals responsible for indexing, referencing, and maintenance of data collections. Figure 8 gives a definition of semantic web. The added elements are metadata (S+), and they enable the information portals to be able to do a number of newly added sophisticated functions like interpretation, negotiation, planning, decision making, ratings, trust services, and many other ones. So, semantic web is an extension of the current web that enables computers to be more helpful to the real needs of their users.

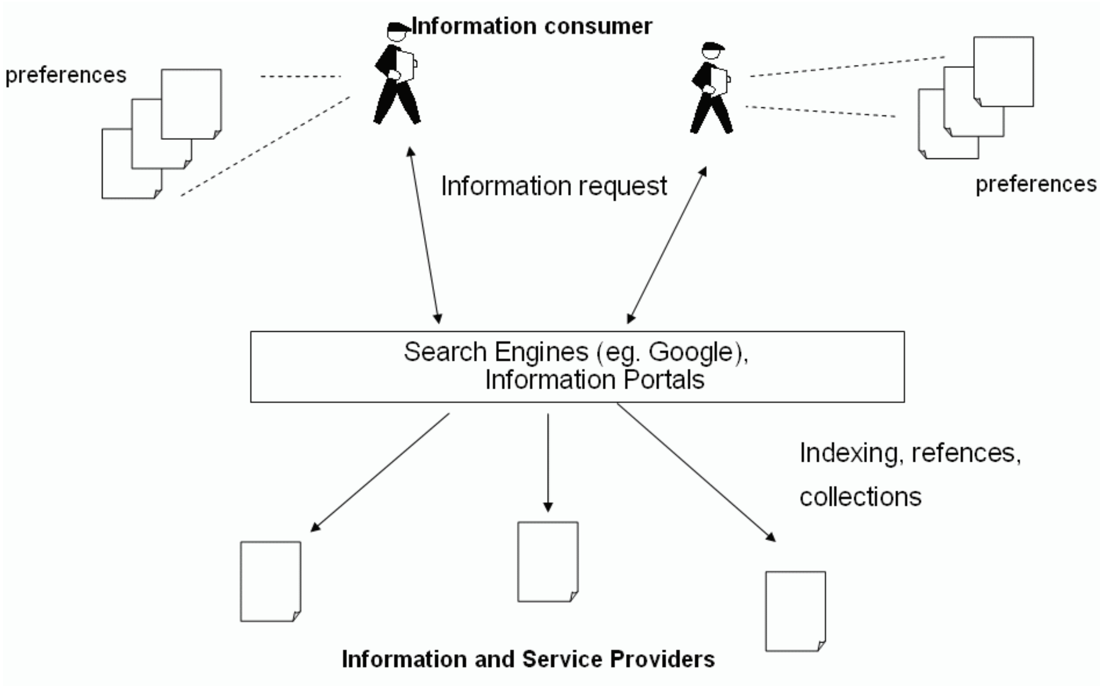


Figure 7: Web today. Legend: User preferences are described in a way understandable to search engines, based on URLs (Universal Resource Locators). Explanation: Users are information consumers.

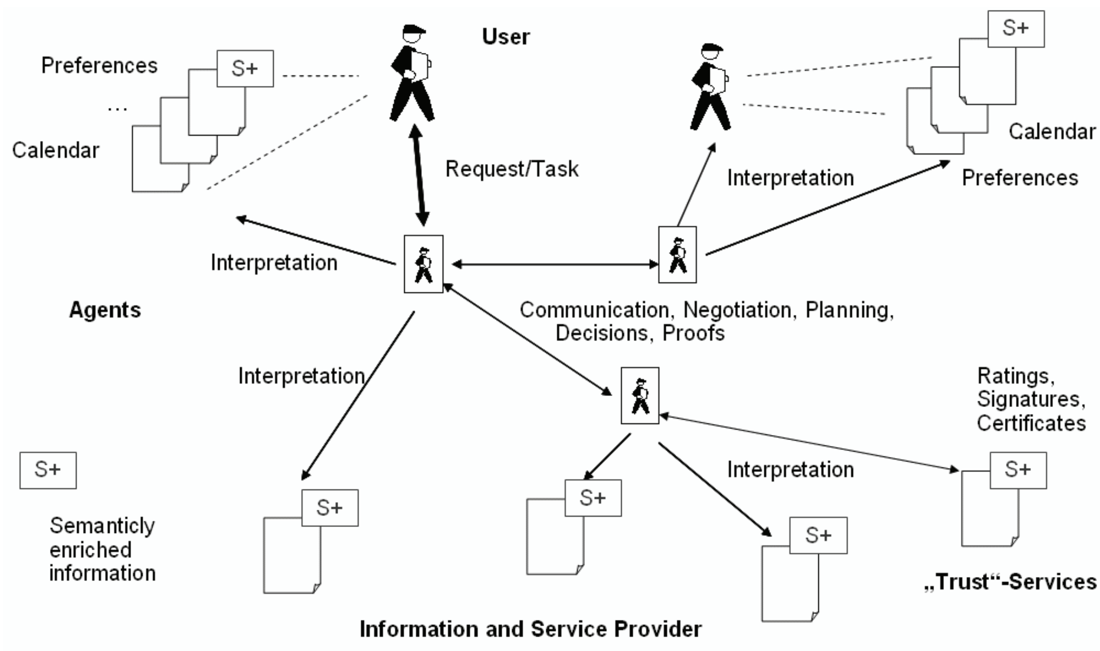


Figure 8: Semantic web: Legend: S+ refers to metadata. Explanation: Users are now knowledge consumers.

The introduction of semantic enables the implementation of a number of qualitatively new concepts and applications on the web, like context awareness (linking based on the meaning of information elements, rather than on the predefined URLs), filtering (visited pages can be rated, which can later on be used for generation of automatic recommendations), annotations (one can add comments to the information on the web, which can be shared by future visitors of the same or related pages), privatization (one can create his/her own database of information from the web).

A layered model of semantic web is shown in Figure 9. The tower of semantic web is build on foundations consisting of metadata and URIs (Universal Resource Identifiers). The concept of URI is more general than the concept of URL. One URL refers to a specific web page, while one URI may refer to a finer granularity (subset of a web page, or even a single word on a web page). Consequently, semantic coverage can be made more sophisticated!

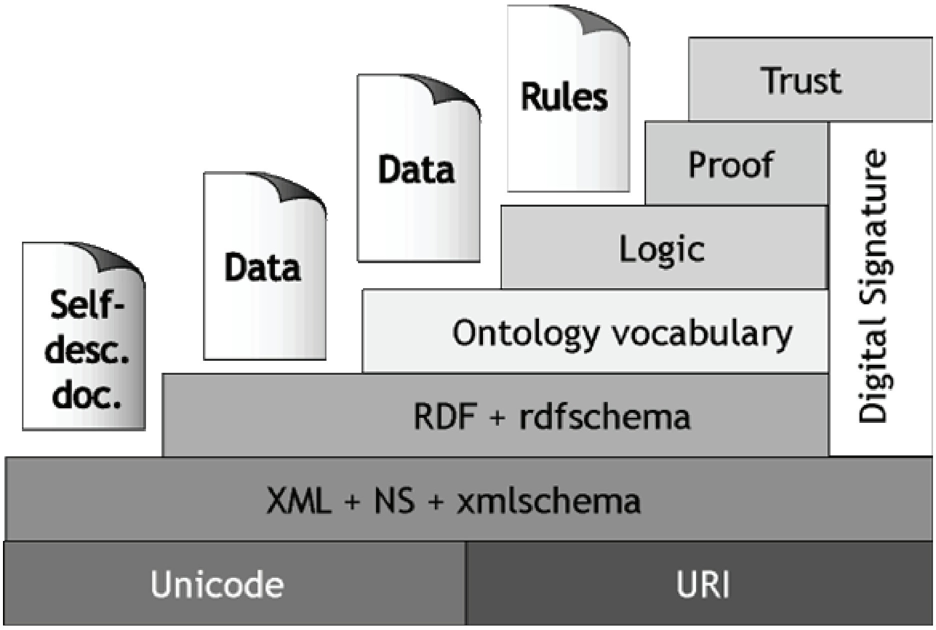


Figure 9: A layered model of semantic web. Legend: All mnemonics are defined in the text. Explanation: The reusability crisis of XML was overcome by the introduction of XML schema. Simple metadata created by XML can be made more sophisticated, and consequently closer to the level of typical user queries, if RDF is used. Analogously, RDF schema resolves the reusability crisis of RDF. With ontology languages one can describe better the knowledge of interest for a specific knowledge query, and one can get rid of the knowledge items not relevant for the given knowledge query. The concepts of logic, proof, and trust still represent research topics.

The major three development strategies of semantic web are: evolution support (building new techniques on the top of the existing ones), minimalist design (making large progress through small steps), and inference (based on the predicate logic). Such a strategy is enabled by the existence of the concept of the called XML stack, as indicated in Figure 10.

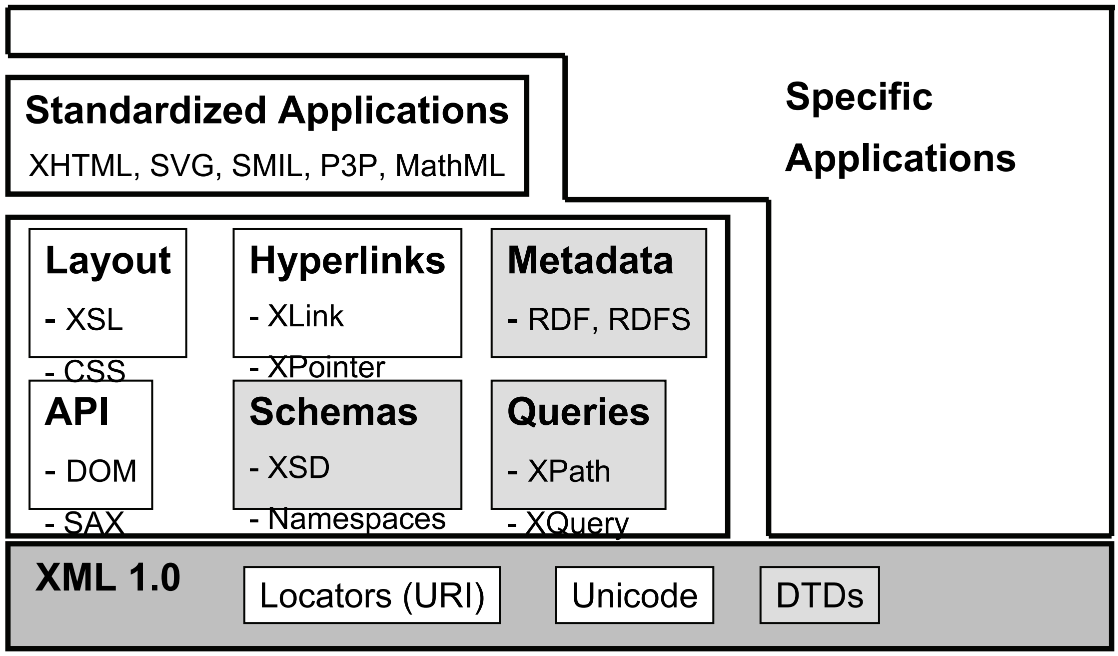


Figure 10: Architecture of the XML stack. Legend: All symbols are well known from the open literature. Explanation: The XPath language is crucial, since it enables the access to the most elementary semantic concepts, but an elaboration is needed that enables the treatment of context dependant semantics.

New vocabularies can be defined with RDF. As indicated before, with RDF one can combine simple metadata (atomic metadata) into more sophisticated metadata (molecular metadata). In this way, one enables that the semantic level of metadata is on the same level as the semantic level of typical user queries. This capability of RDF is enabled with the mechanism called reification. Another mechanism of importance is collections; it enables semantically related knowledge to be grouped, for easier handling.

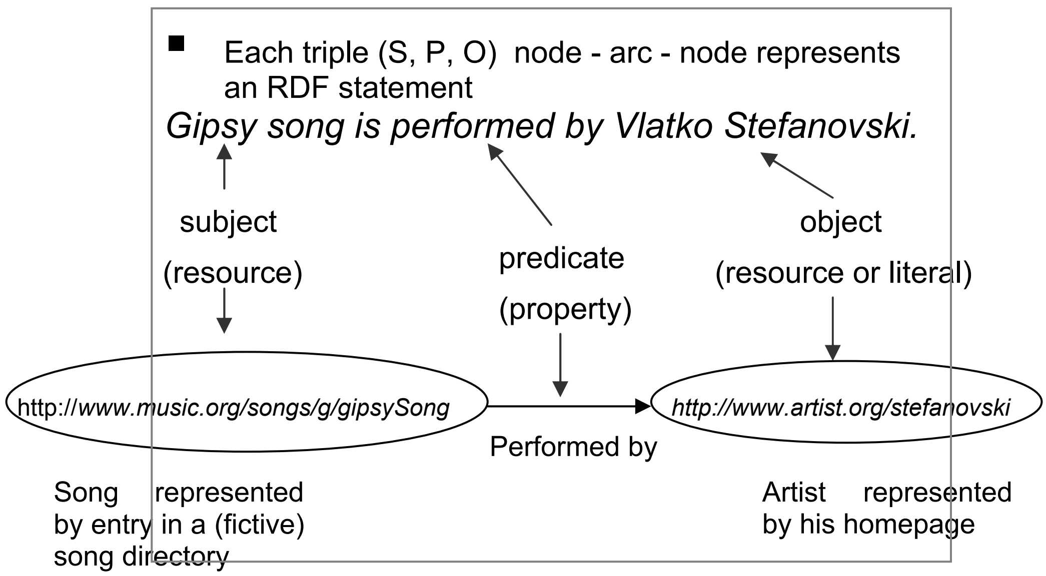


Figure 11: RDF Statement and Graph. Legend: Self-explanatory. Explanation: The essence is the predicate logic.

Ontology is a specification of a conceptualization. Conceptualization is an abstract (simplified) view of the world that we wish to represent for some purpose. An example of an ontology tree is given in Figure 12. In other words, if we need

to know only about one aspect of a problem, then all non-related knowledge has to be eliminated; however, without any negative impact on the semantics.

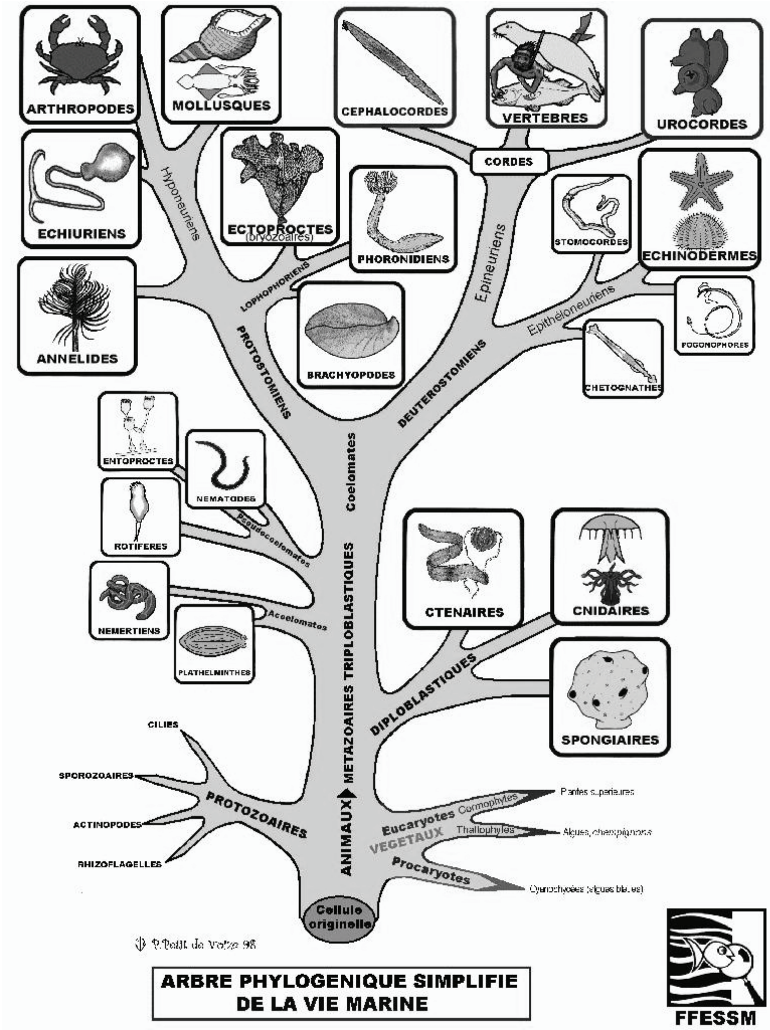


Figure 12: An ontology tree. Legend: Self-explanatory. Explanation: This tree enables one only to view relationships in a structure, and abstracts/neglects all other non-relevant information.

The most popular ontology languages are DAML+OIL or OWL. The OWL Lite is a subset of OWL. In these systems, the body of the ontology consists of classes, properties, and instances. The major component of an ontology is a taxonomy (class hierarchy). The major ontology related problem today is how to treat semantic ambiguities.

4 Conclusion

This paper gives a comparative overview of datamining and semantic web, and underlines the urgent need for research leading to better concepts and tools for treatment of semantic ambiguities! For a more detailed treatment of these subjects, an interested reader is referred to the references of this paper, or to the proceedings of IPSI conferences [4].

5 References

In addition to the references listed here, an interested reader can consult also 7 different books, coauthored/coedited by the author of this paper, at his web site. Information form these books was also used in preparing this paper. A common characteristic of these 7 books is that for all of them, a Nobel Laureate wrote a foreword (7 different persons). They are related to IPSI conferences [4].

[1] Jovanovic, N., et al, 'Tutorial on Datamining,' galeb.etf.bg.ac.yu/vm/, May 2004.

[2] Vujovic, I., et al,'Tutorial on Semantic Web,' galeb.etf.bg.ac.yu/vm/, June 2004.

[3] Milutinovic, V., 'Web Site,' galeb.etf.bg.ac.yu/vm/, July 2005.

[4] 'IPSI Conferences Web Site' www.internetconferences.net, August 2005.

ADVANCING EDUCATION IN VIRTUAL AND REAL WORLDS BY META- INNOVATIONS

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1 Introduction

We have many challenges in education today. In fact, education is constantly getting more challenging as our technological, social, political, commercial and cultural complexities increase. We can look back to civilizations in the past, like the Egyptian society, where essentially very little changed over 3000 years in the days of the Pharaohs (Blainey, 2000, p. 85). However, today every facet of our available existence is changing, either due to external factors or because we would like to reorganise our lives and environments. So are our existing educational policies and theories adequate to the task? Are we approaching the multiplying challenges in an optimal way or can we do better?

I submit that we can do better, and the issue we need to tackle in my view is the fragmentation and reliance on old approaches in the development of new educational practice and theory. In fact I would argue, as Erno Lehtinen mentioned in his EARLI 2003 presidential address in Padova, Italy, that it is no longer satisfactory for thinking educators to work exclusively within the confines of individual educational theories but rather take a wider view in practical and theoretical developments.

However, I would go a step further and argue that what we need is not only the application of individual situationally-appropriate theories for different contexts as Erno Lehtinen advocated, which is already a major advance on the common practice of applying a single theoretical framework to all situations, e.g. see the almost universal advocacy of for “social constructivism” paradigm, but we need to develop meta advances in theory and practice. (The “meta” term in this context is used to indicate overarching linking of parts to make a more powerful and cohesive whole, e.g. as used in the term ‘meta-analysis’.) This means that we need to develop **meta-theories of education** that incorporate existing teaching, learning and educational theories into harmonious broadly-based descriptions and prescriptions of educational activities and interacting factors. We need to develop an overall orchestra out of individual theories, which then play together like musical instruments performing a symphony – a Sibelius symphony no less! By the way what I am advocating is not a simple or trivial exercise, as any symphony composer will tell you!

Secondly, I believe we also need to take a more holistic view of our educational practice, e.g. as Saba (2003) recently suggested using systems theory in modern distance education. In facing the challenges of the mix of virtual and real education we may be overlooking critical factors and ending up like the University of Mid-America consortium (McNeil, 1993). They had a wonderful start, great technology, good buy-in from the students (how would the University of Lapland like to have applications to enrol 20,000 students?), but failed due to organizational problems that were not resolved by the component partner universities in time.

So we also need **meta-practice models**, which take into account the real and virtual aspects of education and educational affordances and possibilities. How might we do this? I will present three examples. One from the past, one from the present and one from the future.

2 The Past

In my doctoral research in the 1990’s I contrasted discovery learning, e.g. see (Bruner, 1961, 1962), with a more structured instruction, which used worked examples extensively as a main form of instruction. This approach was based on the Cognitive Load Theory (CLT) (Sweller, 1988; Sweller, van Merriënboer, & Paas, 1998). In effect I had two competing educational theories which made broad and opposing predictions about the utility of different forms of instruction. So who was right? Sometimes they both were right, sometimes one was right and the other was wrong.

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Let me explain. Instead of either theory being applicable in all circumstances they were found to be differentially suitable. The factor that made the difference was students' prior experience. We can summarise and cautiously generalise the findings as shown in Figure 1.

	Discovery Learning	Worked Examples Instruction
Good prior knowledge	Good learning	Good learning
Poor prior knowledge	Poor learning	Good learning

Figure 1: Results of the discovery learning vs. worked examples instruction in experiments in (Tuovinen & Sweller, 1999).

For the students with good prior knowledge both discovery and worked examples approaches were equally effective, although my experiments gave a hint that the discovery approach might be significantly better with even greater prior knowledge than my students had during this experiment. (The trend for the reduction in the utility of worked examples with increasing expertise has been shown to be correct and has been termed the "expertise reversal effect" (Kalyuga, Ayers, Chandler, & Sweller, 2003; Kalyuga, Chandler, Tuovinen, & Sweller, 2001).) However, for students with poor prior knowledge in the field of study, i.e poor prior schema, the structured instruction that employed substantial study of worked examples, was significantly more effective than discovery.

So now we have a better understanding of how we should structure instruction according to the individual needs of students. One group of students with poor schema definitely needs structured instruction using worked examples. So the cognitive load theory prescriptions are particularly beneficial for them. The students with good schema do not necessarily need the worked examples, and in fact the discovery learning approach might be better for them.

Thus we need to combine these results into a synthesis of the two apparently incompatible educational explanations. However, the factor that provides the glue is the consideration of differential student learning needs. Under one set of conditions one theory applies, under alternative conditions, the other predicts the beneficial learning conditions and outcomes better. Of course the new information gathered from this empirical investigation has now been incorporated into an expanded version of the Cognitive Load Theory. Perhaps it could also be published as an interesting extension of the discovery learning theory perspectives as well.

3 The Present

Presently I have been thinking about the prescriptions and descriptive power of "multiple perspectives" view of educational multimedia and the "variability effect" in the Cognitive Load Theory. The multiple perspectives view of multimedia has been strongly advocated as one of the main benefits to be derived from the use of educational multimedia (Moreno & Duran, 2004; Rowland, Wright, & Harper, 2004). However, the experiments in Cognitive Load Theory context suggest the multiple perspectives approach may lead to harmful redundancy effects (Kalyuga, Chandler, & Sweller, 1999; Mayer, Heiser, & Lonn, 2001). Other studies such as (Moreno & Duran, 2004) and a review of the empirical experimental results (Tergan, 1997) indicate that using multiple representations approach in educational content presentation is not an unqualified universal benefit for learning and the students need to be provided with scaffolding and various forms of extra help, such as verbal guidance, for the learning to be generally useful, and even then multiple representations pose problems for novices.

In the Cognitive Load Theory framework the "variability effect" is thought to consist of varying the examples and exercises to provide a better understanding of the applicability of the general principles taught (Sweller et al., 1998). However, in the CLT context the limit of the working memory has been a key emphasis and so it has been understood that the variability in the examples does add significantly to the cognitive load and so the combined intrinsic and extrinsic cognitive load needs to be sufficiently low to allow room for added or 'germane' cognitive load generated by the problem variability. If we compare the multiple perspectives approach to multimedia with the variability effect, we notice they are trying to achieve the same effect. Both of them are seeking to provide a greater range of alternatives to a given procedure, process or content. However, generally the multiple perspectives approach does not recognize limits on the variability whereas the variability effect incorporates the cognitive load limitations principle in its basic description.

Thus in this sense we could see the multiple perspectives view of educational multimedia design as an instance of the variability effect in the CLT. In fact we could show this effect as a Venn diagram as pictured in Figure 2.

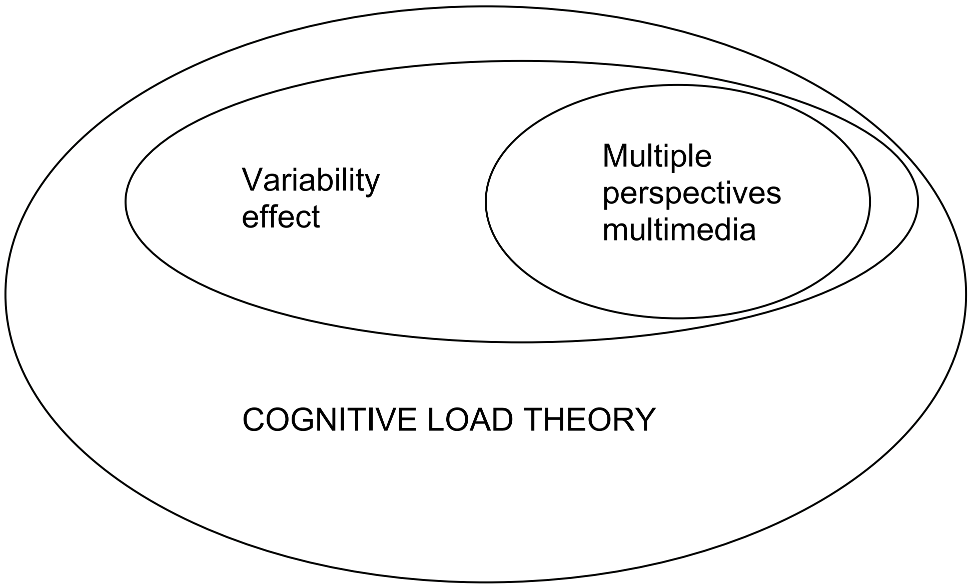

Figure 2: Relationship between 'multiple perspectives' in educational multimedia, 'variability effect' and 'cognitive load theory'.

This provides a different slant to the variability effect, which has been usually discussed in terms of providing different practice examples for the students to work through. It broadens its application to multimedia design as well as suggesting the increase of germane cognitive load via varying the beneficial exercises.

In this sense the synthesis of these two ideas provides better understanding of the limits of the multiple perspectives principles, while at the same time suggesting to the people a new way to increase the germane cognitive load when there is capacity in the working memory to accommodate extra processing of multiple perspectives.

4 The Future

The above two examples deal with the synthesis of theories, but with very real empirically-established consequences. In this example we will look at the incorporation of **meta-practices** to achieve improvements in educational practice. By meta-practice I mean that the practice takes into account numerous pragmatic factors that will make the students' educational experience better than if we just focused on changes in the classroom, but where the new practices are based on relevant educational theories and innovative applications of new educational technologies.

In this situation I will be discussing how the classroom experiences in schools may be improved by applying virtual technology and methods. However, the new practices need to be designed according to suitable educational principles, which take into account the circumstances of the schools, school systems, students, and the organisers. In this sense the design of these practices is sited in the context of the systems theory (Saba, 2003), but where other educational theories are linked to a new practice prescription to form a **meta-theoretically-based meta-practice**.

One of the perennial problems in education has been the meaninglessness or lack of relevance of classroom learning, i.e. the dissociation between the learning content and methods of the classroom and the world of experience and practice being taught and/or being experienced by the students. Rousseau (Page, 1990) was an early critic who recognised this problem. In Rousseau's time the common schooling involved memorisation of the Greek and Roman classics, and he thought this approach stifled children's natural tendencies for activity, and made them deceitful, selfish and pretentious. In his view classical education was boring, mostly beyond the children's comprehension, and simply taught predigested information without much benefit for the students' practical life. The enforced silent motionless student behaviour caused the students to hate education and made them into 'passive, feeble and stupid' citizens. His father devised a 'cunning plan' for encouraging Rousseau to read the books in his library by forbidding his son to read the books, but conveniently leaving the key to the book cupboards in an easy place for his son to find and enjoy the forbidden fruits of reading the best of modern thought.

Some of the responses to this perceived problem have been the authentic learning (Clark & Estes, 1999; Corrent-Agostinho, Hedberg, & Lefoe, 1998; Crocker & Fendt, 1998; Dehler & Porras-Hernandez, 1998; Fitzgerald, Standifer, & Semrau, 1998; Harper, Hedberg, & Wright, 2000; Harrell Jr., 2000; Herrington, Reeves, Oliver, & Woo, 2004; Naidu & Oliver, 1999), situated learning (Griffin, 1995; Herrington, Oliver, Herrrington, & Sparrow, 1997; Herrington, Sparrow, & Herrington, 2000; Knapczyk & Chung, 1999; Micheller, 1999; Rosenfeld, 1999; Royer, 2001) and autonomous learning (Clifford, 1999; Kaur, Fadzil, & Ahmed, 2005; Lee, Yamada, Shimizu, Shinohara, & Hada, 2005; Melzer, Hadley, & Herczeg, 2005; Pahl, 2005; Wang, Wang, & Wu, 2005; Yumuk, 2002) schools of thought. These concepts are often intermingled and in most of the references noted above, they have been implemented via modern technology-enabled educational environments. In fact, technology, particularly the modern information and communications technology implemented in various ways via the Internet network, has been promoted as a key vehicle for enabling autonomous, authentic and situated teaching and learning.

The problem to be addressed at this point in time is the improvement in the relevance and authenticity of the science education provided in a Middle Eastern country, while giving the students a greater degree of control over their learning, i.e. greater student autonomy. The challenge is to move beyond the classroom, to bring the reality of science in the world to the students linking it with their school curricula, without necessarily interrupting the total fabric of the schools and school systems by huge numbers of excursions or other incredibly expensive and difficult to organise activities.

Let us take the example of chemistry education. One of the key uses of chemistry in Middle East is in oil production. Most of our cars in the world run on oil products sourced from the Middle East. So an understanding of the chemistry in oil production is of authentic interest to the students of the country. In many schools in the world oil chemistry is taught by formulae, e.g. learning about the long molecules of carbon chemistry. Yet how much do each of us that have dutifully learned our basic organic chemistry understand about how it actually relates to the operations of a typical oil refinery? What better example can these students have of needing to bridge the near and present reality, the operation of the oil refinery, and the study of chemistry at school?

What could we do to bring these two worlds together in a practical and an increasingly student-controlled manner? Firstly, it seems that we could look to site the relevant organic chemistry topic(s) at a common time in the school year when the oil refineries were accessible for demonstrating their fundamental operational processes. Thus with liaison between the curriculum designers/providers and the oil refinery operations the two aspects could be coordinated to occur at a mutually convenient time. Then the chemistry curriculum of the school needs to re-designed to ensure that it is organised to make use of the oil refinery processes to illustrate by suitable examples the concepts in the school curriculum. The operations from the oil refineries can then be transported into the schools by the magic of the flying carpet of interactive television. We are used to seeing television from authentic locations where disasters, such as the bombing of the London transport system, or major events of international significance, such as the announcement of the next Olympic games city, are broadcast in real time as the event actually unfold. How does this work? It is not at all difficult in these days of outside broadcast (OB) units for all television companies to source content from the field as requested by the program producers in the studios and then broadcast immediately either over free-to-air stations, by cable or by satellite networks.

At the same time it is not at all difficult to combine the live footage with previously captured and prepared footage, animations, graphics, sounds, etc., which illustrate and simplify the complex operations shown in the real refinery. This is part of the normal operation of a television station. Thus it is proposed that a production system incorporating OB facilities under the control of the TV studio would be able to bring relevant experiential learning environments to schools. However, we can go way beyond simply providing educational television for schools. After all this has been done for decades. Firstly, what is different here is that each television event must link intimately to the chemistry lessons designed for the schools. The students in the schools will be progressing through their chemistry studies in the topic of organic chemistry at the same time in all the schools when the broadcasts from the field are provided. Secondly, what is possible now is to then provide a feedback link from the schools, directly from the students, to the studio controlling the broadcasts via a real-time link to affect the activities of the broadcast. I proposed such a system in 1995 when the World-Wide Web was still in its infancy (Tuovinen, 1995, 1996). Thus the students and the teachers in the schools can request particular views, explanations and discussion about the field events. Just imagine a student sitting in a school hundreds of kilometres away wanting to get a better view of the fractionating column in a refinery, and a better explanation of how the viscous goo found in the ground is separated into the various commonly known components, such as fuels, lubricating oils, etc. Not only can the request be sent to the studio, by the magic of the Internet, but the on-site engineers can be asked by the on-site presenters to explain in more detail the alternatives they need to deal with in designing and maintaining the systems, etc., in terms of the chemistry they are learning at school.

Thirdly, what is then possible is discussion among the students in real time or asynchronously about a whole range of issues, such as the social impact of oil production and use, the environmental issues of oil production, transport and use, etc. In this way organic chemistry becomes a living and topical issue. It provides an example for the students about the societal and democratic nature of decision making processes about the application of chemistry to whole range of possible uses, and shows the students how the modern technology enables them to have an influence on the process. For example, with perhaps hundreds or thousands of students wanting to influence the OB views of the refinery, ways of getting consensus or majority rulings over Internet need to be implemented. Thus once various alternative action proposals have been submitted to the studio the students need a quick way of voting or expressing opinions, which are then quickly collated and the total results displayed very quickly. This is where the Internet shines. There are many systems available for voting and collating information over the Internet, which can be used in real time as the students participate and watch the results unfold.

So in this brief glimpse into the design of an authentic, situated cognition-based system of learning that emphasises student-control of learning, we have an example of a meta-theory-based meta-practice where all the parts of the educational system need to work in harmony to produce improved learning.

I submit that this is the promise and imperative of our education today. To seek to link existing educational theory and practice which individualises education while at the same time providing the scope and scale to provide it to ever larger numbers of students with increasing quality and relevance.

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Conference Papers

Themes and Topics

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Knowledge construction and hypermedia

One Practical Algorithm of Creating Teaching Ontologies

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The paper presents one practical approach aimed at developing teaching ontologies. The underlying research framework is pursuing a methodology that will scaffold the process of knowledge structuring and ontology design. Moreover, special stress should be placed on visual design as a powerful learning mind tool. For more comprehensible understanding the process of developing a practical ontology from the domain of introductory C programming is described.

Keywords: ontology, visual knowledge engineering, knowledge acquisition, knowledge sharing and reuse, NBE.

1 Introduction

The achievements in the field of Artificial Intelligence help to develop a range of ways of symbolic and graphical representing of knowledge. A well-chosen analogy or diagram can make all the difference when trying to communicate a difficult idea to someone, especially a non-expert in the field. The idea of using visual structuring of information to improve the quality of student learning and understanding is not new. Knowledge engineers make use of a number of ways of representing knowledge when acquiring knowledge from experts. These are usually referred to as knowledge models.

Teachers are also knowledge engineers. They are used to work with concept maps, mind maps, brain maps, semantic networks, frames (Conlon 1997), (Jonassen 1998), (Sowa 1984) and other conceptual structures. As such, the visual representation of the general domain concepts facilitates and supports student understanding of both semantic and syntactic knowledge. A teacher operates as a knowledge analyst by making the skeleton of the studied discipline visible and showing the domain's conceptual structure. At the present time, this structure is called an *ontology*. However, ontology-based approaches to teaching are relatively new fertile research areas. They originated in the area of knowledge engineering (Boose 1990), (Eisenstadt et al 1990), (Wielinga &Schreiber 1992), which was then transferred to ontology engineering (Fensel 2001), (Jasper & Uschold 1999), (Mizogushi & Bourdeau 2000).

Knowledge Engineering traditionally emphasized and rapidly developed a range of techniques and tools including knowledge acquisition, conceptual structuring and representation models (Adeli 1994), (Scott & Clayton 1994).

Since 2000 a major interest of researchers focuses on building customized tools that aid in the process of knowledge capture and structuring. This new generation of tools – such as Protégé, OntoEdit, and OilEd - is concerned with visual knowledge mapping that facilitates knowledge sharing and reuse (Protégé 2004), (OntoEdit 2004), (OilEd 2004). The problem of iconic representation has been partially solved by developing knowledge repositories and ontology servers where reusable static domain knowledge is stored. Ontolingua, and Ontobroker are examples of such projects (Ontolingua 2004), (Ontobroker 2004).

This paper proposes a clear, explicit approach to practical ontology design. The underlying research is pursuing usage of the visual, iconic representation, and diagrammatical structures. The special stress is put on visual design as a powerful learning mind tool. For more comprehensible understanding of the process, the process of developing a practical ontology from a course of introductory C programming is described. In the remainder of the paper, we will describe some theoretical issues regarding ontological engineering and present our proposed algorithm for ontology design. Moreover, we will describe our detailed practical example following the proposed algorithm. In conclusion, we provide insight into the discussion of the current and possible future work.

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2 Using ontological engineering for teaching purposes

We start the discussion of theoretical issues of ontological engineering by reviewing different definitions of ontology from literature circulating within the field.

2.1 Ontology Definitions

Ontology is a set of distinctions we make in understanding and viewing the world. There are numerous well-known definitions of this milestone term (Neches 1991), (Gruber 1993), (Guarino & Giaretta 1998), (Gomez-Perez 2004), that may be generalized, e.g.:

- ✓ *Ontology is a hierarchically structured set of terms for describing a domain that can be used as a skeletal foundation for a knowledge base.*

Such definition clarifies the ontological approach to knowledge structuring while giving enough freedom to open-ended, creative thinking. For example, ontological engineering can provide a clear representation of a course structure, main terms, methods, and their inter-relationship.

Ontology as a useful structuring tool may greatly enrich the teaching process, providing students an organizing axis to help them mentally mark their visions in the information hyper-space of the domain knowledge.

2.2 Creating Teaching Ontologies

Ontology creating also faces the knowledge acquisition bottleneck problem. The ontology developer encounters the additional problem of not having any sufficiently tested and generalized methodologies, which would recommend what activities to perform and at what stage of the ontology development process. An example of this can be seen when each development team usually follows their own set of principles, design criteria, and steps in the ontology development process. The lack of structured guidelines and methods hinders the development of shared and consensual ontologies within and between the teams. Moreover, it makes the extension of a given ontology by others, its reuse in other ontologies, and final applications difficult (Guarino & Giaretta 1998).

Until now, only few effective domain-independent methodological approaches have been reported for building ontologies (Swartout, Patil, Knight& Russ 1997), (Fensel 2001), (Mizogushi 2000). What they have in common is that they start from the identification of the purpose of the ontology and the needs for the domain knowledge acquisition. However, having acquired a significant amount of knowledge, major researchers propose a formal language expressing the idea as a set of intermediate representations and then generating the ontology using translators. These representations bridge the gap between how people see a domain and the languages in which ontologies are formalized. The conceptual models are implicit in the implementation codes. A re-engineering process is usually required to make the conceptual models explicit. Ontological commitments and design criteria are implicit in the ontology code.

Figure 1 presents our vision of the mainstream state-of-the-art categorization in ontological engineering (Guarino, Welty 2000), (Jasper & Uschold 1999), (Uschold & Ggruninger 1996) and may help the knowledge analyst to figure out what type of ontology he/she really needs. We use Mindmanager™ as it proved to be a powerful visual tool.

Frequently, it is impossible to express teaching information in a single ontology. Accordingly, subject knowledge storage consists of a set of related ontologies. However, some problems may occur when moving from one ontological space to another that could be solved by constructing meta-ontologies that may help to resolve these problems.

We can propose different types of teaching ontologies that can aid effective learning:

- ❖ Main concepts ontology,
- ❖ Historical ontology (genealogy),
- ❖ Partonomy of the discipline,
- ❖ Taxonomy of the theories, methods and techniques, etc.

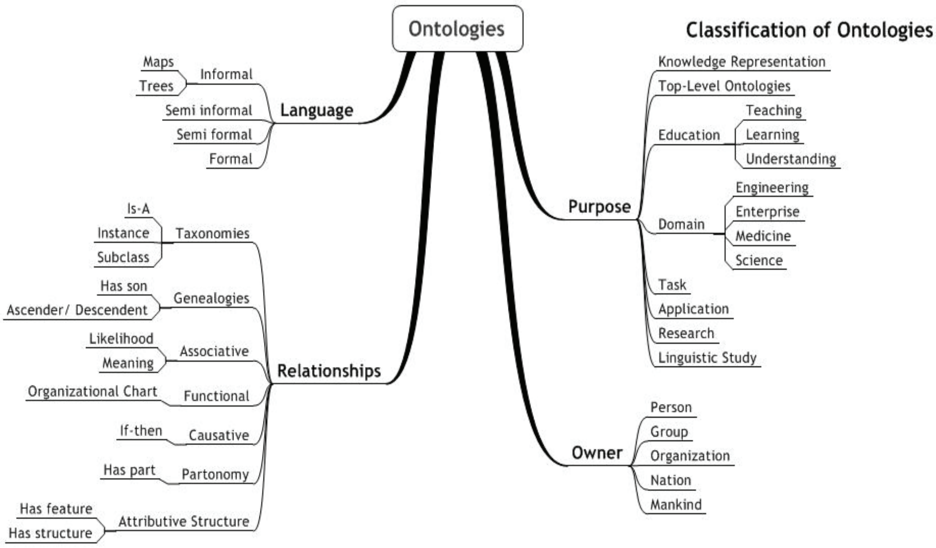

Figure 1. Ontology classification

The concrete set of ontologies depends on personal vision, teaching subject and awareness level of the students. Generalizing our experience in developing different teaching ontologies for e-learning in the field of artificial intelligence and neurolinguistics (Gavrilova & Voinov 1996), (Gavrilova & Voinov 1998), (Gavrilova, Voinov, Vasilyeva 1999), (Gavrilova 2003), we propose a five-step algorithm that may be helpful for visual ontology design. We put stress on visual representation as a powerful mind tool (Jonassen 1998) in structuring process. Visual form influences both analyzing and synthesizing procedures in ontology development process. That is why we believe that the “beauty” of the ontology plays an important role in understanding of the knowledge. The following section describes our 5-step recipe of ontology design and some consideration on layout harmony

3 Ontology Creating

3.1 Five-Steps Recipe

We can propose 5-steps recipe for creating ontology:

1. **Glossary development**: The first step should be devoted to gathering all the information relevant to the described domain. The main goal of this step is selecting and verbalizing all the essential objects and concepts in the domain.
2. **Laddering**: Having all the essential objects and concepts of the domain in hand, the next step is to define the main levels of abstraction. It is also important to elucidate the type of ontology according to **Figure 1** classification, such as taxonomy, partonomy, and genealogy. This is being done at this step since it affects the next stages of the design. Consequently, the high level hierarchies among the concepts should be revealed and the hierarchy should be represented visually on the defined levels.
3. **Disintegration**: the main goal of this step is breaking high level concepts, built in the previous step, into a set of detailed ones where it is needed. This could be done via a top-down strategy trying to break the high level concept from the root of previously built hierarchy.
4. **Categorization**: At this stage, detailed concepts are revealed in a structured hierarchy and the main goal at this stage is generalization via bottom-up structuring strategy. This could be done by associating similar concepts to create meta-concepts from leaves of the aforementioned hierarchy.
5. **Refinement**: The final step is devoted to updating the visual structure by excluding the excessiveness, synonymy, and contradictions. As mentioned before, the main goal of the final step is try to create a beautiful ontology. We believe what makes ontology beautiful is harmony and clarity.

3. 2 Harmony as Conceptual balance

A well-balanced ontological hierarchy equals a strong and comprehensible representation of the domain knowledge. However, it is a challenge to formulate the idea of a well-balanced tree. Here we offer some tips to help formulate the “harmony”:

1. Concepts of one level should be linked with the parent concept by one type of relationship such as is-a, or has part.
2. The depth of the branches should be more or less equal (±2 nodes).
3. The general outlay should be symmetrical.
4. Cross-links should be avoided as much as possible.

3.3 Harmony as Clarity

Moreover, when building a comprehensible ontology it is important to pay attention to clarity. Clarity may be provided through number of concepts and type of the relationships among the concepts. Minimizing the number of concepts is the best tip according to Ockham's razor principle proposed by William of Ockham in the fourteenth century: "Pluralitas non est ponenda sine neccesitate," which translates as "entities should not be multiplied unnecessarily."

The maximal number of branches and the number of levels should follow Miller's magical number (7±2) (Miller 1956).

Furthermore, the type of relationship should be clear and obvious if the name of the relationship is missing. Some tips to achieve visual clarity are described later in section 4.4.

4 Developing Practical Ontology

In this section we describe our attempt to develop ontology for C programming language following the aforementioned 5-step algorithm. We have tried to report the exact practical procedures we followed at each step by including all the visual structures.

4.1 Step 1 - Glossary Development

As previously mentioned the first step in building ontology is collecting information in the domain and building a glossary of the terms of the domain. To build a glossary for teaching introductory C programming course, we collected the terms from two different types of resources: closed-corpus material and open-corpus material.

The closed corpus materials are in the form of lecture notes that are precisely designed for the course. The open corpus materials include several online tutorials in C programming. We extracted the terms from the lecture notes manually by carefully reviewing the lecture handout. The terms from open-corpus material were extracted automatically (Brusilovsky & Rizzo 2002). Consequently, we tried to combine the automatically extracted terms with manually extracted terms to build a single glossary. **Figure 2** presents the combined unsorted glossary.

Data type	While loop	User defined function
Integer	Statement	Parameter passing
Character	Block	By Values
Float	Sequential execution	By reference
Primitive data type	Condition	Kernel command
Expression	Nested if	Function prototype
Data structure	If-else	Pointer & Function
Array	If	Pointer
Array processing	Multiple selections	Computer memory
Data aggregate	Switch	Memory address
String	Complex conditionals	Declaring pointer
Two dimensional arrays	File	Malloc
Declaration of two dimensional arrays	Simple file processing	Stack
	Advanced file processing	Recursion
Variable	IO	Operator
Variable initialization	Input	Pointer operation
Variable assignment	Standard input	Push
Variable declaration	Scanf	Conditional operator
Readable program	Input redirection	Arithmetic operation
Indentation	Standard input	Decrement expression
Understandable program	Output	Pre-decrement
Comments	Printf	Post-decrement
Constant	Printing	Increment expression
Define	Standard output	Post-increment
Literal constant	Output redirection	Pre-increment
Pre-processor	Conversion	Logical operator
Directive	Explicit conversion	OR operator
C compiler	Typecasting operator	Not operator
Loop	Casting	AND operator
Do-while loop	Automatic type conversion	Character operator
Counter controlled loop	Assignment conversion	Relational operator
Sentinel controlled loop	Safe type conversion	Associativity of operators
For loop	Unsafe type conversion	Order of calculation
Nested loop	Function	Precedence of operators
Threshold controlled loop	Function parameter	
	Standard function	

Figure 2. Glossary of the terms for teaching C programming

4.2 Step 2 - Laddering: Building an Initial Mind Map Structure

At the second step we built an initial visual structure of the glossary terms. The main goal of this step is the creation of a set of preliminary concepts and the categorization of those terms into concepts. A mind map can be a useful visual structure for this step. **Figure 3** presents the mind map of our initial categorization. Since the categorization in this step is preliminary, some of terms might not fit into any of the initial categorization. We should mention that the categorization in this step is done entirely manually. However, we employed the lecture notes, which were used to build the glossary in the previous step, to build the initial categories as well. We can consider the lecture notes, as expert help, to design the ontology. This is due to the fact that the lecture notes were designed by the expert who is teaching the course for couple of years.

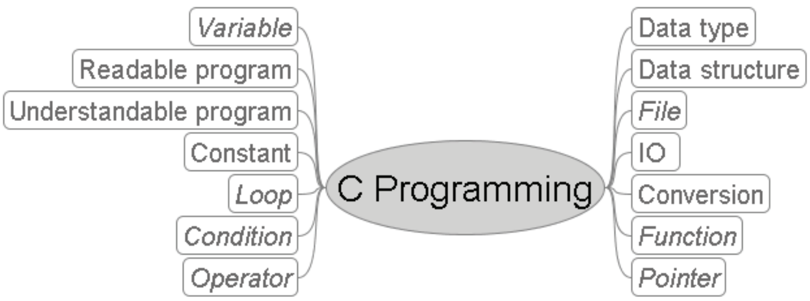

Figure 3. Trivial categorization

Figure 4 presents the details of our initial categorization of the terms into the concept in **Figure 3**. The visual structures presented at this step, illustrates the idea of how an ontology can bridge the gap between the chaos of unstructured data presented in the glossary and be a clear means of showing mapped representations. Another good example of this bridge can be the ontology of Italian artistic schools which is built from chaos of names of great Italian artists (Gavrilova 2003).

4.3 Steps 3 & 4 - Disintegration/Categorization: Building a Concept map with more Precise Hierarchy

At next step we composed more precise concepts and hierarchies by analyzing the glossary and previously built visual structure. First we employed the top-down design strategy to create meta-concepts such as "Date", "Structure", and "IO". Then using the bottom-up strategy we tried to fit the terms and concepts into the meta-concept. Moreover, we created the relationships between the concepts. A concept map is the most useful visual structure for representation of the results of this stage, since it gives the ability of defining the relationship in addition to building the hierarchy. The output of this step is a large and detailed map, which covers the course in the hierarchical way[1]. However, since this ontology is designed for teaching purposes it is important to offer the overall picture and a general hierarchy as well.

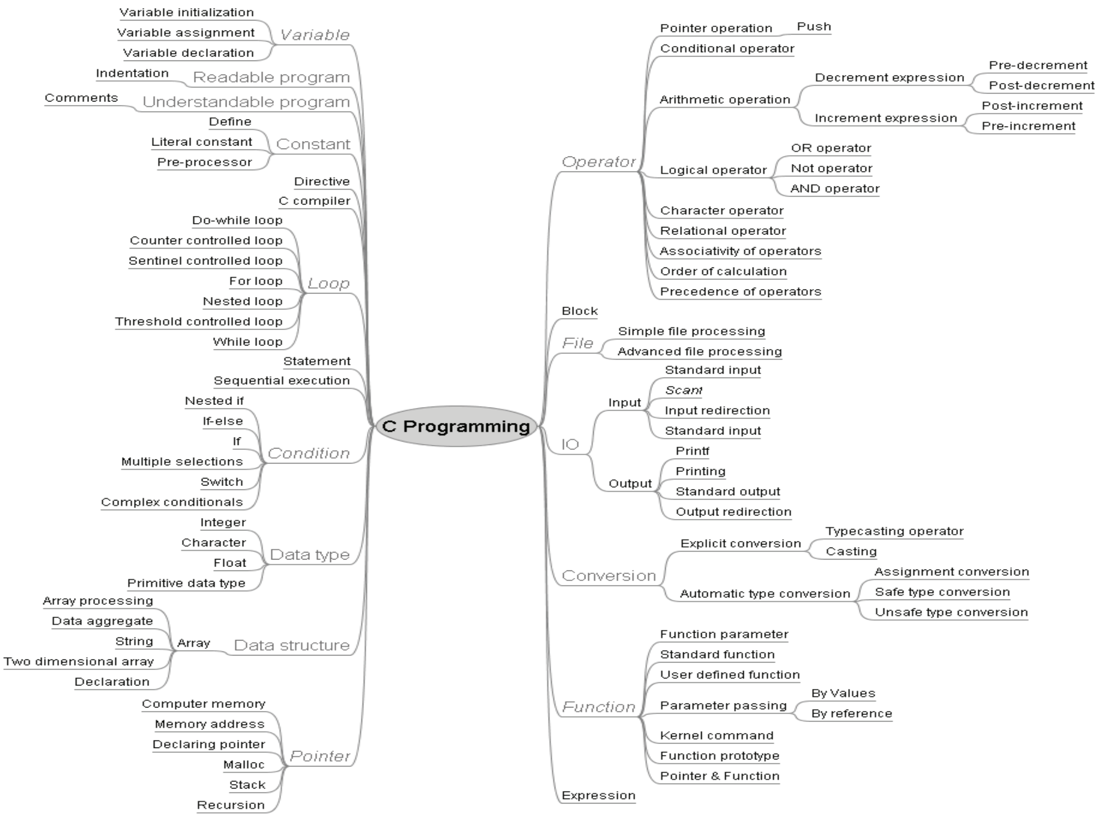

Figure 4. Details of first level categorization

Therefore, based on the detailed concept map, we built the general ontology which is shown in **Figure 5**.

[1] Because of the huge size of the concept map it is difficult to include it in the paper

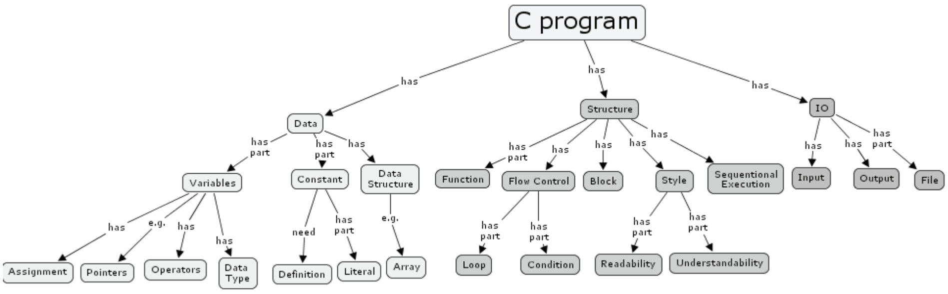

Figure 5. General ontology

4.4 Step 5: Refinement

As described in the algorithm, the final step is devoted to making the ontology beautiful. The followings are some practical tips that we may be taken into consideration while designing the ontology:

1. Use different font sizes for different strata (as shown in **Figure 3** and **Figure 4**).
2. Use different colors to distinguish particular subsets or branches (as shown in **Figure 5**, not very clear in the black and white printout).
3. Use a vertical layout of the tree structure/diagram (as shown in **Figure 5**).
4. If needed, use different shapes for different types of nodes.

Moreover, we re-built the general ontology while taking into consideration the harmony and clarity factors. Comparing **Figure 5** and **Figure 6** presents these changes. Consequently, we tried to balance the depth of the branches by adding one more level to the "IO" branch. Another feature of harmony is having the same relationship at each level. Since this is not easy to achieve, we tried to differentiate the level of the nodes based on the relationships in the same depth. For example, all nodes with the "has" relationship are at the same level and all the node with the "has part" relationship are also at the same level. Moreover, to achieve clarity we removed all unnecessary nodes and use the standard relationships that are easy to understand.

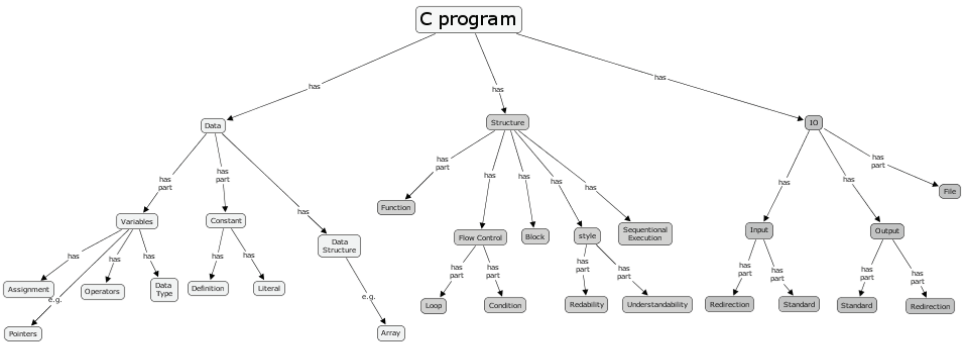

Figure 6. Harmony and clarity in the ontology

5 Discussion

We have already developed more than 20 teaching ontologies. Our research stresses the role of knowledge structuring for developing ontologies quickly, efficiently, and effectively. To achieve this goal we follow David Johnassen's idea of "using concept maps as a mind tool." The use of visual paradigm to represent and support the teaching process not only helps a professional tutor to concentrate on the problem rather than on details, but also enables pupils and students to process and understand great volume of information.

The development of knowledge structures in the form of ontologies, provides learning support and scaffolding that may improve student understanding of substantive and syntactic knowledge. As such, they can play a part in the overall pattern of learning, facilitating for example analysis, comparison, generalization, and transferability of understanding to analogous problems. Therefore, a visual knowledge structure editor provides a two-dimensional, iconic model that represents the author's understanding of the key elements in the concerned knowledge based.

At a basic level of knowledge representation, within the context of everyday heuristics, it is easier for educationalists simply to draw the ontology using conventional "pen and pencil" techniques. However, for more sophisticated knowledge representations, it is necessary to master appropriate programming and the involved language, or to use ell-known ontology editors.

It is possible to use any of the available graphical editors to design visual ontology, e.g. Paintbrush, Visio, Inspiration, or Mind Manager. But any effective computer program for knowledge engineering should perform the functions described for structuring the stages of a subject domain. Accordingly, it should correspond to the phenomenological nature of the knowledge elicitation involved using the appropriate algorithms previously detailed. This program must support the knowledge engineer through incorporating game rules that are clear, transparent, and functional. Ideally, the knowledge engineer should be able to tailor the program to his or her specific requirements. Concerning this, each analytical stage may be represented visually and accurately modelling the knowledge domain, elements already being realized in some commercial expert system shells.

This described approach can be applied to developing those tutoring systems where general understanding is more important than factual details. Furthermore, ontology design may be used as an assessment procedure for expressive as opposed to exploratory learning. For both formative and summarizing assessment purposes, students can clearly indicate the extent as well as the nature of their knowledge and understanding through creating ontology and explaining the involved processes.

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Building a bridge between school and university - critical issues concerning interactive applets

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Mathematics can be considered as typical example when discussing about the gap between school and university. The main problem might be how students could develop their procedural school thinking towards abstract conceptual thinking. Among neglected topics in the development of mathematics education is the frequently mentioned use of modern technology, especially hypermedia utilizing interactive Java applets. This paper highlights critical issues by implementing such kind of technology in the teaching of university mathematics. It seems that moving from old studying culture towards modern one is full of cognitive, emotional and social problems. Our experiences do not support the view that using interactive applets would bring special advantages without an appropriate pedagogical framework. Even though they seem to bring interesting and useful elements in learning and assessment, it is especially the reflective tutoring that needs more consideration.

Keywords: applets, binary operation, computer-based, conceptual, function, interactive, procedural, technology-based

1 Introduction

When maintaining popular discussion concerning *PISA* studies, problems in tertiary mathematics education are easily forgotten even though these quite global problems have been recognized among the international scientific community, as among *ICMI*[1]. One of the basic questions is the gap between school and university (cf. Holton, 2001). Griffiths & Oldknow (1993, p. 1) see university mathematics as a collection of discrete courses with little interdependence. After long experience as mathematics educators we agree and find that the basic arguments of the Joint European *MODEM* project[2] still hold:

> *Mathematics tends to be explained as an organized body of knowledge, in which students are largely passive, practicing old, clearly formulated, and unambiguous questions for timed examinations. The large body of theory is found to be abstract and depends on an unfamiliar language. These features are of course essential for the purposes of a professional mathematician, but they leave many students dispirited and bored, and their performance in more advanced courses is poor because the foundations are weak: the examiners are reduced to setting only bookwork or stereotyped questions, which can be remembered without becoming a vital part of the student.*

Concerning the gap between school and university it is appropriate to discuss some basic concepts in the university freshmen's mathematics. One central concept is *function*, which constitutes a necessary background for higher mathematics and has been considered by many educational researchers as Tall & Bakar (1991), Breidenbach *et al.* (1992), Tall (1992), Vinner & Dreyfus (1989), and Brown *et al.* (1997). Using a quite recent analysis of conceptual and procedural mathematical knowledge by Haapasalo & Kadijevich (2000), in the Department of Mathematics at the University of Joensuu we have been searching for a certain balance between students' more or less procedural school thinking and conceptual academic thinking. This has been a part of *DAAD* project with Leibniz Institute for Science

[1] The International Commission of Mathematical Instruction; http://www.mathunion.org/Organization/ICMI/

[2] Modernization of European Mathematics Education (http://www.joensuu.fi/lenni/modem.html)

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[online http://ktk.ulapland.fi/ISBN951-634-980-3]

Education (IPN), University of Kiel. Our earlier reports (Pesonen *et al*. 2002, Pesonen *et al.* 2004) have concerned with learning of mathematical contents. In this report we just highlight some relevant aspects of technology-based learning. We represent these findings from two case studies made by utilizing interactive Java applets in the learning of functions and binary operations. The Java applets offer graphical representations of mathematical concepts, which can be explored by the students interactively in dragging mode (more details described in paragraph 3.3).

2 Aims and objectives

The aim of our research was to generate hypotheses, what special benefits do the dynamic interactions offer and what new types of difficulties in conceptual thinking arise. What advantages are there in manual dragging by the students (within the applets) and what in automatic animation? How students use the tracing function and what significance do the given hints have? In the second step we analyse whether the different representation formats (symbolic, verbal and the graphical given through interactive applets) led to different test performance. In a qualitative step we consider possible explanations to these difficulties, for example why conceptually identical but functionally slightly different implementations lead to diverging interpretations.

3 Theoretical background

We represent shortly the framework, which we used in designing the applets and in realizing the learning environments including assessment.

3.1 Interplay between conceptual and procedural knowledge

In order to be able to consider the learning of mathematics from dynamic point of view, we adopted recently established knowledge type characterization of Haapasalo & Kadijevich (2000):

• *Procedural knowledge* denotes dynamic and successful utilization of particular rules, algorithms or procedures within relevant representation forms. This usually requires not only knowledge of the objects being utilized, but also ~~the~~ knowledge of format and syntax for the representational system(s) expressing them.

• *Conceptual knowledge* denotes knowledge of and a skilful "drive" along particular networks, the elements of which can be concepts, rules (algorithms, procedures, etc.), and even problems (a solved problem may introduce a new concept or rule) given in various representation forms.

Because the dominance of the first one over the latter one seems quite natural both in the development of scientific and individual knowledge, an appropriate pedagogical idea also in mathematics could be to go for spontaneous procedural knowledge. The logical relation between the two knowledge types in this so-called *developmental approach* is based upon a *genetic view* (i.e. procedural knowledge is necessary for conceptual one?) or a *simultaneous activation view* (i.e. procedural knowledge is necessary and sufficient for conceptual knowledge). On the other hand, it seems appropriate to claim that the goal of any education should be to invest on conceptual knowledge from the very beginning. If so, the logical basis of this so-called *educational approach* is the *dynamic interaction view* (i.e. conceptual knowledge is necessary for procedural one), or again the simultaneous activation view already mentioned. The latter means that the learner has opportunities to activate conceptual and procedural features of the current topic simultaneously. By "activate" we mean certain mental or concrete manipulations of the representatives of each type of knowledge. Being in the intersection of two complementary approaches, the simultaneous activation view is loaded with some expectations concerning the planning of learning environments. Modern technology, of course, offers natural solutions for these kinds of activities.

3.2 Multiple representations of concept attributes

When designing our Java applets we utilized the framework of the Finnish *MODEM*-project (see Haapasalo 2003), which offers a sophisticated interplay between conceptual and procedural knowledge (see Figure 1). Because our aim was not to plan a comprehensive learning material for the mathematical concepts under our consideration, we mainly applied the basic structure of mathematical concept building in the right hand box of Figure 1. However, in order to be able to describe the task types of our applets, we have to understand the idea of the concept building.

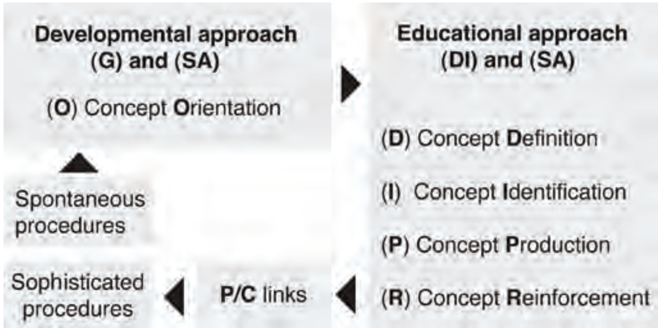

Figure 1. Sophisticated interplay between developmental and educational approach within the *MODEM* framework

When searching for convenient ways to introduce a function or a binary operation into a *verbal, graphic* or *symbolic* form, basically we should have given students opportunities to orientate themselves in the concept. It is this kind of *Orientation (O)* that forms the first phase of the systematic concept building in the right hand box of Figure 1. It basically utilizes a developmental approach: the interpretations of the situation can be based on mental models of the pupils, coming, more or less, from their naïve procedural ideas. These act like a wake-up voltage in an electric circuit that triggers another, much more powerful current to be amplified again. The procedural and conceptual knowledge types start to support each other, offering a nice opportunity to use the principle of simultaneous activation, for example. This principle, being at the intersection of the logical definitions of the two approaches, links the developmental approach and educational approach in a most natural way.

The role of the Concept *Definition (D)* is to offer students the opportunity to make their own investigations, to express the investigation results especially in verbal forms in each case, and to argue about these results within the collaborative teams and between the teams. As a result of social construction, a definition for the concept is born, meaning that students try to fix the relevant determiners of the concept in verbal, symbolic and graphic forms. Especially in the phases of orientation and definition, creative thinking and productive work is needed. The next phases of concept building utilize the principle of dynamic interaction. The idea is to give students a sufficient number of opportunities to construct concept attributes and procedural knowledge based on them.

In the phase of *Identification (I)* we have to give students opportunities to train themselves in identifying concept attributes in verbal *(V*), symbolic *(S)* and graphic *(G)* forms. For this we need six kinds of tasks *(I)*: *IVV, IVG, IVS, IGG, ISS* and *ISG.* During the learning process, the teacher must be ready, if necessary, to begin with tasks that require distinguishing between only two elements before going on to the identification of several elements.

In the phase of *Production (P)* we have to give pupils the possibility to produce from a given presentation of the concept another representation in a different form. The development of production *(P)* requires nine combinations: *PGV, PGS, PGG, PSG, PSV, PSS, PVS, PVV* and *PVG*. The tasks of identification and production must be achievable without any complicated processing of information on the student's part.

In the phase of *Reinforcement,* the goal is to train and utilize concept attributes and to develop procedural knowledge to be used in problem solving and applications.

The interaction between verbal, symbolic and graphic forms described above gives, right from the very beginning, an excellent framework not only for learning but also for an assessment of students' conceptual understanding (we will speak about *VSG-tasks,* hereafter).

We must point out clearly that in our case study students did not have opportunities to utilize the whole framework in Figure 1. Missing of the orientation and definition phases as described above might have been the basic reasons why students had difficulties in the utilizing of our applets. It is the viable definition for the concept through students' social constructions that would have been the ideal case. We used definition tasks only for assessment in the same way as we did with identification and production tasks, applying also the theories of concept images and concept definitions (e.g. Vinner & Dreyfus 1989; Vinner 1991). The applets were from the very beginning aimed to whitewash students' naïve and stereotypic conceptions based on school mathematics, and to increase their sensitivity to use different glasses when looking at mathematical objects.

3.3 Interactive Graphical Representations (IGR)

Binary operations are two-variable functions, whose variables in linear algebra are usually vectors. Therefore the traditional static graphical representations become inadequate. Thus, a completely new "learning dimension" can be added by using dynamic figures. We utilized the *MODEM* framework above in our *Interactive Graphical*

Representations (IGR). These allow - and mostly require - the learner to interact with the figures by dragging with the mouse or using control buttons. In our case the *IGR* pictures are implemented using dynamic geometry Java applets (JavaSketchpad and Geometria, see Pesonen 2001; Ehmke 2001). The advantage of *IGR* is that students become engaged with the content and the problem setting and get a "feeling" for dependencies between the given parameters. Dynamic pictures offer new possibilities to solve problems (e.g. draw a trace or use scaling). Also an automatic response analysis, which enables immediate feedback, can support concept understanding and "learning when doing". Disadvantages are that computer activities are time consuming (especially in developing) and also the integration into a traditional curriculum may be problematic. The measuring of students' achievements must be thoroughly reconsidered.

By a *sketch* we mean a dynamic interactive applet construction containing text parts, figures, and geometric elements (points, lines, rays, segments, circles and more advanced constructions), which is meant to be manipulated with the mouse. Control buttons can be used for showing, hiding, moving and animating the sketch elements (see Figure 2 in Chapter 5.1).

4 Methods

For the analysis of our research aims, two studies were conducted in the Mathematics Department of the University of Joensuu. The pilot study was done within a first semester Introductory Mathematics course in November 2002 (N = 42). The students were mainly mathematics majors and the course lectures had already dealt with logic, sets and relations, but not yet functions. This study comprised a 2-hour exercise sessions in 2 groups. The first part of the learning material was implemented by the Geometria applet and it contained interactive sketch tasks about sets and relations, with focus on the introducing the function concept. The second part consisted of an html form containing dynamic *JavaSketchpad* figures (see Figures 2 and 3) together with the appropriate problem sets. The answers were sent directly to the teacher. In both parts of the working periods the students' actions were recorded by a screen capture program, and later the material was analyzed with qualitative methods. The second study was done during the first course on Linear Algebra (N = 92) in March 2004. These students were heterogeneous in their background: most of them were first year mathematics or physics majors but about 20% of them were 1st to 3rd year computer science majors. The test items were posed to the students using the course management system *WebCT*. We represent the most important affective findings of our studies, concentrating mostly on students' difficulties to utilize certain sketches that contain special technical or mathematical features. Some cognitive findings are represented just for considering possible explanations to these difficulties[3].

5 Results

5.1 Study 1

The aim of the first study was to analyse how students use the special advantages of interactive applets. In the following we summarize the main findings. A more detailed description of the results is given in Pesonen *et al.* (2003).

What advantages are there in manual dragging, what in automatic animation? Dragging was very popular throughout the tests. All students used this feature to interact with the learning content. Dragging is advantageous when studying what happens in special positions in the sketch and in the controlling of parameter values. The study confirms that animation is useful in attracting students' attention to special situations. Most students used animations when it was helpful or necessary, but only 40% when it was not crucial. In some problems dragging was crucial. For example, when the students had to find the special places themselves, not all managed in this. A typical difficulty could be seen in the Problems concerning the Figure 2: The base value a can be controlled on the parameter axis in the bottom, where also the Neper number *e* is marked. For which values *a* is the function $x \rightarrow ax$ increasing? Varying the parameter a causes the whole curve $y = a^x$ change. Therefore, dragging *a* around the number 1 was crucial in finding out the values for which the function is increasing. On the basis of the screen capture analysis we found empirically some relationships between using the dragging mode for exploring special cases and solving the task correctly.

[3] The applets and tasks used in the two studies are found through the URL address http://www.joensuu.fi/mathematics/MathDistEdu/Animations2MentalModels/RovaniemiNBE2005/index.html

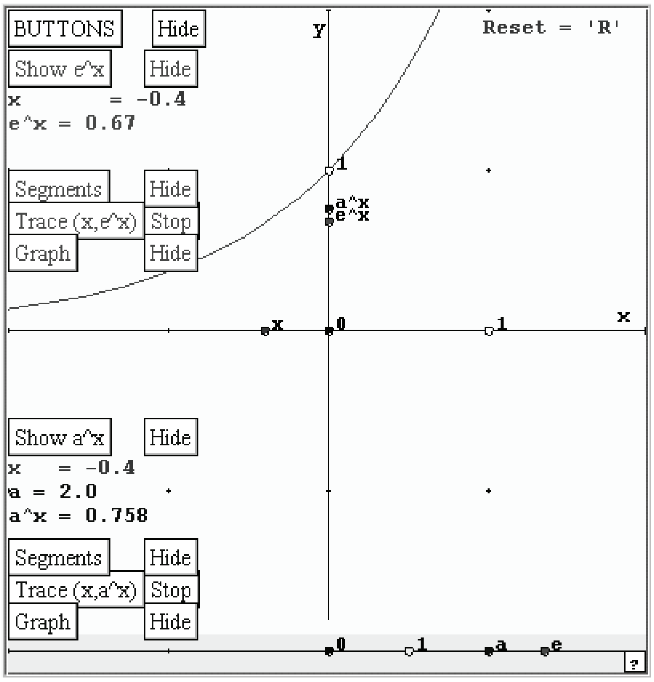

Figure 2. A screen shot of the sketch concerning exponential functions

What can be said about tracing? The tracing facility, that was available in some tasks, plots the positions of the function value in the co-domain. This feature can be switched on and off by two labelled buttons inside the sketch. As long as the function is switched on, every point visited by the function value is marked. If the function is switched off, no new points are marked, but the old ones are still visible. They can be deleted by a small button, marked by a red X. An example of the trace after moving *x* from 1 to 0 is given in Figure 3. Our results show that about half of the students used tracing when it was available. In our learning material tracing facility was not well guided. The students had difficulties in applying the feature in a fruitful way. It could be seen that 67% did not clear the traces, which caused problems with messy figures. However, the tracing command could be used very fruitfully for the visualisation of the image of an interval (Figure 3).). In this task some students showed a misconception about the *range* or *image* of a given function. They seemed to determine the image of a real interval simply by taking as image the interval between the image points of the left and right endpoints of the domain interval. The video analysis confirmed that these students had only examined the endpoints and did not use the possibility of tracing, which would have led them to the correct answer.

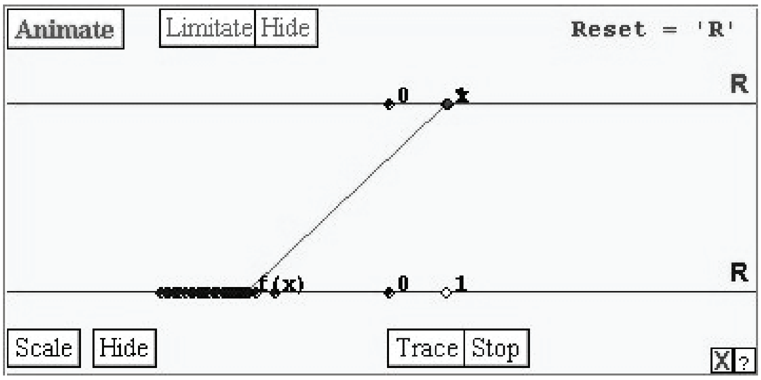

Figure 3. The dark dotted line visualises the image of the interval [0, 1]

What significance do the hints have, how much and what kind of guidance is ”optimal”? Hints were available by pressing a hint button within the sketch. This button shows a modal window with a helping text. By the close button, the hint disappears and the work can continue at the point where it was interrupted. Hints were available in five applets. The results concerning the use of hints were alarming. Applet hints must be offered only when crucial; the students stopped using hints as soon as they found them not useful.

5.2 Study 2

The learning material of the second study contained problems concerning verbal, symbolic and graphic representations of mathematical binary operations. A first descriptive report (Pesonen *et al.* 2005) shows that students who could identify a binary operation given through a verbal description are also able to identify a binary operation in a symbolic representation form (r = 0.31). This was in accordance to the findings in the *MODEM* project (Haapasalo, 2003, p. 15), where especially the verbalisation was an important step for the concept building. In contrast to this, identifying binary operations given in an interactive graphical form, do not stand in correlation with these two "classic" representation types (verbal-graphic: r = 0.04, symbolic-graphic: r = 0.05). To analyse this remarkable result deeper a qualitative study was applied post-hoc. The students were interviewed in a web-based questionnaire about their understanding of the interactive graphics. We chose from the test the most difficult task (p = 0.18) represented in Figure 4. The sketch contains three point objects: movable ***u***, fixed ***v*** and the image ***uov***. Because ***v*** is a fixed point, the function **o** cannot be a binary operation on the whole plane.

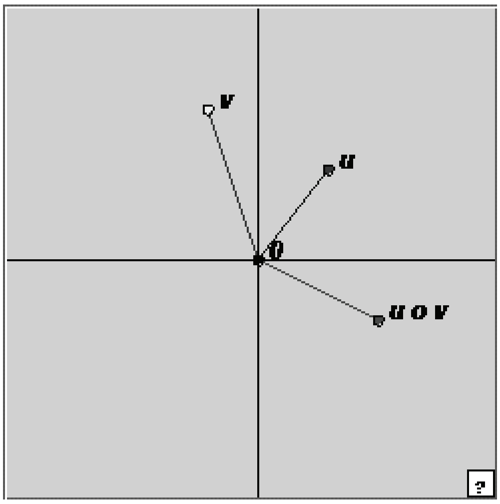

Figure 4. A sketch where the student interpretations were most diverging

We asked a group of students (N = 29), who could not solve this item correctly, some question about the item to find out why the difficulties arise. The student's responses show that all students have recognized that the point ***v*** can be dragged (which would be necessary for a binary operation in the plane). Therefore, we can exclude that someone has not used dragging to solve the question. Further the students were asked:

a) I thought it is irrelevant, because ***u*** moved and the result was visible and moved.
b) I thought it is irrelevant, because ***u*** moved and the result was visible.
c) I thought it is irrelevant, because ***u*** and ***v*** and the result are seen.
d) I was confused and answered positively, just for sure.

About 70% agreed to statement a), about 40% to b), about 30% to c) and about 20% to d). This shows that students have difficulties to interpret the mathematical meaning of the applet constellation. Point ***v*** is fixed, so it cannot reach the whole domain. However, student did not have difficulties to identify analogous problems when represented in a symbolic or verbal form. This difference can be seen if we compare the average solution rates for verbal, symbolic and graphic *identification* tasks (Table 1). The group showed only small differences in the solution rates for symbolic and verbal tasks (symbolic: +4.3 %, verbal: –3.7 %) but a higher deficit in solving graphical tasks (–12 %).

Also an open text field was offered for their verbal explanations. For several students it had been enough to see that when ***u*** moves also the result moves in the plane.

Table 1. Solution rates for verbal, symbolic and graphic *identification* tasks

	Symbolic tasks	Verbal tasks	Graphical tasks
All students	74.4 %	55.8 %	71.8 %
Students with item wrong (Figure 5)	78.7 %	52.1 %	59.8 %

In the questionnaire we also showed these students three slightly different sketches about a certain binary operation on the real line interval [-c, c] (namely relativistic addition of speeds, but this was not told). We asked which of them suited best, and which worst, for illustrating that it really is a binary operation on the interval. Clearly worst was voted

the one in which the result ***u*o*v*** is seen even if the operands are dragged outside the interval. The other two were rated nearly equal; in the first the operands are tied to the interval and in the second the result vanishes whenever one of the operands is outside the interval.

6 Conclusions

Kadijevich (2004) points out four areas, which have been neglected in the research of mathematics education: 1) promoting the human face of mathematics; (2) relating procedural and conceptual mathematical knowledge; (3) utilizing mathematical modelling in a humanistic, technologically-supported way; and (4) promoting technology-based learning through applications and modelling, multimedia design, and on-line collaboration. These findings give special challenges to utilize modern technology in all its forms. Today even small pocket computers allow the use of the drag-and drop technology, where the student can easily manipulate mathematical objects between two windows, illustrating two different forms of mathematical representation. In many cases this means forming links between conceptual and procedural knowledge, which is a relevant perspective to evaluate the sustainability of educational technology, as done in Haapasalo & Siekkinen (2005). Their five implications fit the exemplary results of our two studies, which show that interactive learning modules offer new features and challenges not only for teaching and learning of mathematics but also metacognitive skills. Especially the possibility of dragging, tracing and animation provide a new aspect of representing mathematics. But as we have seen in the second study, the new possibilities easily come together with cognitive problems for a considerable part of students. Especially the interactive graphical representation can become problematic, as reported in Sierpinska *et al.* (1999). They found that students showed quite surprising ways in interpreting dynamic figures concerning plane vectors and basis. The interactive component seemed to differ from the classical representation formats (verbal, symbolic), which are traditionally used in school mathematics.

Our experiences show that moving from old studying culture towards modern technology-based one is full of cognitive, emotional and social problems (cf. Pesonen *et al.* 2005). The using interactive applets, for example, would not bring special advantages without an appropriate pedagogical framework. Even though they seem to bring interesting and useful elements in learning and assessment (as we have seen in study 1), it is especially the reflective tutoring that needs more consideration. Perhaps the most promising aspect of technology-based learning is to utilise the principle of simultaneous activation of conceptual and procedural knowledge. This allows the teacher to be freed from the worry about the order in which student's mental models develop when interpreting, transforming and modelling mathematical objects. Our examples hopefully show that more or less systematic pedagogical models connected to an appropriate use of technology can help the teacher to achieve this goal. Interactive applets can be used not only for learning but also for assessment and for increasing new kinds of complexity for the content – being an essential element when building a bridge between school and university.

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ICT tools for teaching and learning

Teaching and Learning with ICT within the Subject Culture of Secondary School Science

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This paper reports some of the findings from the Science Subject Design Initiative team in the ESRC Interactive Education Project at the University of Bristol. The subject culture of secondary school science, characterised by a content-laden curriculum and assessment, but also with a tradition and requirement for practical work, is briefly described to give a picture of the environment in which the use of ICT was planned. Six science teachers, working in UK comprehensive schools, with between 2 and 18 years' experience in the classroom planned subject design initiatives (SDI) in which practical work was simulated by software. Team discussions and individual interviews following the SDIs are summarised and early conclusions presented about the resulting shift in pedagogic approach and subject culture.

Keywords: science, simulation, subject design initiative,

1 Introduction

1.1 the InterActive Education Project

In recent years we have seen a massive drive to incorporate ICT into every aspect of school life - policy initiatives aimed at increasing the use of new technologies have seen over £1.7 billion invested in training, hardware and software in UK schools. Teachers are increasingly expected to develop innovative ways of teaching with ICT, to use these technologies in administration and management and to use the Internet to develop new ways of communicating with parents, students and other practitioners.

Alongside these changes in school, students' use of computers in the home is increasing, presenting teachers with the challenge of marking computer-produced work, negotiating students' growing expertise in the use of new technologies and confronting inequalities in differential access to computers in the home.

The InterActive Education project, funded by the ESRC Teaching and Learning Programme 2001-2004, aimed to provide systematic approaches and practical means of overcoming some of the challenges presented by these developments and set out to examine the ways in which new technologies can be used in educational settings to enhance learning.

Central to the project is the contention that effective and innovative practices in teaching and learning require a combination of practitioner and researcher expertise. Design is informed in an iterative way by theory, research-based evidence on the use of computers for learning, teacher's craft knowledge and the research team's expertise. The focus therefore was on iterative design and evaluation of learning initiatives with a period of piloting before substantive evaluation. Thus teachers, teacher educators and university researchers worked in partnership to develop Subject Design Initiatives (SDI), which were teaching interventions, planned and prepared by the teachers to include an element of ICT in their lessons. These lessons were digitally videotaped for subsequent discussion and analysis. The SDIs were undertaken in key curriculum areas, including science in secondary schools, (pupils in the 11-18 year age range). The

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project schools were identified by negotiation between the Project Director and the head teachers of the schools, who then identified willing subject teachers to participate in the project. The science team consisted of six specialist science teachers (5 male and 1 female), with between 2 and 22 years' experience in the classroom, three university lecturers with expertise in teacher training and one professor of education with particular expertise in educational ICT.

Much work of the science team centred on the use of software to simulate practical work. This was an important focus, because teaching and learning in school science is traditionally rooted in the hands-on, learning-by-experience strategy of the laboratory-based "experiment". Fundamental questions about the nature of school science and its pedagogy are raised by the possibilities offered by new technologies to simulate experimental apparatus and procedures as well as methods of data gathering and analysis, for example: How real is real? Is school science the same as scientists' science? Is an idealised data set more or less valid for teaching and learning scientific concepts? These issues were problematised and theorised in team discussions.

1.2 the subject culture of science

The six science teachers were all individually interviewed at the outset of the project. We were particularly interested in what science itself meant for them, and how they saw the subject culture of school science. Deeply rooted in their biographical experience, the views and beliefs that they held and used in relation to the curriculum content they taught were inextricably bound to their individual systems of ideas and procedures for the organisation of learning in their classrooms. This has respectively been referred to as 'science as paradigm' and 'science as pedagogy', (Baggott la Velle *et al,* 2004). Essentially, they held a social constructivist view in which science education intersects both the natural and social worlds (Cobern, 1998). They provided many examples of teaching and learning episodes that were grounded in the everyday experience of their learners. Their espoused pedagogical styles were likewise peppered with such ideas that 'it should be real', 'should be taught through an applied, contextualised background', etc. They saw practical work as being a fundamental and motivating element of science education, echoing a report by Jim Donnelly in 1995, who found that science teachers took for granted that practical work was done in school science.

2 Relationship between 'school' subject and subject

The teachers in our interview series drew a clear distinction between school science and scientists' science, acknowledging that students in school were not carrying out 'watered down science' or 'aping scientists in research labs'. That science now covers such a wide and diverse range of human activities in different cultures across the globe points clearly to the impossibility of science education reflecting 'real' science'. For example it would be simply too complicated to define a 'scientific method' to reflect this diversity for the purposes of curriculum design.

Almost without exception, the teachers in our design initiative group saw science as a contextualised, human activity, and this view linked closely with their espoused pedagogic identity. Relating scientific ideas to everyday experience was seen as very important, and several teachers stressed the relevance of introducing discussion of ethical issues to their teaching. There was evidence of palpable pleasure in knowing about the subject matter of science. For one teacher it was his credo:

> I mean, science for me is a way of life really. In the way that some people's religion is a way of life. And science helps me understand the world. And with that I don't feel I need a religion, I don't have a faith. This is mine. It takes the mystery out of the world. Some people don't like you taking the mystery out of the world – but for me to understand things and how they work, it's the fascination, the awe aspect.

Two teachers spoke of their fascination for science from childhood. Their early reading or the encouragement of their parents fuelled this:

> ….my father's interest in science influenced my early childhood….

The teachers' views of science formed the foundation for the expression of a number of pedagogical and subjective educational theories that were also embedded in biographical experience. The responses of the science teachers therefore reflected a diversity of beliefs and perceptions. When talking about his educational and professional background one traced a developmental and adaptive linkage between his school days, his later career as a researcher and his current role as a teacher:

> At school I'm not sure I was allowed to be that creative to be honest. Because the teaching in those days was very traditional. At university it was a lot different and there was a lot of opportunity to be creative in your thinking and doing…When I went back to the Food Research Institute…I worked with a lot of people who were extremely creative and I learned a lot from them. Just their way of thinking was quite…quite...it had a major effect on my own work and teaching.

Another was strongly influenced by his own higher education, linking this to his teaching:

> I worked as a post-doctoral researcher after my PhD years at university, and for various and many reasons thought I might be able to make a difference doing science and teaching kids. And so I opted for a PGCE course…..

The teachers' views of the characteristics of science were closely entwined with their feelings about it. The notion of science having a creative aspect cropped up in several interviews, for example:

> ….and I worked with a lot of people [in his research career] who were extremely creative. And I learned a lot from them. And just their way of thinking was quite…was quite…had a major effect on my own work.

However, several teachers felt that school science offered few opportunities for this creativity:

> The nearest I get to being sort of creative in science, I suppose, is through the PRI work – through the Pupil Research Initiative at Sheffield where I now act as a teacher associate.

This idea that school science is very different to scientists' science was almost universally held:

> School science needs to move on in terms of experiments….we're teaching 18th and 19th century science…..the real world is different.. why are we still boiling beakers of water with Bunsen burners?

This resonates interestingly with the idea that in school science pupils are initiated in a 'ritualistic or fetishistic way' into a new domain in which the Bunsen burner is the icon of school science (Delamont *et al*, 1988).

3 Assessment regime in Science

In UK science education, assessment is traditionally summative: end of topic tests; National Curriculum Assessment Tests at age 14; General Certificate of Secondary Education (GCSE) examinations at 16; practical skills assessment within the National Curriculum (Sc1) regularly from 11-16. Although the influence of *Assessment for Learning*, a central plank of the 2004 National Secondary Strategy, is now increasing enacted in UK science classrooms, the teachers in the InterActive Project undertook their SDIs before the national roll-out. Consequently, they were much concerned with summative assessment within an essentially modular scheme of work, typically expecting to test pupils' knowledge and understanding of a topic approximately every twelve lessons. Their interviews and discussions strongly reflected this.

> Well, I suppose my biggest bugbear is the Science curriculum, that it's so overloaded and doesn't really offer much inspiration to the students. It's so content-driven, fact learning by rote.

4 Dominant concerns in Science

An obvious tension exists between the weight of the UK science curriculum with its assessment instruments and the traditional requirement that the subject is essentially learned through practical experience. School science "experiments" are essentially messy, time-consuming and often inconclusive, (Wellington, 1998). This conflict forms the basis of current and recent debate in science education. Briefly, the issues include:

- **Breadth and Balance**: How broad should science education be? Biology, chemistry and physics only or geology, psychology, archaeology – are these really science? What should be the balance?

- **Integration versus Separation**: should each science be taught separately, or should science teachers take a topic and present it in an integrated way? e.g. topics such as flight, energy, as in schemes such as SCISP, (1974). Why is this not ubiquitous? “Broad and Balanced” science of the 1980s + statutory National Curriculum with clear boundaries between disciplines.

- **Process and Content:** skills and processes, as opposed to facts, laws, theories.

- **Balance and separation**: Should values come into sc ed? Can we escape value-laden facts? Values inherent in choice of facts?

- **Practical work and ICT:** dilemma of doing and understanding or doing and arriving at misconceptions. Choice of practical and whether to adopt it is fundamental to planning for teaching and learning in science. Should practical work be done virtually?

5 The use of practical simulation and changes to the culture of school science

Early discussions about what the SDIs might comprise identified the teachers’ interest in simulation of practical work. In the team meetings, various examples of simulation software were demonstrated and discussed, and the teachers began to generate ideas for their SDIs linked to forthcoming topics that they were scheduled to teach. In many cases, such as the Focus Science Investigations[2], the simulation software was precisely tailored to the UK National Curriculum and its assessment, reflecting the concern of the teachers to provide teaching and learning experiences that fell within this framework.

Although scientists use computer simulations for modelling in many areas of research and development, the classroom-based simulation packages selected by our teachers do not fall into this category. Again, demonstrating the difference between school science and scientists’ science, the pupils were being asked to repeat “experiments”, where the outcome is known. The fact that these were *in silico* as opposed to *in vitro* is irrelevant. Deployment of simulated school experiments affords new opportunities for learning. As the teachers acknowledged, simulations have the power to liberate the learner from laborious, repetitive procedures and truly to *experiment* for example by changing variables in a way that would be impossible in a lab situation.

As we have reported before (Baggott la Velle, *et al,* 2000, 2003) to be effective the teachers must adapt their pedagogic approach when departing from the traditional practical approach to science education. To varying degrees they have demonstrated this by harnessing the visual impact afforded by simulations to aid understanding of abstract concepts such as structure and bonding, chemical reactions and electricity. Another example lies within one of the apparent shortcomings of simulation software: that of result predictability. Here, the teacher can encourage criticism of the simulation, by discussing its limitations and what this might mean in terms of the underlying science.

In science education the construction of knowledge requires learners to be *active* decision makers, choosing between a number of options instead of the passive recipients of another's interpretation. The grandees of learning theory, Piaget, Dewey and Bruner all advocated involvement of the learner in the learning process. One of the defining characteristics of a simulation is the requirement of the user to make decisions in order to accomplish a goal. Simulations designed for use in science teaching allow pupils to take control of the organisation and content of their own learning; this is central to their effectiveness, Wishart (1990); Osborne and Hennessy, (2003). In this regard, the play aspect of simulation is an important motivator (Blissett and Atkins, 1993). Play requires an act of imagination that stimulates the pupil’s mind through engaging in a rule-based activity that brings expectation of differential rewards. The imaginative faculty requires the pupil to speculate, to project permutations, to anticipate outcomes and mentally to create different situations and scenarios. The rewards (and disappointments!) result from the outcome of a choice or choices made from a range of options. This heightened gaming stimulus from projecting expectations involves developing pupil understanding beyond the options provided by conventional teaching, (Vygotsky, 1978; Wood and Attfield, 1996, p.68).

This ‘edutainment’ element, may account for the pupil-appeal reported in the simulation evaluation by Watson and

[2] Focus Educational Software, Ltd. http://www.focuseducational.com/

Baggott, (1997). Well-designed simulations are therefore not a break from learning but a most effective learning strategy: They challenge a learner's fantasy and curiosity within the context of rule-bound 'play'. However, we should not lose sight of the fact that reality is much, much more than simulation. Substantial differences exist between the real world and the simulated world. To appreciate the difference fully, the pupil needs to experience both.

A review of teachers' reports on their use of ICT in science lessons by Rogers and Finlayson (2003) discovered that simulations were the most popular category of software used in science. Over 95% of science teachers reported that

using simulations enabled them to achieve their teaching objectives and their reports referred to simulations stimulating thought and clarifying ideas as well as being an efficient use of time and motivating for students. Newton and Rogers (2003) consider that potential benefits to student learning such as clearer understanding and thinking arise in science lessons when teachers exploit intrinsic properties of the software such as the speed of processing large quantities of data and the dynamic display or animation of changes.

However, our research suggests that using simulations effectively is not as straightforward a task as it first seems. Baggott la Velle, McFarlane and Brawn (2003) describe the complex and interrelated processes of subject, pedagogical, pupil, technological, curricular and contextual knowledge transformation that a science teacher must undergo in order to teach successfully through simulation software. Wellington (2000) actually lists a number of dangers inherent in simulation use in science: they are idealised versions of reality built upon invisible, unquestionable, often simplified models of a scientific process that give the students the impression that every variable is easily controlled. Newton and Rogers (2003) point out that the *planning decisions* made by the science teacher about the mode of application of the software are critical to securing the potential learning benefits described earlier.

6 The Simulation Subject Design Initiatives

In science a dominant concern with how to manage science experiments and the assessment of practical skills led to the choice of computer-based simulations. Various demonstration copies of commercially available software encouraged the teachers to focus upon simulations for their SDIs. There was a brief discussion about other types of ICT usage, but each was quickly rejected, e.g. data-logging took too long to set up and results were uncertain/unpredictable; skill-and-drill CD-ROMs were seen as demotivating except for revision.

Table 1 outlines the science topics taught in the SDIs during the academic year 2002-03, together with the software packages deployed.

Table 1 Science Topics and Software on which the SDIs were based.

topic	package
Terminal velocity	Focus Educational Science Investigations[3]
Photosynthesis x 2	Focus Educational Science Investigations
Radiation	Multimedia Science School[4]
Structure and bonding	Hutchinson Science[5]
Simple electric circuits	Crocodile Clips[6]

[3] http://www.focuseducational.com/science/focus_on_science_investigations_1.html

[4] http://asp.platolearning.co.uk/scienceschool/index.html

[5] **ASIN:** B00005AC4I **CD-ROM** - June 30, 2001

[6] http://www.crocodile-clips.com/crocodile/physics/index.htm

Resistance in a circuit	Furry Elephant – Electricity Explained[7]
Respiration and breathing	Multimedia Science School
displacement reactions, voltaic cells, photoelectric effect,	Web based free animations

The individual teachers planned and taught their SDIs and the lessons were videotaped. Pupils and teachers were separately interviewed after the lessons. Following the SDIs, the research team considered the outcomes. The following points are a summary of these discussions:

- Simulations aid comprehension
- Instant graphs and analysis tools reduce drudgery (2)
- Simulations are a useful revision aid or as an orientation device prior to an investigation (2)
- They avoid real world messiness and provide sanitised or clean data sets which are useful for analysis, and which can allow students to evaluate their real experiments, investigations and data against an idealised model. This was felt to be particularly useful for lower ability pupils or those who don't see the important aspects or those who become obsessed with procedure (not mutually exclusive categories).
- The visualisation of dynamic processes is powerful, especially the slowing down of fast ones, even though idealised (2)
- The ease with which variables can be altered, especially the facility to give 'impossible' values (in the real world)
- The facility to move from microscopic to macroscopic and vice versa with ease
- The power of ICT to facilitate a different teaching and learning *approach* recognised
- The power of ICT to develop a different teaching and learning *culture* appreciated.

In post-SDI interviews, the teachers were asked specifically to reflect on their planning decisions for deploying simulations in science lessons. These decisions appear to relate to the intrinsic properties of the software. The results show that through taking the opportunity to teach through simulation every teacher rethought rather than replaced their teaching with ICT and moved on from their original perspective that simulation was an impoverished version of practical work. Their reflections on the intrinsic properties of simulation software:

- confirmed previous research (reviewed by Osborne and Hennessy, 2003) that suggests student exploration and control, dynamic visual representation and freedom from laborious processes to be the most salient features linked to successful use of simulation;

- shed new light on various teaching strategies that can be planned for the use of simulation in school science. The teachers recommended: deploying simulations after teaching a topic to consolidate understanding, allowing students to control the computer with encouragement to explore and giving students opportunity critically to review the model used in the simulation software;

- highlight issues concerning the moment-by moment direction, locus of control and focus of student learning.

7 Preliminary Conclusions

This paper has reported how the subject culture of secondary school science, characterised by a content-laden curriculum and assessment, but also with a tradition and requirement for practical work, is challenged by the use of ICT which as a multipurpose digital tool can be used in the classroom to transform learning through:

- the development of radically new knowledge domains, practices and tools. In science new pedagogical content knowledge domains (Shulman, 1987) emerged in which teachers demonstrated that they use simulations in adaptive ways to enhance learning. The work of Carey Jewitt on multimodality and technology-mediated learning (Kress *et al*, 2001) suggests that in the case of Multimedia Science School the simulated visual

[7] http://www.furryelephant.com

representations enable students to express ideas and make meanings which neither they nor the teacher could readily do in a different mode of communication or in one mode alone. The teachers in this study reported that pupils readily engaged with the science representation afforded by the simulation.

• the democratisation of knowledge domains which would have been previously inaccessible to the majority of students. In the teaching of critical thinking in science simulation allowed the possibility of asking 'what if?' questions. Pupils were able to pursue such questions to their conclusion because of immediate feedback and teasing out the implications of the questions. Our research evidence suggests that computer-based activities are commonly effective for motivating interaction and stimulating discussion. In this respect, simulations can develop collaboration and co-operation and can foster learning through peer interaction, both co-operative and dissonant. Through discussion, the simulated practical exercise in science involves negotiation, estimation and examination of alternative ideas, demonstration of different interpretations of evidence. This enhances the development of pupils' social and scientific skills. It forms an aspect of a pupil's learning environment,

providing secure opportunities for competition and leadership practice. The teachers in our study understood that competition may overshadow collaboration and co-operation, and carefully managed this.

• the provision of access to complex knowledge domains through the rapid processing of normally time-consuming practices. This has been referred to as the liberating effect of simulation in science education, where the process of practical work can actually get in the way of pupil's learning, (Scaife and Wellington, 1994). Here we have seen evidence of simulation as swift and sanitised: pupils can quickly repeat experimental runs, change variables and set up virtual equipment in a fraction of the time it would take to do it with traditional laboratory apparatus. Simulation also frees pupils from the messiness of some data sets, such as that generated by faulty meters, low batteries and loose wires in investigations on electrical circuits, for example.

• the provision of digital scaffolds for particular learning aims. A particular set of learning aims in which skills of the scientific process, such as hypothesising, measuring, recording, inferring, etc is associated with Sc1, the Scientific Investigation section of the National Curriculum. Simulation software affords opportunities for pupils to enhance their abilities in these areas. So if the learning aim is to extrapolate information from which a theory can be generalised from a data set, quickly producing a graph so that the trend can be readily appreciated enables pupils more rapidly to reach the higher order thinking skill.

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Looking technology supported environments from conceptual and procedural perspectives

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When considering technology-based learning, the focus has been shifted from a technology-oriented viewpoint to humanistic view, stressing cognitive, affective and social variables involved in the learning processes. However, the impact of knowledge structures and pedagogical philosophy has been neglected. As regards that philosophy, learning may be based upon developmental approach assuming that procedural knowledge is based on conceptual one or educational approach assuming the opposite. The aim of this paper is to evaluate the sustainability of educational technology in the light of these approaches. We want to highlight five questions, often neglected in discussion. To answer these questions, a cavalcade of concrete examples will be represented in the light of our framework theory. Our examples show that the focus should be shifted from students and classroom activities to teachers and to activities outside the classroom.

Keywords: conceptual, developmental, educational, design, procedural, teacher education, technology-based

1 Introduction

When designing any learning environment, we meet the conflict between conceptual and procedural knowledge: Do we have to understand for being able to do, or vice versa (Haapasalo 2003). Implementing of technology makes this more complicated but at the same time opens new, maybe progressive approaches, especially when learning through design is utilized. Our task is to uncover and explore these paths contributing to a better education for both students and their teachers. Even if teachers may have difficulties in accepting flexibility in the *ICT*- based learning (cf. Forcheri *et al*. 2001), a hypermedia-based instruction design, for example, can improve educational practice, provided that pedagogy is linked to technology, instructional units are planned collaboratively, and a support in their classroom utilization is given to teachers (Cleland *et al*. 1999). A detailed analysis of the Finnish *TIMSS* and *PISA* results reveal indirectly (Kupari 2003, Törnroos 2003) that it is not necessarily the school teaching that impacts on students' performances. This makes educational research interesting - which factors in our education are important for the development of thinking abilities? If we accept the assumption that the main task of education is to promote a skilful 'drive' along knowledge networks so as to scaffold pupils to utilize their rich activities outside school, it seems appropriate to look for an appropriate educational approach. On the other hand, the fact that students seem to learn effectively many kind of skills – even mathematical ones – outside the school, forces us to ask if there is something wrong inside the school as far the question "how to learn" concerns.

2 Aims and objectives

The aim of this paper is to consider the interplay between conceptual and procedural knowledge, at first. This framework is used to analyze students' and teachers' cognitive and social behaviour in technology-based learning

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environments. By using examples from mathematics and early childhood education – being special topics of the authors – we represent typical difficulties and benefits of technology-based learning from the following perspectives:

- *Metacognitions: Does technology enhance the learning skills among teachers and students?*
- *Software design*: What kinds of benefits are derived from learning by design?
- *Teacher education:* What would be the appropriate way to implement technology in teacher education?
- *Minimalist instruction*: Is it reasonable to implement technology when the time is very limited?
- *Progressive hardware and software*: Does the allocation of learning shift from classroom onto freetime?

3 Background

3.1 Relationship between instructional approaches and educational technology

Technology-supported learning environments often appear as "interactive e-textbooks", based on objectivist-behaviorist tradition to learn basic facts and skills. The learning is divided into small hierarchical items or stimuli with immediate feedback to a correct answer. Studies (e.g. Siekkinen 2004) have indicated that there are coherent patterns between teacher's instructional approach and the quality of technological applications used in the classroom. Some studies (e.g. Niederhauser & Stoddart 2001) indicate that computer-oriented teachers, especially during preschool and first school years, prefer to use clearly skill-based applications. More generally, there seems to be a relationship between teachers' epistemological and pedagogical perspectives and their way to use educational software. These concerns are even more crucial, when students use technological applications in more informal way, as on their free time. In constructive approaches the relationship to technology is not only limited to the ready-made learning packages. The technological applications for learning (e.g. robotics, multimedia-authoring software, simulations) are used as an expressive medium by teachers as students for the enhancement of reflective thinking. In the developmental psychology and in mathematics education, for example, one of the main interests is how students articulate and realize the interaction between conceptual and procedural knowledge Rittle-Johnson & Siegler (1998).

3.1 Interplay of conceptual and procedural knowledge

In authentic actions performed by a person, procedural and conceptual knowledge can often be distinguished only by considering at which level of consciousness the person acts. The former often calls for automated and unconscious steps, whereas the latter typically requires conscious thinking. However, procedural knowledge may also be demonstrated in a reflective mode of thinking when, for example, the student skillfully combines two rules without knowing why they work**.** For being able to consider the learning from dynamic point of view, we adopted recently made knowledge type characterization of Haapasalo & Kadijevich (2000):
• *Procedural knowledge* denotes dynamic and successful utilization of particular rules, algorithms or procedures within relevant representation forms. This usually requires not only the knowledge of the objects being utilized, but also the knowledge of format and syntax for the representational system(s) expressing them.
• *Conceptual knowledge* denotes knowledge of and a skilful "drive" along particular networks, the elements of which can be concepts, rules (algorithms, procedures, etc.), and even problems (a solved problem may introduce a new concept or rule) given in various representation forms.

Because the dominance of the first one over the latter one seems quite natural both in the development of scientific and individual knowledge, an appropriate pedagogical idea also in mathematics could be to go for spontaneous procedural knowledge. The logical relation between the two knowledge types in this so-called *developmental approach* is based upon *genetic view* (i.e. procedural knowledge is necessary for conceptual one) or *simultaneous activation view* (i.e. procedural knowledge is necessary and sufficient for conceptual knowledge)[1]. On the other hand, it seems appropriate to claim that the goal of any education should be to invest on conceptual knowledge from the first beginning. If so, the logical basis of this so-called *educational approach* is *dynamic interaction view* (i.e. conceptual knowledge is necessary for procedural one), or again the simultaneous activation view. The latter means that the learner has opportunities to activate conceptual and procedural features of the current topic simultaneously. By "activating" we mean certain mental or concrete manipulations of the representatives of each type of knowledge. Being in the intersection of two complementary approaches, the simultaneous activation view is loaded with some expectations concerning the planning of learning environments. Modern technology, of course, offers natural solutions for these kinds of activities.

4 Methods

Our paper is a mainly a meta-study, utilizing first author's *MODEM* –project (*Mo*del Construction of *D*idactical and *E*mpirical Problems of *M*athematics Education; http://www.joensuu.fi/lenni/modemeng.html) and recent studies made in the Pedagogical Faculty at the University of Joensuu. We also implement our own observations and experiences as teachers and tutors in teacher education and in service-in-training courses – not neglecting our observations of our children, neither.

5 Results

5.1. Metacognitions

Does technology enhance the learning skills among teachers and students?

Many educators still believe that learning, especially by children, should begin with concrete objects and that it could move towards abstract things just after that. Every-day life, however, is full of counter-examples showing that human brains have to search links between concrete and even very abstract things simultaneously. Very often "concrete" means acting procedurally, and "abstract" refers to conceptual features. Figure 1 shows how the simultaneous activation principle, being in the intersection of the two pedagogical approaches, can be utilized especially when planning and realizing technology-based learning environments: a pupil can manipulate the concrete slope with the mouse and look how its abstract symbolic representation is changing. On the left-hand screen (s)he has to handle just few data chunks, whereas on the right-hand screen (s)he should have some metacognitive abilities to regulate his/her own learning[2].

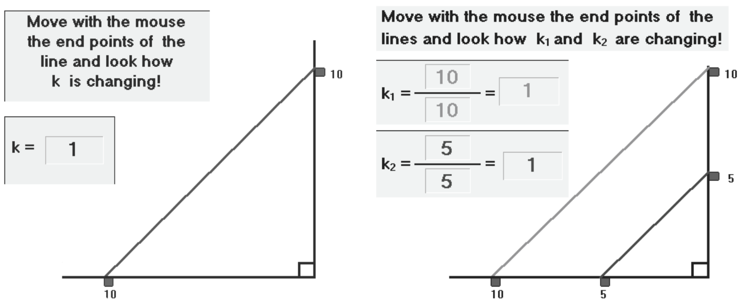


Figure 1. Utilizing the SA method in technology-based learning environment

1 Concerning the logical relation between conceptual and procedural knowledge, four views can be found in literature (cf. Haapasalo & Kadijevich 2000). The two approaches here are based on these views.

2 We refer to Haapasalo (2003) to illustrate how to move from the concrete slope to the abstract mathematical concept gradient, and how the mathematical concept building can be scaffold by utilizing the dynamic interaction method. The whole software can be downloaded freely at http://www.joensuu.fi/lenni/programs.html

Our experiences during more than 20 years as *CAL* tutors clearly show that in most cases it is the poor meta-cognitive abilities that cause the difficulties for the learning, preventing the forming of desired conceptual-procedural links even though the software designer would manage to design a beautiful "call to dance". Figure 2 illustrates how a novice learner changes all possible components on the right hand side of figure 1 to get just a total data overflow. This prevents recognizing of the essential aspects, whilst an expert learner can see the relevant attributes by just one mouse dragging (on the left). The first author has, during more than then years, had only a couple of times luck to meet this kind of learner among hundreds of students and teachers having been observed. This can be interpreted that students and teachers would need comprehensive guidance for behaving in a problem-solving situation. For that, basic strategies (as changing components of the problem, taking a special case, etc) in the sense of Polya's (1973) checklist would be appropriate.

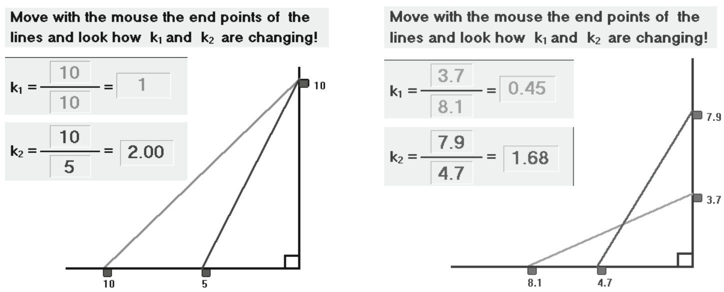
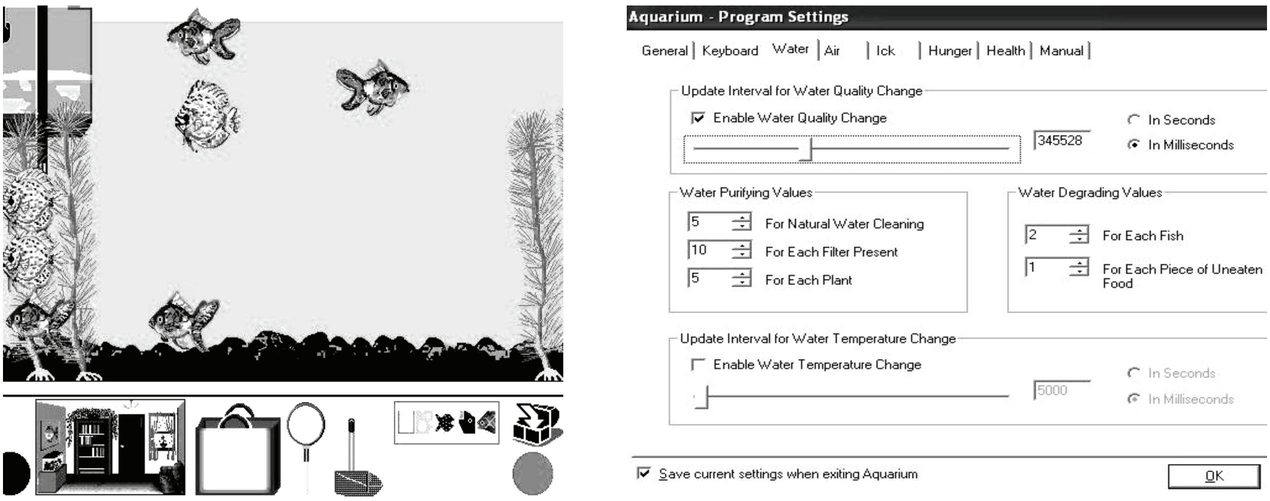


Figure 2. Expert (on the left) and novice (on the right) by utilizing the *SA* method.

Our second example (Figure 3) is taken from *Kidware* aquarium simulation program (see Mobius 2002)[3], which we can unfortunately not visualize in this paper as we did in the concerence presentation. The simulation allows even young children to discover the core concepts of balanced ecosystem (how e. g. parameters of warmth and air affect the quality of water, which in turn affects the health of fish in the aquarium). These kinds of computer simulations contain an artificial model of a system and processes, in which conceptual and procedural knowledge is embedded to be applied in knowledge representations. This has a strong relation to constructivist learning (de Jong & van Joolingen 1998,



Siekkinen 2003).

Figure 3. Aquarium simulation environment (left) and setting of conceptual and procedural controls (right).

In Kuopio city, a specific project with preschool aged was carried adopting this kind of simulation-orientated software (Siekkinen 2004, Siekkinen 2003, Hyttinen et al. 2003). Children (N= 132) were interviewed about their motivation to use computers, which also in turn represents children's various levels of metacognition. Interestingly most children's (40 %) answers related to reading, arithmetic, information searching, expressing own ideas by painting and drawing,

[3] See animation of Aquarium simulation at http://www.edu.joensuu.fi/siekkinen/aquarium.wmv

etc. Playing computer games - which was expected to be most expressed motivation to use computer - was expressed by relatively few children (22 %) and to learn to use technology as basic skills to use software and computers were expressed. After two years using of interactive simulation programs these children were interviewed again. The results indicated that metacognitions were increasing by10 % and entertainment- relatedness decreased by 12 %. The cognitive playing with subject (including conceptual-procedural elements) has been considered important not only in early education, but also e.g. in the history of mathematics (Zimmermann 2003).

Implication: The missing of metacognitive abilities often events the desired learning even though the technological solution would offer a direct access to a conceptual – procedural link, for example. Technology can enhance as well metacognitions as problem-solving skills in the sense of Polya (1973).

5.2. Software design

What kinds of benefits are derived from learning by design?

Studies of design processes have produced useful information concerning problem solving and group dynamics, for example. Eskelinen's (2005) dissertation uncovers how different kinds of approaches and support for reflective communication affect students' conceptions of teaching and learning, group dynamics and interest in *ICT* support. The participants (N=48) designed their hypertext based software for the learning of conceptual and procedural mathematical knowledge of measurement and accuracy. The sample was divided into four sub-groups according to the two pedagogical approaches (educational - developmental) and the communicational tutoring (yes – no). The research was based on quantitative analysis of the follow-up measurements by questionnaires administered in different phases of the design process. The results clearly show that design of a technology-based learning environment within an adequate constructivist theory linked to the knowledge structure offers promising respond to the main challenge of teacher education: to get students understand which are the basic components for teaching and learning. The developmental approach based on spontaneous procedural knowledge seems to be appropriate concerning as well cognitive as affective variables. To apply the educational approach to stress the importance of conceptual knowledge, educator needs a lot of sensitivity concerning cognitive and emotional variables in the learning process.

Implication: Learning by design is one of the most sophisticated way to implement technology, opening new productive ways to develop constructively orientated teacher education and service-in-training (e.g. Ojala, Wright & Siekkinen 1996). We would like to share the view of Jonassen (2000) that those who learn more from the instructional materials are their developers, not users. Therefore teachers and students should design ICT-based lessons and thus become knowledge constructors rather than knowledge users.

5.3. Teacher education

What would be the appropriate way to implement technology in teacher education?

Eskelinen's (2005) findings give strong support to the position that technology should be implemented strongly in teacher education programs. The research doesn't support the conception that computer skills in teacher education should be taught separately from the information structures and pedagogical thinking. Järvelä (2003) made interesting findings when researching how conceptual and procedural approach affects in teachers' learning of basic skills in *ICT*. The research material consisted of portfolios, which teachers wrote during their service-in-training course. The study suggests that there are three different types of learners, and that the instructions should be tailored to meet these needs. *Conceptual-oriented* learners aim to learn things advancing from conceptual knowledge towards procedural knowledge. *Procedural-oriented* learners act in opposite way – they advance from procedural knowledge towards conceptual knowledge. *Procedural-bounded* learners concentrate only on procedural knowledge. Neither procedural nor conceptual approach, in their most simply and exaggerated forms, seem to represent any students' way of learning. Instead of that, developmental approach could act as a successful starting point for all learner types, forming an appropriate basis also for educational approach. The study suggests that the probability for meeting a procedural-bounded learner is higher than to meet a procedural-based or conceptual-oriented one. Neither an exaggerated pedagogical polarization nor learner's earlier know-how seems to create different types of learners, referring to a more or less learner's "built-in orientation" by the learner. Although it is theoretically possible to derive "ideal" methods for teaching *ICT* skills based on different learning orientations, their application into concrete teaching situations might be difficult. Instead it would be fruitful to consider if it is possible to affect on persons learning orientations. The conceptual-oriented learner seems to bear the ideal student when learning *ICT* skills. This implies a natural question: Is it possible to convert procedural-bounded and procedural-based learners into conceptual learners?

Integration of technology in curriculum is even more complicated process than to learn to use technology (Siekkinen 2004). The dual-focus orientation could be best achieved when teacher education has a focus on well-defined curriculum that is consistent with and supportive technology used. Among teachers, especially at early level classes, acceptance of new learning theories as well as technological applications varies from resistance to curiosity. When considering effectiveness of in-service training there is a need to consider also teacher's practicability ethics, which refers to criteria how innovations are adopted: Is innovation congruent with own current practices? Will those who urge you to change provide you with the necessary resources (e.g. time, materials etc.)? Cost-reward relationship: given cost in terms of time and energy required to adopt proposed innovation, will it provide to you with sufficient psychical rewards (e.g. positive or negative feedback from students, other colleagues, parents, director, administration)? If the answers to these issues tend to be negative, teachers may discard the proposed innovation.

Implication: Teachers carry their own history and personal/social/*institutional* orientations of learning. For finding an optimal way to learn *ICT* skills, education must be tailored to fit these orientations and these skills should not be taught separately from the information structures and pedagogical thinking.

5.4. Minimalist instruction

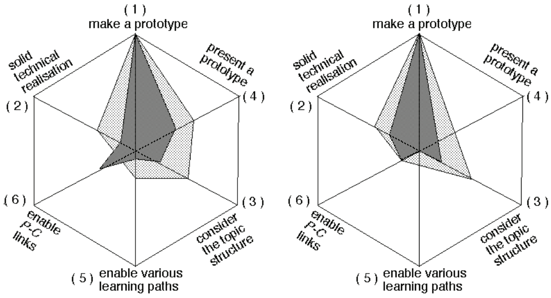
Is it reasonable to implement technology when the time is very limited?

We consider this question in the light of a case study concerning learning by hypermedia-design, through which teacher students developed HTML files comprising Java applets downloaded from the Internet (Kadijevich & Haapasalo 2003). The first author organized for 22 students a workshop, which was utilized especially to get experiences how introduction to hypermedia could be done in an optimal way. For this purpose, conceptual and procedural approaches were used in an "exaggerated" way in the sense of van Merriënboer (1997), Chatfield (2000), Shih & Alessi (1994), Ben-Ari (2001), and Urban-Lurain (2001). Students' abilities to design hypermedia were considered on six principles of Mayer (2001), illustrated in Figure 4. When 'developing these hypermedia lessons, the topic to be learned (i.e. mathematical content to be used for this purpose) was not the focus. The researcher wanted to go to the limit concerning sufficient instructions to begin a successful design process. Because of the very limited time, some kind of 'Minimalist Instruction' was adopted in the sense of Carrol (1990) and Lazonder (2001).

Procedural approach basically involved a harmless playing with a prototype of a very simplified applet site on the host computer, aiming to change the text and the interactive picture to achieve something more mathematical for pupils. For being able to make the necessary changes, students needed guidance about what parts of the document they could develop. At the starting point it was enough to learn to reveal the HTML code. After learning to open a page on the host computer and the desired applet page on the Web simultaneously, students could recognize the similarity in the critical places. Hereafter, they started to develop the site by making changes with trial and error, for example. This approach suits for a tutor who has very limited knowhow concerning Java applets or HTML codes. However, problems can be encountered when the students loose the logic of their actions and meet 'conceptual barriers' in the sense of Chatfield (2000). The conceptual (educational) approach was based on a mini-lesson about knowledge of a Web page involving an applet, i.e. what minimum requirements would be necessary and what is the logic of the HTML source structure. Furthermore, students were hoped to understand the advantages and restrictions of particular programs to create, edit and browse HTML pages that contain applets (cf. Ben-Ari 2001 and Urban-Lurain 2001).

Students were quite satisfied with their success, and their own requirements were compatible with the end products. Most students expressed encouraging comments about pedagogical ideas gained through the workshop. Students' differences in their experiences on computer did not cause any problems as the students themselves defined the goals for their products. Concerning the impact of the pedagogical polarization, the procedural group (Figure 4b) eagerly discussed pedagogical issues. Students considered what would be interesting for children more than technical issues of their Web pages. On the other hand, the conceptual approach seemed to force students in the second group (Figure 4a) to discuss the logical and technical structure of their Web pages. The restricted time caused that most students reached only multimedia design requirements (1) and (4). However, many students especially within the conceptual approach, discussed improvements they could do to their productions if they would have time to do that. Thus, also requirements (2) and (3) were implicitly involved. The open-ended goal setting of the workshop caused an ambitious end by three students of the conceptual group. They started to design sophisticated material for teaching and research purposes, basing upon all six design requirements[4].

[4] Such an applet is located at http://cc.joensuu.fi/~lenni



(a) Prototypes within conceptual workshop

(b) Prototypes within procedural workshop

Figure 4. Overview of student's answers (dark polygons) concerning Mayer's six principles.
The light polygons represent tutor's expectations with respect of the time resources having used.

Implication: It seems reasonable to implement technology even though the preparation time is very limited. Procedural and conceptual approaches should be tailored to fit different learner types.

5.5. Progressive hardware and software

Does the allocation of learning shift from classroom onto freetime?

We already described above that students tend to use computer on their free-time in more sophisticated way than what educators believe. Both author, for example, have had opportunity to observe how their own children have worked hundreds of hours at home with the *Kidware* program intensively and collaboratively. We would, however, concentrate in this chapter in representing very progressive hardware and software, which future students carry even in their pockets.

About 20 years, it has been possible to interpret symbolic representations as graphs by using small computers. However, students should understand these symbolic representations at first, before being able to utilize computers in conventional way. Within our conceptual-procedural framework presented above, we cannot be satisfied with this kind of one-way ticket. We illustrate new kind of activities by utilizing *ClassPad 300*, a modern pocket computer made by Casio (2003). Most *ClassPad* applications support simultaneous display of two windows, allowing to access the windows of other applications from the main application and to perform drag and drop activities (i.e. copy and paste actions), and other operations with expressions between the Main Application work area and the currently displayed screen (Graph Editor, Graph, Conic Editor, Table, Sequence Editor, Geometry, 3D Graph Editor 3D Graph, Statistics, List Editor, and Numeric Solver). We give here just one example, which shows how the properties of dynamical geometry programs have been extended to allow interplay between algebra and geometry (being one of the major factors in the history of mathematics, by the way).

Without knowing anything about the analytic expression of a circle, we can just play harmlessly by drawing a circle in the geometry window (frame 1 in the figure 5), and then drag and drop the circle into the algebraic window (2). Something surprising happens: The circle seems to be expressed in algebraic form $x^2+y^2+0.8xy-12.55=0$. Let's manipulate (3) the equation by changing the constant to 25, then drag-and-drop it to see the new circle (4). It seems that only the radius changes. Let's go back to the algebraic window to do more manipulations (5). This time, let's change the coefficients of the second degree variables: 1 to 2 and 1 to 9: The equation $2x^2+9y^2+0.8xy-12.55=0$ seems to make an ellipse.

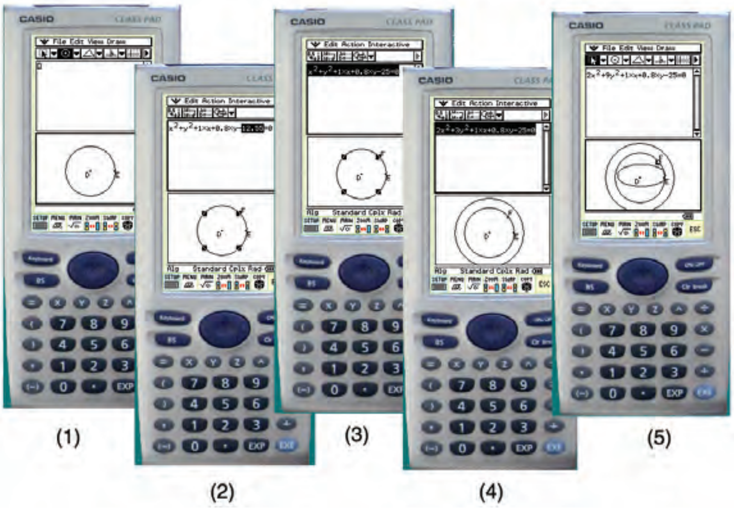


Figure 5. Utilizing the simultaneous activation method with *ClassPad*

Of course *ClassPad* modules would allow us to continue the mathematics making on a more exact level. Drag and drop activities can be utilized almost for every topics of school mathematics and they might offer a desired bridge between school and university. We believe that *ClassPad* is a promising step towards technology that would allow the mathematics making even on students' free time. Our example shows that even the most abstract concepts can be based on students' spontaneous ideas. Our position is that doing should be cognitively and psychologically meaningful for the student. Building a bridge between geometry is just one opportunity to utilize *ClassPad*. Even if just imagination of the user might put limits for inventing of environments within simultaneous activation, for example, most operations are still complicated to be realized without obtaining first basic routines to use the equipment. Non-optimal user interfaces has been studied by Carrol (1990, p. 8) and Norman (1986), for example.

Implication: Teachers and students should be made aware what happens outside the classroom, especially when progressive technology concerns.

6 Conclusions

Concerning the learning to use technology, basic operational principles of new applications are quite similar (Urban-Lurain 2002). We would like to share the position of Shih & Alessi (1994, 154): "Instruction that emphasizes *how to* can be effective in a particular context but may not transfer to novel situations because it does not teach the knowledge underlying the skills. On the other hand, instruction that emphasizes the *why* can provide richer knowledge applicable to a variety of contexts but creates discrepancy between instruction and application—that which we teach is not what we expect students to do." Procedural skills are not sufficient for a transfer effect, if the logic and meaning beyond the skills is unknown. Chatfield (2000) speaks about conceptual barrier when the user does not have conceptual knowledge to be able to use more complex functions of applications (cf. Brandt 1997 and Borgman 1999). On the other hand, the problem of conceptual knowledge is its slow applicability (Neves & Anderson 1981). When having mere conceptual understanding of an application, retrieving the needed information from the memory and interpretation to concrete procedures can be difficult. Interpretation or modification of conceptual "facts" for certain situation is slow, requiring additional tests and functions. Applying of procedural knowledge is faster, because procedures can be directly used in the situation without any time consuming interpretations. If the application to be learned is simple in nature, conceptual training can lead to awkward use of the application (cf. Olfman & Mandiwalla 1994). These kinds of aspects push us to find a sophisticated interplay between developmental and educational approach (see Haapasalo 2003) as well concerning the topic to be learned as the using of technology. If we agree that the main goal of education is to develop both procedural and conceptual knowledge and to make links between the two, very important research questions are what is the quality of technological application and how different technologies and pedagogical solutions affect the relation between the two knowledge types. From our considerations and especially from our five implications above we conclude that technologically supported learning environments can in essential way empower procedural and conceptual knowledge construction and enhance students' and teachers' metacognitions. The implementation of technology requires dual focus approach: a well-balanced coherence between teacher's instructional orientation and technological applications. Eskelinen's (2005) findings give encouragement that such a balance could be reached in a well-planned teacher education.

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Introducing ICT in Higher Education:

The Case of Salahaddin/Hawler University

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Abstract: The democratization of Iraq as well as changes in the pedagogical paradigm place new demands on higher education. Higher education in Iraq is one of the sectors that have undergone much destruction.

In the last decades, there has been extensive use of Information and Communication Technology (ICT) in education as a tool for enhancing learning and teaching strategies. This can be seen in accordance with constructivist approach of learning; where the student is active in his/her learning. Within this change of paradigm, it is now impossible to ignore the potential of ICT, and especially that of the Internet (Trindade, 2002). Therefore, in this paper we have suggested a new infrastructure at University of Salahaddin/Hawler for implementing ICT, which will serve as a basis for improving teaching and learning. The aim is to support the university's academic mission, which is to move from teacher-centered teaching strategies to a more student-centered approach in a computerized environment.

Keywords: Information and Communication Technology (ICT), Learning and teaching strategies, learning styles

1 Introduction

"I never try to teach my students anything. I only try to create an environment in which they can learn."

Albert Einstein

Democratisation in Iraq as well as changes in the pedagogical paradigm place new demands on higher education. The higher education in Iraq is one of the sectors which have undergone much destruction. The long-standing difficulties and international embargo on Iraq has hindered developments in the country. In particular, it has affected quality of education, and lead to a poor quality of the graduating body. In general, teaching and learning material as well as qualified staff are scarce. For years teaching methods have been based on memorizing rather than comprehension, through reading lectures notes because of poor facilities. The remaining researchers in different fields have also been influenced by the environment and deprived from their needed scientific contacts.

In this paper we have suggested a new infrastructure at University of Salahaddin/Hawler for implementing ICT in higher education, which serves as a basis for improving teaching and learning. The aim is to support the university's academic mission, which is to move from teacher-centred teaching strategies to a more student-centred approach. In a traditional classroom environment the teacher cannot support all forms of learning styles (Gardner 1983), which means that some students' needs will probably not be satisfied. To give the students the opportunity to learn in accordance with their abilities, the education provided has to be individualized. Therefore, it is important to offer alternative ways of teaching and here ICT can play an important role (Edman & Mayiwar 2003, Mayiwar & Hakansson 2004). A combination of this technology and pedagogical new ideas will afford opportunities for all learners, everywhere and at any age, to reach their potential during their life time (Emurian 2002).

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2 Historical Background

The existing system of education in Iraq is the result of a long chain of historical processes. Its origins are rooted in the typical form of religious Quranic schools "Kuttab" and goes back to the educational system which was introduced by the Ottman rules in the mid 19th century. It has also been influenced to a great deal by the British during the period from the First World War to 1958, and by Egypt who assisted in providing curricula, teachers and educational management in the early stages of the modern Iraqi state. However, the framework of the modern educational system has developed more after 1968, when education was given a leading priority by the state. Education was regarded not only as one of the major public services besides health, but also officially as the means to prepare the potential manpower required for the economic, social, cultural and political development of the country. In the late 70 and 80s education and schools became the tools for the ruling Baath party machine to infiltrate their ideas and justify their aggressive wars on Iraqi neighbors (Sadik 1989).

Higher education in Iraq started in 1908 when the Baghdad Law School was established. This was followed by the foundation of Baghdad University in 1956. Today university education in Iraq is provided by twenty universities and many technical institutes.

Salahaddin/Hawler University was established in 1968 in Sulaimania city then transferred to Hawler (Arbil) city in 1981. Today University of Salahaddin consists of 20 colleges and 68 academic departments. The total number of students in 2004-2005 is 17355. The University grants BA and B.Sc., MA, M.Sc. and Ph.D. degrees in various subjects and specializations.

3 Information and Communication Technology (ICT)

According to the broad World Summit on the Information Society's (WSIS 2004) definition, ICT refers to a set of activities that facilitate by electronic means the processing, transmission and display of information while development projects pertaining to activities that relate to the socio-economic well-being of the country or community.

The term ICT (Information and Communications Technology) includes all kind of communication devices or applications, such as radio, television, cellular phones, computer and network hardware and software, satellite systems and so on. It will also include various services and applications associated with above applications, such as videoconferencing and distance learning.

It is important to acknowledge that the use of ICT as a tool for enhancing learning and teaching has both advantages and disadvantages that have to be considered. According to William Davies (isociety 2003) in the *UK Work Foundation report,* ICT will change the structure of our everyday life, but it will do that only through the invention of new traditions, which means that we are not doing anything new we just do the old things in new ways that suit our lifestyles better.

Alexander and McKenzie (1998) have reviewed 104 out of 173 projects relating to ICT for teaching and learning in Australian higher education between 1994 and 1998. As a result of their study the following benefits have been given:

- improved attitudes to learning
- improved quality of learning
- improved productivity of learning
- improved access to learning
- the opportunity to interact with others internationally
- enhanced communication between students and instructors
- the development of information and technological literacy

According to the European Union Commission, the importance of ICT lies less in the technology itself, rather than in its ability to create greater access to information and communication. However others like Will Hutton argue that whilst technological resources are regarded as the key to organisational and social challenges of our times, one can argue that as ICTs have failed in delivering the above promised benefits as ICT have paid little attention to the social infrastructure. Other social disadvantages identified by Norman Nie and Lutes Erbing (2000) in the first Stanford

University Internet and Society report suggested that the internet was making people isolated rather than being socially connected (isociety, 2003). They also concluded in their report that this decline in the social connection brings with it advancement in technological connectivity.

In considering both the advantages and disadvantages of ICT, we have come to a conclusion that ICT will bring more benefits to the university education in Iraq.

4 Learning and Teaching Approaches

Entwistle (1981) defined four orientations to learning: meaning, reproducing, achieving and holistic. A combination of these four orientations together with external factors, such as the need to pass examinations or the interest for the subject, can lead to learning strategies which categorized certain approaches to study, from deep to surface levels of thinking (Capel et al. 1999). Marton et al. (1996) argue that there are two main strategies for learning; surface and deep. In a surface approach to learning the students focus on memorizing set of facts, reproducing parts of the content and thereby developing an atomic view. The deep approach to learning takes place when students focus on significant issues in a particular topic and reflect on what they have read, relating their own previous knowledge to the new knowledge they have obtained. The students look for the overall meaning of the material and thereby develop a holistic view, which is desirable. The new pedagogy helps students focus more on knowing what to know, where to find and how to store knowledge (Loveless & Ellis 2001).

In traditional classrooms teachers focus on remembering as much as possible, which is the case for Higher Education in Iraq.This current position needs to be reformed from a surface approach to learning to a deep strategy for learning which we argue could be supported by the introduction of ICT to university education.

5 Current Infrastructure at Iraqi Universities

The hard circumstances suffered by Iraq in the past quarter of a century, affected the quality of education, and lead to poor graduate quality control. Amongst the reasons for that is the mass expansion of higher education, at the expense of the quality, and poor facilities available which lead to:

- Overcrowded classrooms and weak relations between students and their teachers.
- Because of poor facilities, teaching methods are based on memorizing rather than comprehension through reading lecture notes on a particular subject.
- The theoretical aspect of education also suffered from poor status of labs and shortage in modern equipment.
- Teaching based on one textbook kept students away from going to libraries to look and search for other books and references.
- Old curricula which are incapable to cope with modern developments and hence have a negative affect on the quality of graduates.

The higher education in Iraq is one of the sectors which have suffered a great deal. The buildings were destroyed, burnt or looted. In some governorates the destruction reaches up to 84%. The basic problems can be summed in the following:

- The lack of buildings and suitable classrooms for the increase in the number of students admitted.
- The shortage of instruments and laboratory equipment.
- Shortage of computers and internet networks. It is therefore required a communication infrastructure to ensure the flow and exchange of information between colleges of the same universities. The infrastructure may be used to enhance information and academic exchange with other universities in and outside Iraq.
- The poor and ambiguous relations between higher education as a sector and the demands of the labour market. It is also worth mentioning that serious constraints exist in some rare academic specializations.

- There is rising need for the university management to develop itself based on a reassessment of the university's needs.

Prior to the American war on Iraq, there were 15000 computer systems (P III, PIV) in the higher education sector in Iraq. Most of these computers were looted during the liberation of the country. An estimated need for computer equipment by the ministry of higher education in Iraq puts the need to 30000 computer systems in order to rebuild the infrastructure of Iraqi universities. That is based on the assumption of one computer for five students. We believe that the need is much higher than this figure and the need exits 70000 computer systems for the higher education in Iraq. As for the internet, the ministry of higher education survey (2004) states that there are 110 separate networks which form 43%of the Iraqi colleges and institutes, i.e., one network per college.

6 The existing ICT infrastructure at Salahaddin/Hawler University

The university of Salahaddin/Hawler is located in a semi independent area of Kurdistan region which has been disconnected from the central Iraqi government in July 1991. As a result, the region was subjected to double economic blockades, one from the international community, being technically part of Iraq and another more severe one from the Iraqi regime itself. This had a negative effect on the university infrastructure in the area. It is therefore, difficult to talk about ICT infrastructure at the university. As mentioned previously Salahaddin/Hawler University was established in 1968 and now contains 20 colleges (faculties) with a total number of 17355 students. The University grants BA, B.Sc., MA, M.Sc. and Ph.D. degrees in various subjects and specializations with a handful of computer systems and a limited access to internet. To that end, we are suggesting in this paper a new and modern infrastructure of ICT for Salahaddin/Hawler University.

7 Suggestions for a New ICT Infrastructure for the University of Salahaddin/Hawler

According to Collis (1999), the use of ICT in higher education focuses on:

- The dissemination of information and of publications.
- Communication between teachers and students and between students.
- Collaboration: group discussions, joint project work, etc.
- Information & resource handling: search engines, access to multimedia databases, etc.
- Specific teaching & learning purposes: such as interactive tutorials, quizzes, simulations, test, and video-conferencing for lecture participation.
- For course integration: WWW-based course-support systems.

Guided by Collis's approach and our deep understanding of the ICT needs, we propose the following infrastructure of ICT for the University of Salahaddin/Hawler:

- ✓ To connect all the administrative buildings as well as the services buildings such as library, continuous education, computer centre, administrative affairs, financial affairs, training, medical center and others to the intranet system.

- ✓ To design and create electronic classes for teaching and allow the users to direct connections with seminars and conferences.

- ✓ To develop an extensive pool of trained ICT manpower at all levels to meet the requirements of the University.
- ✓ To promote widespread use of ICT applications in faculties and departments for efficient teaching, research and learning.
- ✓ To design and create an electronic library as per international standards and including most of the items and lessons given by the different branches of the university, and to assure a connection with one international library.
- ✓ To supply a dedicated information rate satellite service capable of servicing the current and future information data needs of the university. In effect a sufficiently sized and robust bandwidth service for the University that will be available at least 99.9% of the year.
- ✓ Supply wireless Line of Sight architecture with sufficient capacity to support all colleges within the University.
- ✓ To supply and install the infrastructure and the required hardware for the reliable, computerized, LAN (Local Area Network) for use by the students and educational staff of University.
- ✓ To supply and install an adequate number of servers supported by the appropriate networking infrastructure (hardware and software) to connect the computers to servers, printers, plotters, scanners and other peripherals through the university.
- ✓ To provide e-mail services to all students and staff within the University in order to be able to complete their work more efficiently and assist the University in communicating and supporting them in that endeavor.
- ✓ Establish efficient and effective practices within the University that reflect information systems working today.

The suggested ICT infrastructure will not only benefit student but can also be used to utilize teacher performance. The ICT infrastructure will increase access to information, communication and to online courses. Moreover, teachers can also be supported in their teaching by introducing ICT in the classrooms as a pedagogical tool.

8 Conclusions and Further Work

The main objective of this paper has been to explore some issues relating to use of Information and Communication Technology in higher education sector in Iraq. An appropriate infrastructure for implementing ICT at the university has been suggested.

As mentioned before, the main approach for teaching at Iraqi universities is still teacher-centred, which results in surface learning. Our attempt is to change the teaching strategies form teacher-centred to student-centred approach by introducing ICT.

We have suggested a new physical infrastructure and also considered pedagogical advantages of using ICT in higher education. This paper has been as a first step toward reforming educational system in northern Iraq. To conclude, ICT has many important contributions to make for Universities in Iraq, but only when we have a good understanding of its technical and pedagogical aspects.

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Design and development

Organisational Development within Course Development

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Finnish high school system is facing a huge challenge in rural areas due to negative changes in population number and also with curricular changes. Educational technology has been suggested as one possible solution as a tool to share organisational resources between networked high schools. In this paper we describe a process of organisational development mostly based on learning organisation approach. It is a part of the ongoing Itäsuomalainen oppimisverkosto 2004-2006 (ISOverkosto) –project. Project aims to improve the good practices developed in the previous project (2000-2003) with 8 Eastern Finland adult high schools to a group of 36 high schools. The main goals of the ISOverkosto project are 1) to support (small) secondary education institutes in the area, 2) to increase co-operation and collaboration among eastern Finland secondary education teachers, 3) to provide flexible and high-quality educational services in Eastern Finland, and 4) to support teachers in adapting to a new operational culture (e.g. use of online learning environments). We suggest tentative model to consider each participating institution (school) as a learning organisation to support development of teacher leadership (extended feel of responsibility of school), which may have positive impact to student outcomes. To gain these aims we try enhance professional development by supporting teachers reflection processes through course evaluation and revision. In the course evaluation we found out that students still need local tutoring as social support, and the conducted first phase courses still rely mostly on learners individual work.

Keywords: virtual high school, professional development, online learning

1 Introduction

Finnish high school system is facing a huge challenge in rural areas due to negative changes in population number and also with curricular changes. Quite many high schools suffer from lack of students at the same time as they are supposed to

enhance their educational activities and course offerings. Educational technology has been suggested as one possible solution as a tool to share organisational resources between networked high schools. Still it is quite a challenge to adapt the educational technology into daily practice. The teaching staff is not yet ready for such and also some concern on the quality of the actual online teaching and learning is a very relevant question.

In this paper we describe a process of organisational development mostly based on learning organisation approach. It is a part of the ongoing Itäsuomalainen oppimisverkosto 2004-2006 (ISOverkosto) –project. Project aims to expand the good practices developed in the previous project (2000-2003) with 8 Eastern Finland adult high schools to a group of 36 high schools. The main goals of the ISOverkosto project are 1) to support (small) secondary education institutes in the area, 2) to increase co-operation and collaboration among eastern Finland secondary education teachers, 3) to provide flexible and high-quality educational services in Eastern Finland, and 4) to support teachers in adapting to a new operational culture. Geographically large area and high number of institutes involved makes the project challenging both in pedagogical and administrative terms. In the previous project the participating high schools were mostly focusing on adult education and online teaching and online course development. The developmental process was based on supporting continuous teamwork and individual professional development in the use of ICT in education. We feel that this approach was successful in many ways not least to produce community of practice that is capable to offer online courses for high schools in continuous manner.

In ISOverkosto project we try to spread out the experiences gained in the previous project to ordinary high schools and simultaneously further develop new forms of virtual high school. The different types of high schools, ordinary and adult, involved in this work need to share same vision on the functioning of the virtual high school network. The networked organisation to provide education is a new way to almost all participating schools. Since there is no previous similar working culture in those institutions all personnel need to be taken into account and be confirmed by the benefits of networking. We believe that this is a matter of organisational learning; professional development occurring simultaneously both at individual level and at organisational level. Due to the limited time of the project, only three years, it is essential to utilise previous experiences as much as possible.

In this paper we discuss theoretical basis to consider virtual high school network as a strategic alliance in which learning organisation approach could be utilized to offer a potential zone for development for participating individuals. Furthermore we suggest tentative model to consider each participating institution (school) as a learning organisation to support development of teacher leadership which may have positive impact to student outcomes. In school improvement the main goal is to improve quality of teaching, in this case online teaching, we apply Jonassen's (1995) criteria of meaningful learning as a tool to evaluate and improve quality of an online course. In this paper we present the evaluation of the first so called "Teachers' apprenticeship-courses" as a starting point to further individual and organisational development in domain of online teaching.

2 Situated learning for organisational development

Organisational learning is connected to situations where a rapid change and constant development are taking place in order to adapt changing circumstances. In the discussion about organisational learning a lot of emphasis has been set on the shared mental models or theory-in-use (Argyris and Schön, 1978 sited by Ghosh, 2004). Burgoyne (1996) offers a working definition: "a learning organisation continuously transforms itself in the process reciprocally linked to the development of all its members." The organisation must have some way to change smoothly its operations, enriching its context by having some processes that changes the organisation policy and operations in organisational level and thinking and doing in individual level (Burgoyne, 1996).

Since educational systems are always seeking for better ways to operate, it is quite natural that the learning organisation approach has been applied also in school settings. One interesting example of this is Australian, Tasmanian LOLSO-project (Leadership for Organisational Learning and Student Outcomes) which has been a three-year-project to investigate effect of organisational learning approach to change school practices and effects of that on student outcomes (Silins & Mulford, 2001). They found out that learning organisation approach has positive impact on teachers' conception of work, they call it teacher leadership. Teachers' work (leadership) on the other hand has positive impact on student participation, engagement with school (Silins, 2000) and academic self-concept which also affects academic achievement (Mulford & Silins, 2003). Teachers' leadership means that teachers take responsibility on whole school happenings and not just of their own classrooms. They claim that the learning organisation atmosphere is a supporting factor for development of teacher leadership. On their analysis of teacher responses on the nature of school as learning organisation they found some key characteristics: trusting and collaborative climate, taking initiatives and risks, shared and monitored mission and continuous professional development (Mulford & Silins, 2003).

For newcomers it is often difficult to understand organisational culture and atmosphere or make mental models about the organisation. Lave (1991) suggest that the building of shared cognition is a process of becoming a member of community of practice. Lave also anchors the learning to the situated activity in which the person participates in the activities of the community and while acting in the community he/she has constant negotiations of meanings with the other members of the community. She calls this process as legitimate peripheral participation, and with peripheral presses the point that the process is gradual with increasing level of responsibilities according to the mastery of the area. One form to apply situated conception of learning is cognitive apprenticeship and to utilise technology to support the working process of communities of learners. In cognitive apprenticeship one tries to include domain knowledge, heuristic knowledge, metacognitive strategies and learning strategies. This is done in authentic real-life context in which by scaffolding an individual or an organisation can support the construction of own understanding of the problem in hand. Cognitive apprenticeship includes teaching and learning strategies such as: articulating own reasoning process, monitoring the knowledge construction or problem solving process, reflection on the process in order to find better or more general ways of thinking, and modelling of the effective process (Collins, Brown, & Newman, 1989). Jonassen (1995) discusses the role of technology in supporting cognitive apprenticeship model of teaching and learning and defines qualities of meaningful learning. He also suggests three possible roles for the technology to support the teaching learning process: using technology as a (productive) tool, as an intellectual partner and using technology to build up the learning context (Jonassen, 1995). We believe that these factors, in addition to supporting students learning, also support learning of teachers. Dimensions of meaningful learning serves even as an instrument to evaluate quality of an online course.

In recent learning research ever increasing attention has been put to forms of collaborative learning (e.g. Dillenburg, 1999). Ghosh (2004) combines organisational learning and collaborative learning by introducing concept of strategic alliances. According to him in strategic alliances autonomous organisations work for joint accomplishment of individual goals linked to corporative mission. Strategic alliances offer partners opportunities to transfer embedded knowledge between them by providing opportunities for joint building of the mental models about the functioning of the collaborative effort they are involved with. He also connects the Vygotsky´s socio-cultural-historical learning theory into organisational learning by treating the strategic alliances as potential zones for development. Furthermore, he combines the used tools/artefacts, also technological, to the interpersonal communication and meaning making process which precedes the intrapersonal, individual level. We also believe that the technological tools like online learning environments and digital material repositories can scaffold the learning process of the individual participants or the organisations. However, in the process of building trusting and collaborative climate also face-to-face meetings of different groups of teachers and individuals are essential. According to Ghosh, Vygotsky´s point of view ties the history of the organisations and their personnel to the collaborative learning effort. In this case we have organisations involved that has quite a wide scope of knowledge and skills in using technology in education, especially online learning environments, and therefore the apprenticeship model of teaching seems to be suitable for the in-service training of teachers.

3 Course development

Mulford and Silins (2003) mention continuous professional development as one of the key characteristics describing a school as a learning organisation. In learning organisation approach it is assumed that the professional development (e.g. learning) is closely tied to functioning of everyday practices and also research on in-service training of teachers seems to support this demand (e.g. Galanouli, Murphy & Gardner, 2004). Teachers are nowadays described to be reflective, inquiring professionals who are willing and capable to carry out constant professional development. We believe that one possible theoretical model to support reflection is Korthagen´s (1999) ALACT model of reflection consisting five phases 1) **A**ction 2) **L**ooking back on the action 3) **A**wareness of the essential aspects 4) **C**reating alternative methods of action 5) **T**rial. It is a spiral model starting and ending to an action, and basically the first and the fifth phases are same (Figure 1). According to Korthagen the third phase, awareness of the essential aspects, is the most difficult to implement. We believe that one valuable point of view is to evaluate the meaningfulness of the online courses which the virtual high school consortium has produced. So the evaluation of the courses serves two purposes simultaneously: description of the nature of online education produced in the teacher community and as feedback to continuous professional development of online teachers and their organisation.

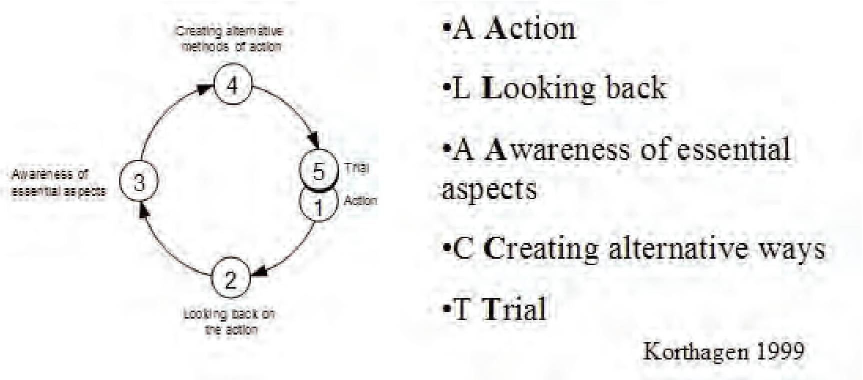

Figure 1. ALACT model for ideal reflection cycle

In ISOverkosto project the professional development is seen as a method to advance quality in the online courses. The quality is seen as a property of the courses based on the learning theories used in the course design. The aim is to develop the quality of the courses using Jonassen's (1995) theories of meaningful learning. According to him learning must be active so that learners have responsibility and control of their own learning, learning must be constructive so that learners can build up on previous knowledge and reconcile possible cognitive conflicts, collaborative so that learners can advance each others skills and knowledge, intentional so that learners can form and achieve learning goals, conversational so that learners can benefit from the meaning making process and differing opinions, learning should be contextual so that it is anchored in meaningful authentic tasks and reflective so that learners can externalise and re-evaluate their decisions and process. In this chapter we describe the process that we call "koulutuskurssi" – teachers' apprenticeship-courses, which means normal courses in the web for the learners but a development and learning process for the senior teachers and local tutor teachers.

Senior teachers in these courses have usually a lot of experiences about teaching and learning in the web-based learning environments. Most of them have been involved in teaching and learning online for several years. These teachers design the courses and are responsible of the course contents and learners activities and also of the assessment. In addition to senior teachers, there are also local tutor teachers in each school so that learners can get support when needed. Tutor teachers don't have earlier experiences about teaching and learning in web-based learning environments. Their role is to help and encourage learners during the online courses and particularly to learn (in-service training) to use new learning environments. For learners these courses are normal courses in the web-based learning environments.

There have been so far three teachers' apprenticeship-course unities each containing 9 to 10 different courses. Teachers' apprenticeship-courses consist of three phases (see Figure 2). The first is a beginning meeting where senior teachers present their courses for the tutor teachers, describing the aims of the courses, learning methods, different tools in learning environment etc. The teacher and tutor make an agreement about their different roles during the course. The second phase involves carrying out the online course. After the course is the third, evaluation and reflection phase. In after-course meetings teachers evaluate courses using an evaluation form which has been constructed based on Jonassen's (1995) theory about meaningful learning. Senior and tutor teachers evaluate and demonstrate their courses to other teachers. The idea is that teachers reflect their teaching methods and evaluate and compare how different methods worked since the aim is also to share ideas and best practices. Right after these courses we also gather feedback from learners and tutor teachers by web-based questionnaires. In addition, the courses are also evaluated by researchers who use the same evaluation form as the teachers. These results and feedback from learners and tutor teachers are presented for teachers in the after-course meeting as basis for the conversation. In these conversations we have found ways to develop next courses, what is good, have there been any problems, what needs to be improved and so on.

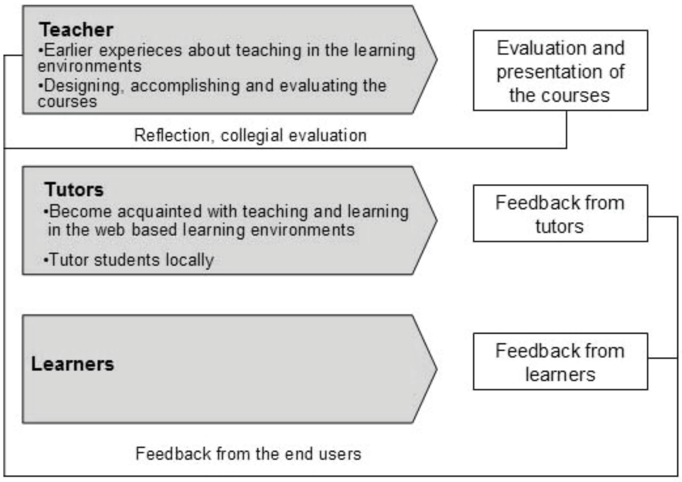

Figure 2. Apprenticeship curse

4 Experiences from the teachers' apprenticeship-courses

Teachers' apprenticeship-courses were also evaluated by researchers using the same evaluation form as the teachers. The results of the course evaluations had strong similarity compared to models made by Manninen (2003). Manninen describes four different ways of teaching in web-based learning environments (Figure 2). The differences are based on different roles of teacher, learner and learning materials. In the first model the learning process is very well guided process by teacher and learning materials. The structure of the course resembles normal contact teaching where teacher controls the learning using learning materials. The second model is based on discussions. Teacher and learners are actively involved in learning process using asynchronous discussion forums. Teachers' role is important in guiding learners to think and in helping learners to reflect their ideas and learning experiences. Model three consists basically of self-study learning materials. The learner follows ready-made materials involving guides concerning what and how learner should learn and also the materials to be studied. The fourth model is a learner-centered model where the learning materials and teachers are only supporting the learning process and the learner groups themselves are responsible for the learning results. (Manninen 2003).

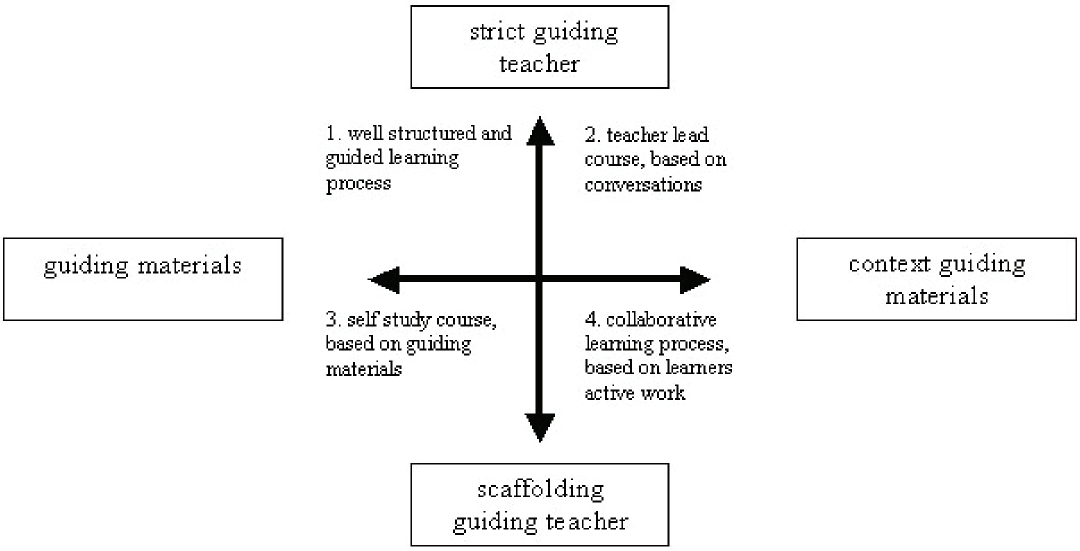

Figure 3. Manninen's different ways of teaching in web-based learning environments

Compared to the models in Figure 3 the teachers' apprenticeship-courses represented mainly models one, two and three. Only model four was totally lacking in our data. A common feature for all the studied courses was very clear and easy-to-follow structure. Materials and learning assignments were clearly presented containing various instructions, for example instructions for different learning tasks, technical instructions and also a common learning and reflection instructions. We believe that because of the clear structure the feedback from the learners was mostly positive.

The second common feature for the courses was the lack of collaboration. The learning process contained a lot of learning assignments that learners carried out alone, without peer interaction. Learners mainly interacted only with the teacher. They accomplished their learning assignments and returned them to the teacher who gave feedback. Most of the courses were constructed so that learners did not have a need to interact with the other learners. The peer interaction was mainly used in courses that were designed according to model two in Figure 3. In these courses the learning process was carried out using discussion forums instead of learning assignments that learners accomplish alone.

Local tutor teachers had a very important role in the teachers' apprenticeship-courses. They had actually surprisingly many tasks. Tutor teachers served both as a technical support and as a pedagogical support. They helped learners with learning assignments whenever they could and they also arranged face-to-face meetings when needed, very often in a weekly basis. Probably the most important role of tutor teachers was encouraging learners and help learners to plan and to stay in their timetables. The tutor teacher's underlined role may result from the lack of other collaboration in the studied courses. When learners did not get much feedback from the other learners all around Eastern Finland they consulted the tutor teacher available in their own school..

5 Conclusions

Forming a network of high schools (virtual high school) seems to be rather demanding task. There needs to happen quite a many changes in the daily practices at the schools and their working policy and not least in the job description of a teacher. Therefore it seems to be reasonable to investigate the process happening at the schools and also how network based tools that are used in this project. Based on above analysis it seems to be so that local tutoring is quite essential for the young students and some kind of teacher leadership, enlarged sphere of responsibilities, is essential. It is still to be seen, if the learning organisation approach is to be taken place in participating high schools and if so, will it lead to some kind of teacher leadership and better student outcomes.

The courses that was conducted and analysed seemed to be designed for individual, self-paced studying, representing models one, two and three in Figure 3. During the ongoing project our goal is to proceed toward more collaborative courses emphasizing peer interaction. The idea is to emphasize models two and four in Figure 3 that represents collaborative, learner-centred courses, containing also studying in small groups over Internet.

These results were used in after course reflection sessions with teaching staff, but the data concerning the courses designed and conducted after that are not yet analysed. Again what kind of changes these interventions had caused is to be investigated. It is also a matter of further investigation to try to find out what kind of professional development has happened among senior teachers, and among new beginners in the field of online pedagogy.

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Perspectives on the roles of a web-based environment in collaborative designing

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This paper presents perspectives on the roles of a web-based environment as a tool and a context for a case of computer supported collaborative design process in the context of academic design education. The aim of the paper is to call attention to how web-based environment in its multiple roles serves or affects a collaborative design process. The subject is here reviewed through the viewpoint of design discipline but the nature of the subject as an area of multi-, inter-, and transdisciplinary research is brought into discussion. The main focus of the paper is in design collaboration through a web-based environment. The paper brings to the fore four perspectives which are closely intertwined: web-based environment as a medium for 1) distribution of expert knowledge, 2) presentation and viewing of concept ideas, 3) evaluation and feedback, and 4) guidance and supervision of the process. The case referred in the paper is an authentic, collaborative, computer supported concept design process which has been documented with various methods for qualitative study with various approaches. The participants of the design process included design students, consultants, project personnel and representatives of end-users. The study is related to the on-going research project Facilitating Social Creativity through Collaborative Designing at the University of Lapland. The research project is funded by the Academy of Finland through the Life as Learning – programme.

Keywords: computer supported designing, collaborative designing, network-based design interaction, constructing knowledge through design, web-based environment

1 Introduction

1.1 Design and research

Research in the design discipline is always somehow related to designing. Yet in academic design education, there often seems to be a gap between research and education of the design students. In our department the multiple simultaneously on-going research projects have created unique opportunities for learning through designing and in the same time bridging the gap between research and education. The research projects concentrating on the collection and utilisation of user knowledge create opportunities for student design projects and direct utilisation of the research knowledge of end-users. In the same time the students' design projects create circumstances for studying authentic design processes in research projects interested in the activity of designing.

Design in itself as a discipline invites multiple perspectives and multi-, inter-, and transdisciplinary research approaches. Design and social sciences have made connections in the study of users of design products whereas in the study of the activity of designing connection with psychology and cognitive sciences etc. is natural and evident. Equally designing as a process or context of learning brings together researchers with pedagogical and design interests.

Designing as a form of activity is assumed to represent some of the highest cognitive skills of human activities. Consequently learning through designing is seen as an interesting setting for the study of the development of cognitive as well as social and aesthetic skills. Further in Finland, design is considered as a key factor of our competitiveness in

the global economy. Still we have not yet established neither a strong scientific tradition of studying individual and collaborative processes of designing, nor strong pedagogical models and practices that would support learning through designing in general or collaborative designing in web-based environments in particular.

1.2 The CoDes – research project

The subject and approach of the paper are based on the goals and foundations of the Facilitating Social Creativity through Collaborative Designing (CoDes) research project. The purpose of the CoDes project is to analyze challenges of learning through designing in different levels of educational and professional design contexts. A special focus of the project is to address challenges of collaborative designing and examine the possibilities provided by virtual design studios to cross boundaries between educational institutions and enterprises, and facilitate horizontal learning of designers in multiprofessional teams. In addition the project aims to explore how new media- and design technologies enable to advance understandable design communication.

The project relies on multiple methods, approaches and units of analysis. The data in the project contains content-rich ethnographical data, such as video recordings of the face-to-face studio teaching situations and design team meetings, participant observations, and structured interviews. In the project, several collaborative environments are used in order to obtain a richer understanding of the role of a virtual environment's diverse functions in support of the collaborative process.

The CoDes research project is carried out by the consortium of the department of Textile and Clothing Design from the University of Lapland and the Department of Teacher Education from the University of Joensuu during the years 2003-2006. The project is funded by the Academy of Finland through the Life as Learning – programme.

2 Aims and objectives

The aim of the paper is to introduce a design case, which provided an opportunity for testing the applicability of a web-based learning environment in a collaborative concept design process. From the researchers' point of view the case offered an opportunity to simulate and explore a method of working and communicating that could be applied and developed further both in professional and educational contexts of design. From the perspective of the participants of design process the case represented an authentic design process.

The paper presents perspectives on the multiple roles of a web-based environment as a tool and a context for the case. The goal of the paper is to call attention to how the web-based environment serves or affects a collaborative design process. The purpose of the paper is to present the context of our data collection and bring forward the perspectives which emerged for consideration during the process and initial analysis. The discussed perspectives are not intended to be examined as final results of the study but as themes and grounds for prospective studies.

The authors of the paper have a twofold relation to the case in question. In this paper we examine the case from the perspective of researchers but we have been involved in the process also as participants. The author A was involved in the design process in project personnel supervising and guiding the use of the web-based environment. The author B was one of the designers of the concept design team. The data for the CoDes research project was collected while participating in the process.

3 Background

As tools for computer aided design have developed, so have also the conceptions of the relation between designing and the means and tools changed. Nowadays there seems to be growing a misconception of the tool's meaning for designing – many people seem to think that learning to use design tools equals learning to design. Tools have different roles in different phases of the design process, but mastering of a tool does not make one a designer. Nevertheless, tools have an inevitable relation to designing and especially to the outcomes of designing. May the outcome be illustrations, presentations or design artefacts the appearance of the outcome and the process is always affected by the tools that were used.

The web-based environments for design collaboration are becoming globally more common both in professional use of designers and in design education. In the industrial context this has been affected by the cost-based motives which are a factor in education as well; the limited resources have increased a wish to make use of web-based environments and their facilitating characteristics in surpassing the limitations of time and location. Web-based environments enable collaboration of multiprofessional teams without a physically shared working environment. This was the circumstances also in our particular case.

The presented design case was conducted as a joint effort of two research projects. The approach in the paper is grounded on the previously demonstrated foundations of the CoDes project. The contentual parameters and challenges of the design case were founded on the objectives of the Methods and Models for Intelligent Garment Design (MeMoGa) research project.

One of the goals of the MeMoGa project is to produce applications in the area of wearable intelligence. Consequently the introduced case represents a design process of an intelligent workwear concept for heavy industry. The user-centred approach of the MeMoGa project provided a chance of exploring an authentic collaborative design process where end-users of the product were also participating. In addition of the expertise of end-users the design process of intelligent workwear concept utilized also expertise and collaboration of representatives of textile technology, electronics, wearable technology, physiology, as well as industrial and clothing design. Figure 1. illustrates factors and elements that affected the process and use of the web-based environment in the collaborative design process.

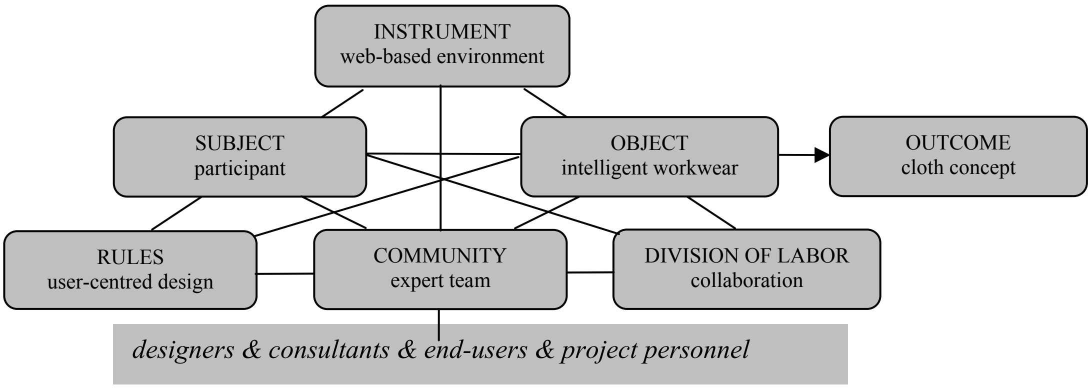

Figure 1. The chart of the operational system in the design process (based on Engeström, 2004 and Diaz-Kommonen, 2002)

4 The design case and methods of data collection

4.1 Description of the case

The concept design phase of design process is the early stage of product development process – sometimes called "the fuzzy front end" (Cagan & Vogel, 2002). There are many definitions for the term *concept design* but often it is used to define a phase of the research and development process that aims for innovative solutions and defines key elements or functions of a product but does not aim for an outcome that could be forwarded directly to manufacturing or marketing processes. (Keinonen et al. 2003) A design concept is a description of functions, technology and appearance of a product as well as of services it provides. A design concept is often presented with sketches, illustrations, modelling and supported with verbal descriptions. (Ulrich & Eppinger, 2000)

The design process in question represents computer supported collaborative designing. The process took place in 1.3.–28.5.2004 at the University of Lapland. The web-based environment for the process was developed into Discendum Optima (http://www.discendum.com) learning environment. The participants in the design process included a team of four designers (two students of clothing design and two students of industrial design), consultants of physiology, material technology, electronics and wearable computing (n=4) from collaborating universities as well end-users (n=6) from three different heavy industry companies and project personnel (n=3). Three of the consultants participated as researchers of the MeMoGa project and one of the consultants was employed particularly for the purposes of the design process. The consultants used facilities of their universities. The end-users – employees from collaborating heavy industry companies – participated in the process during their working hours without additional compensation in premises of their companies. The designers and project personnel were located at our department. The communication between designers, consultants, end-users and project personnel was conducted in the network-based environment except for lectures and face-to-face meetings of the design team. The designers and project personnel had prior experience of working with at least one web-based environment, two of the consultants had some experience of a web-based environment and none of the end-users had previously been working with a web-based environment.

4.2 Data collection and analysis

The meetings of the design team were documented on audiovisual recordings. The solitary working of designers outside the meetings was not recorded into the data except for material the designers produced during the process. Most of the

produced material such as sketches, notes etc. were imported into the web-based environment during the process. All the communication and produced visual and textual material were saved in the Discendum Optima environment. The web-based data has also been printed out for documentation. Data was also supported by web-based questionnaires and diaries which were aimed at documenting use of the environment. In addition designers, expert consultants and project personnel were also interviewed after the process and two of the end-users filled in a web-based questionnaire. The methods of analysis include different qualitative approaches. The collected data will be examined from different perspectives with different research problems within the framework of the CoDes research project.

5 The web-based environment as a medium for design interaction and communication

The web-based environment as a tool and a factor of the process has been initially analyzed to have had four roles. The roles of the web-based environment were also the means to enable design interaction and communication. These roles are described in the subsections and presented in the figure 2.

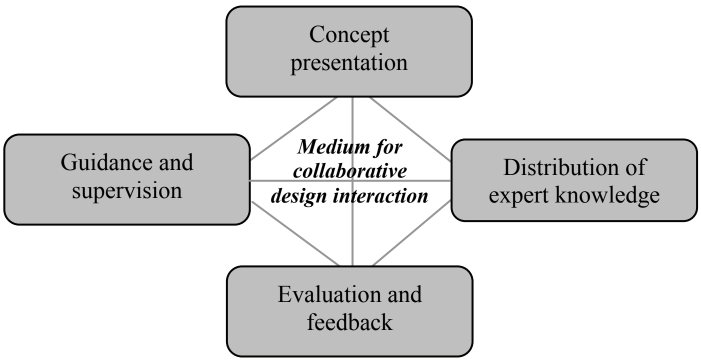

Figure 2. The web-based environment as a medium for interaction in the MeMoGa case

5.1 The web-based environment as a medium for distributing expert knowledge and information

One of the aimed functions of the web-based environment was to enable distribution of the different fields of expertise which the participants were considered to represent in the case; the consultants and project personnel represented expertise of their research fields, the designers represented design expertise and the end-users provided their expertise of authentic tasks and working environments.

The designers were encouraged to both look for information independently and utilise the expertise of the consultants. The designers were advised to import knowledge produced in the process to the environment for consideration and discussion of the other team members. Some of the information was already established in the environment by the project personnel prior to the beginning of the concept design phase and some of the information was produced by the participants as work progressed. The purpose was to support interaction between the designers and other participants so that the team could examine emerging problems and questions in a collaborative and participatory manner.

The consultants were asked to provide information from the fields of their own expertise. The purpose was that they could introduce the existing research knowledge to the designers as they were supposed to hold information that was not easily adoptable and available through mediums on hand for the designers. Their experience on their research fields was considered a valuable asset in the design process. In addition they were hoped to come up with realistic solutions for specific problems and details in the design concept as ideas evolved. The aim was that communication of ideas and challenges involving them could emerge spontaneously between the designers and consultants throughout the whole process.

The project personnel's assignment was to provide enough background information of end-users, aimed contexts of workwear's use as well as challenges of wearable intelligence for the design process. The researchers of the MeMoGa project who were also participating in the process as project personnel had collected information in three collaborating heavy industry companies prior to the beginning of the design phase. The aim of the background research was to ensure that the design team would have an extensive information reserve already in the start of the process. The existence of the background knowledge formed also the role of the end-users as they were not expected to produce any additional information but only participate in evaluation of ideas and offer their expertise on the subject through commenting, feedback and discussion.

5.2 The web-based environment as a medium for presentation

One of the main purposes of the web-based environment was to serve as a medium for presentation of ideas and the design concept. The purpose was that the designers would bring their ideas to the environment to create conversation between the participants and enable the collaborative nature of the design process. The formats of the presentations were not predetermined. The utilized environment includes tools for generation of textual material in different formats and also allows importing material produced outside the environment. The aim was that the consultants could follow the process and evolving ideas and offer their comments whenever suitable. The material produced by the designers was constantly available for the consultants and vice versa. The designers were supposed to offer the consultants information of the ideas and possible problems so that the consultants could contribute appropriately. In practice the consultants were able to review nearly all of the produced material, including the presentations for the end-users.

The end-users were invited to participate in a specific timeframe twice in the process and the material available for them was limited only to the presentations that were hoped to be commented and discussed. The designers were expected to present material that could inform the end-users of the ideas so that they could form an opinion and give feedback to the designers. The first commenting period the designers introduced their ideas through short narratives which represented the concept ideas in the working context. The end-users were also asked to review some moodboard collages and comment on the presented material. In the second period of commenting the design team put together an interactive presentation which included drawings, textual descriptions of concept details and suggestions of colour charts for the concept.

5.3 The web-based environment as a medium for evaluation and feedback

For the designers the process was also a process of learning. This aspect was closely related to the web-based environment's role as a medium for evaluation and feedback. The specific purpose of the evaluation was that the other participants would give the designers opinions and comments on the ideas and concept presentations based on the participants' own expertise.

The consultants were able to give feedback to the designers throughout the process. In addition the process included three separate days that were reserved for more thorough review of material by the consultants and also offered them opportunities to engage in a real-time conversation through the chat feature. The end-users main assignment in the design process was to evaluate and comment the design team's concept ideas based on their working experience. The end-users were not originally believed to engage in a continuous conversational interaction but rather comment on the presentations when specially asked to. This was anticipated because of the end-users limited participation time. Additional challenge to the end-user participation was brought by the fact that the end-users were participating from the premises of their employer and two of them had an opportunity to use computer only in the office of their supervisor.

5.4 The web-based environment as a medium for guidance and supervision

The learning and teaching aspect of the process came visible also in the fourth role of the web-based environment. The project personnel were assigned to guide, manage and supervise the process and the working in the web-based environment as well as offer help and work out the possible technical or other problem situations. The concept design process was scheduled and managed through the environment and the timed elements of the environment were aimed to ease the process through intermediate goals and a structured timeframe. The purpose was also to make the evolving concept ideas visible to the other participants phase by phase in the web-based environment. In addition the project personnel were able to follow the process and advancement through the environment.

6 Design collaboration in the web-based environment

6.1 From interaction to collaboration

Offering a shared tool or technology is not enough to make interaction in a web-based environment collaborative. What is also needed is social infrastructure, to ensure that the interaction of participants would succeed desirably (Lahti, 2004). The essential element in a successful networked collaboration is not the amount of sent messages but the meanings given to them. These meanings are a factor in how the interaction mediated through a networked environment eventually contributes to actions and outcomes. (Matikainen, 2001)

In collaboration the participants interact in relation to the object and to each other. The object represents the issue the participants are managing. In our case the object is both the contentual aspects of the concept as well as the process with its different phases. The levels of collaboration can be divided into three types: coordination, cooperation and reflective communication. In coordination each participant has his own task and participants do not actually communicate to each other. In addition they perform according to a predetermined script or process plan and role differentiation. In cooperation participants have a shared object to manage which they bring into conversation. They also surpass the borders of the predetermined script. In reflective communication participants evaluate and develop also the ways of interaction and role determination as well as the process in general. (Engeström, 2004) Figure 3 presents the objective levels of collaboration in the design case.

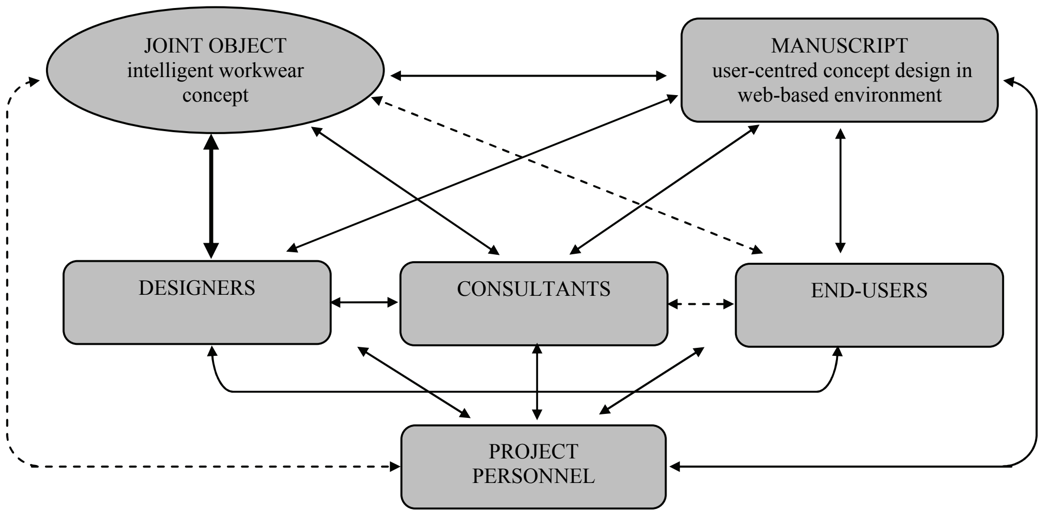

Figure 3. Objective levels of collaboration in Memoga design case (Adapted from Engeström, 2004 and Seitamaa-Hakkarainen, 2004)

The researchers in the CoDes research project have defined collaborative designing as follows: collaborative design means a process of actively communicating and working together in order to jointly establish design goals, search through design problem spaces, determine design constraints and construct a design. The research project emphasizes in particular that the creation of shared design objects is an essential element of collaborative designing. (Lahti, 2004) In the presented design case the goal was to design a single collective concept, which was the outcome of the participation of all of the members through their fields of expertise although the main responsibility of the designing was on the designers.

6.2 From communication to dialogue

Communication plays a vital role in collaborative design. The nature of the communication in a collaborative design process depends on various factors. However communication in design teams by nature resembles dialogic interaction rather than discussion or debate. Sometimes dialogue is used as an interchangeable synonym of the terms conversation or discussion but often it is conceived to represent face-to-face social interaction (Luckmann, 1990) between persons. In this paper the term is conceived as a type of communication which is defined by the nature of the interaction. Discussion has a tendency to encourage fragmentation, categorization and generalization whereas dialogue allows synthesis of divergent conceptions and recognition of nuances. (Heikkilä & Heikkilä, 2001) Discussion and debate can be described through an intention of narrowing down and finding a rationally valid alternative, while dialogue is about gaining deeper understanding of meanings, alternative views and new, larger perspectives. Dialogue enables creativity and is open for possibilities; it helps team members to reach goals they could not have reached on their own. (Örndahl, 1999) As the dialogue is a form of communication that exceeds the verbal language the dialogic nature of interaction is inevitably limited in the communication in a web-based environment. The dialogic nature of interaction can not be expected to emerge in the full meaning of the term in a web environment but communication in the environment may still hold features of dialogue.

Dialogic interaction has been examined also in the relation of learning in a web-based environment. For instance Webb et al. (2004) have established that engagement in dialogue in a network-based learning environment correlates with learning outcomes. The network-based environment in the process certainly opened opportunities for communication and for even a form of dialogue between the designers, consultants, end-users as well as the project personnel. The interaction between designers in the face-to-face meetings typified a dialogue. The same can not be stated on the behalf of the communication in the web-based environment. Reasons for this can be searched in many directions but one of the problems can be analyzed also in the structure of the web-based environment. Collaborative interaction and learning is not effectively supported by the same tools as independent information retrieval. Nevertheless some of the features of the environment also seemed to facilitate interaction – especially the consultants preferred the given opportunity for asynchronous communication which enabled contemplation, retrieval of additional information and reflected answers.

Even though the consultants were not expected to act as full members of the design team the interaction and distribution of expertise did not emerge to the extent it was expected. This was partly analyzed to originate from the foundationally different ways of thinking and acting of the designers and consultants. The consultants expected specific questions of specific problems where their knowledge could be of assistance. At the same time the designers were used to act on the basis of insecure and incomplete information and use their imagination to envision things that could not be known. The designers wished that the consultants would have assumed a more spontaneous role in the generation of information and asked the designers defining questions if the suggested ideas seemed too vague to be commented. The ways of working of the designers and the consultants did not seem to meet in the process despite of attempt.

The role of the end-users was not expected to become a very dominant either. Our case can not be described as participatory design where the end-users attend as active members as Luck (2003) states:

> *When engaged in a participatory design workshop the people who attend are part of the social process of design and play an active part in the issue/problem raising, discussion and decision making processes that are part of the early design stage of a project. The people who are commonly known as the 'users' are active participants in the design process and hence the boundary between 'designer' and 'user' becomes blurred.*

6.3 Breaking through the manuscript

The forms of interaction between the designers and consultants were not predetermined and limited to the web-based environment. The participants were advised to utilize also other methods if the interaction was not found productive. Engeström (2004) notes that instruments can be used in many ways. Sometimes a technically demanding instrument can become an end in itself which displaces the original object.

In our exemplary case the web-based environment was not intended to be an ambition of the process, let alone complicate the interaction. Even though the face-to-face meetings were encouraged neither the designers nor the consultants did make an initiative to organize a meeting. Yet afterwards reflecting on the process both the designers and the consultants brought out their wishes for one or more collective meetings. On this sector the participants' actions follow the type of interaction described by coordination; the predetermined script was followed in such and the borders were not crossed or reassessed.

The end-users' type of interaction remained at the level of coordination. Each of the end-users formed an autonomous opinion of the presentations. Conversational interaction emerged neither between the designers and the end-users nor between the end-users as a group. Partly this was affected by the somewhat asynchronous communication. The networked environment in itself enabled also synchronous communication (chat object), but in practice all the participants were never simultaneously active in the environment. The biggest limitation of the end-users participation was obviously their participation in the process in a limited timeframe during their working hours. This led them to act as they were discharging their duties answering questions rather than engaging in the process as equal participants.

Their contribution was still seen valuable. The designers considered the end-users in the role of an acceptor or rejecter of the suggested ideas.

Even though the communication in the web-based environment did not manage to reach the level of dialogue on all accounts, the communication featured some aspects of it. The designing as a collaborative process proceeded inherently without a leader, even if the team was regularly attended by the project personnel. The same equal attribute of the process endured also in the web-based communication. This may have been largely due to the network environment which affected that the personality of the “speaker” was erased to a certain extent and instead the substance of messages rose as a centre of attention. On this behalf the environment succeeded in fading potential hierarchical relations between the participants which could have interfered with the interaction. At the same time some of the participants felt that the web-based environment sustained the participants as strangers since they were not familiar to each other before the process. The process was obviously also too short to eliminate the unfamiliarity between the participants. The feeling of unfamiliarity caused timidity as especially the consultants were sometimes shy to pose questions relating to the expertise of others.

7 Conclusions

In this case the network-based environment enabled an exiting potential of combining the expertise of designers, consultants as well as the end-users. The potential of utilizing the expertise of end-user appeared especially tempting as

a designer. The user is after all most qualified to evaluate the designed solutions from the perspective of his experience and purpose of use.

7.1 Design collaboration and learning

In the exemplary design case the web-based environment enabled and supported also learning and construction of knowledge. The learning processes involved in the case can be examined from four perspectives. (1) Each one of the participants learned something about the collaboration with different disciplines. As Dias-Kommonen states (2002);

> *Collaboration can subsequently provide one with new ways to look at his/her discipline. [---] As a form of learning, collaboration can expand one’s horizon: One gets to visit other disciplines, learn other languages.*

The process was especially educational as an authentic design task for the design students involved in the process as designers. Clashes of views and frustrating situations could not be avoided in the design process and in interaction in and out of the web-based environment. Misunderstandings and conflicting expectations based on different ways of thinking and acting were emphasized in the web-based activities interfering with the interaction. As Kim states (1990);

> *Different disciplines have different priorities, different thinking style and different values. When people from different disciplines get together, their values collide. What one person finds valuable others do not even notice. And they do not notice that they do not notice.*

But this is also the reason why the distribution of expertise and collaboration between different fields of expertise is productive from the point of view of design process even if it causes frustration to the participants.

(2) The concept design phase of product development process is also seen as a process of learning in both individual and organizational level. (Keinonen et al. 2003). From the designers the case required adoption of a number of new things in a short period of time. The web-based environment passed and preserved this information throughout the process and thereby enabled learning.

(3) For the designers the process was also a chance to develop their knowledge and skills as a designer through an authentic design process. The web-based environment as an instrument required also the adoption of new methods of working. Some of the designers were also motivated through the process to learn the use of new design software and utilize it in production of material for the web-based environment.

The production of informative presentations for the end-users and consultants proved to be an additional challenge for the designers. The particular challenge in communication by design artefacts through the web was asynchronous communication which prevented correction of misinterpretations in real time.

(4) In our design case the web-based environment was a new tool for most of the participants. The consultants and the end-users were also offered an opportunity for a private tutoring of the environment but only one of them asked for additional instruction after distance teaching. A general opinion of the web-based environment was that it was perceived to be at least somewhat advantageous tool in the process. This testing situation gave confidence to recommend use of the environment in our department also in the future.

7.2 What remains to be studied?

Communication and especially dialogue is seen as an essential component of learning on various occasions as well as a key element in collaborative design. In education of design students teaching and learning through design tasks is still in many ways the prevailing practice also in the academic level. However there still remains a lot of study to be done on the phenomenon of learning through design. The development of the academic design education as well as the development of tools for collaborative design in network-based environments should be supported by research on learning through design. In order to promote computer-supported learning in the context of design education there must be a basic understanding of learning involving the activity of designing where one of the salient points of focus is in the dialogic nature of design interaction.

Learning through design is a subject of research that could be best studied combining the expertise and views of multiple disciplines. Neither research based solely on perspectives of design nor pedagogical approaches can approach the subject comprehensively. This is why the subject needs to be brought into discussion in a multidisciplinary forum.

In relation to the use of a web-based environment in collaborative designing there is also need for research on questions about the utilisation of end-users' tacit knowledge in the process. As Luck (2003) states:

> *Explicit knowledge is readily available to designers in design codes and guides but the ability to reveal tacit knowledge is of particular value to the designer, knowledge that would otherwise not be available. The social process of participatory design and design dialogue has enabled the transfer of user knowledge to designers who may be able to use this knowledge for the users' benefit*

In order to reach a level of interaction that could be described as participatory the methods and tools for user-centred design should be developed as well. Additional research on how the web-based environment supports the participatory design process and the interaction between the designer and the end-user is needed also.

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New pedagogical models

Perspectives of Some Salient Characteristics of Pedagogical Models in Network-Based Education

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Abstract. This article discusses the use of pedagogical models as appropriate means of improving the quality of network-based education (NBE). NBE and novel kinds of teaching, studying, and learning environments have recently become an essential part of university-level education. In changing *ethos* of education, one special challenge is facing teachers, designers and researchers: the development of pedagogical models, teaching methods and practices that are applicable in NBE. We argue that by analysing some salient characteristics of NBE it will be possible to develop and evaluate NBE. It is also crucial to analyse how to learn to apply pedagogical models in NBE in an appropriate way. The aim of the HelLa Project was to evaluate university degree programmes in the educational use of ICTs in the Finnish Virtual University. The focus of this study was the 30-ECTS-credit study programme on the educational use of ICT, designed and implemented as part of the Finnish Virtual University Project of the Faculties of Education. The HelLa Project included three case studies in which students' and teachers' conceptions of applying pedagogical models in NBE were examined. The case studies combined qualitative and quantitative research approaches. Data were collected by using two web-based questionnaires for students, by interviewing teachers and students, and by recording the network-based discussions regarding the course assignments. The data were analysed by using content analysis, narrative analysis and statistical analyses. This article draws on the results of the three case studies regarding the conceptions of teachers and students on the application of pedagogical models in NBE.

Keywords: Pedagogical models, network-based education (NBE), educational use of ICTs, virtual university.

1 Introduction

During the past five years the network-based education (NBE) offered by the Finnish Virtual University has become well established. Discussion of developing university-level courses has focused on the pedagogical models, teaching methods and practices used in network environments, as well as on the creation of novel ways to teach, study and learn in these environments (see Britain & Liber, 1999). In the HelLa Project, the special aim was to understand how a high-quality studying and learning process can be supported by developing the use of applicable pedagogical models in network environments. At the same time the challenge was to foster a new culture of teaching, studying and communication in network-based education (NBE).

Pedagogical models have been regarded as tools in designing, implementing and evaluating NBE (Ruokamo et al., 2002; Vahtivuori et al., 2003a; on the concept of NBE, see e.g., Tella et al., 2001, 21). Pedagogical models have also been invoked in the effort to combine explanatory models in didactics and learning theory as well as in the experience-based knowledge, skills and competence of teachers and students (see e.g., Andersen et al., 1995; Dillenbourg 2002;

Banathy & Jenlink 2004). Previously we have referred to these as the teacher's *educational rationale* and the foundation of his or her pedagogical vision (Tella et al., 2001).

2 Aims of the Project

The HelLa Project, a joint research and development initiative of the Universities of Helsinki and Lapland [http://www.helsinki.fi/sokla/media/hella.html] that ran from 2001 to 2003, aimed to evaluate and develop the educational use of ICTs study programmes of the Finnish Virtual University. The particular focus of the research was a 30-ECTS-credit module dealing with the educational use of ICTs. The aim of the module was to familiarise students with the learning theoretical background of educational use of ICTs and media education. In addition, the societal impacts of the media were studied simultaneously with the educational practices of ICTs. The module was designed and implemented nationally as a collaborative contribution of the faculties of education at eight universities to the Finnish Virtual University Project of Educational Sciences [http://www.helsinki.fi/sokla/media/kasvi.html]. As many as 147 students attended the module. The research project contributed to the topical discussion on the design, implementation and evaluation of teaching, studying and learning environments (see Uljens, 1997; Kansanen et al., 2000) which are appropriate with regard to didactics, teaching methodology, and learning theory.

The three case studies from the HelLa Project deal with national pilot courses of the educational use of ICTs module, which was planned in 2001–2002 and implemented in 2002–2003. This article draws on the results of the three cases studies to present the teachers' and students' conceptions of the application of pedagogical models in NBE and their views on the features and principles of network-based teaching and studying (for a more detailed treatment, see Tissari, 2004b; Vaattovaara, 2004; Vahtivuori-Hänninen, 2004; Vaattovaara, 2003; Vahtivuori ym., 2003a; 2003b; Tissari, 2004a; Tissari ym., 2004a.)

The HelLa Project looked into how pedagogical models were reflected in NBE in the Educational Use of ICTs study programme. The researchers in the project redefined this research focus in the context of three case studies (Tissari, 2004b, 84; Vaattovaara, 2004, 54; Vahtivuori-Hänninen, 2004, 29). This article examines how pedagogical models were applied in NBE, and what aspects and salient characteristics of such teaching and studying featured most prominently in the network-based courses offered nationally by the Finnish Virtual University Project. This article examines students' and teachers' conceptions on characteristics of high-quality NBE and on applying pedagogical models in NBE.

3 Theoretical Framework

3.1 About Pedagogical Models

Joyce & Weil (1980, 1) define a pedagogical model as follows: "a model of teaching is a plan or pattern that can be used to shape curriculums (long-term courses of studies), to design instructional materials, and to guide instruction in the classroom and other settings". In this article, we use the term "pedagogical model" to refer to the models of purposive studying and the models of reflective instructional design and implementation that teachers, tutors and curriculum designers and students can apply in the teaching, tutoring and studying processes. (Tissari et al., accepted.)

3.2 Problem-Based Teaching, Studying and Learning

Problem-based teaching can be considered a means of organising a course and the instruction in a way which allows to use problems as the stimuli for and focus of students' work. In a problem-based course, the focal problems of the student's field of study or other real-life problems form the basis for studying and learning and skills development. The problem-solving situation is facilitated through various learning materials and other resources as well as through the support and guidance offered by the teacher or the tutor. Other key elements in this problem-based context are the students' previous knowledge and skills. Students often work in small groups or teams with the teacher supporting them in their learning and studying process (see Boud & Feletti, 1991, 14–15; Hakkarainen et al., 2004; Tissari et al., accepted). Problem-based studying is not a method or a teaching technique; rather, it can be considered an approach to teaching, studying and learning (Boud & Feletti, 1991, 21; Tissari et al., accepted.)

3.3 Reciprocal Teaching

Reciprocal teaching is based on the notion of sharing and combining expertise in teaching and studying (Palincsar & Brown, 1984; see Oatley, 1990). The model makes it possible to approach textual meanings collaboratively and to combine expertise among peers. The point of departure here is to encourage students to construct knowledge together but in a problem-based manner and the way that would best accommodate individual goals and needs in applying what is learned. A key element of the model is making the problem-solving process visible so that the presence and learning paths of other students become part of each student's own learning process. (See e.g., Vaattovaara 2004, 57, 68, 76) (Tissari et al., accepted.)

3.4 Collaborative Learning

Collaborative learning can be defined as an interactive undertaking with learning processes and outcomes that no student could have achieved on his/her own (Tella 1998; Vahtivuori, Wager & Passi, 1999). The basis of collaborative learning lies in the group having convergent aims. Particular emphasis is placed on the importance of having a common working process and on the background community, i.e., the organisational level (Sharan & Sharan, 1992; Tella, 1998; see Castells, 1996; cf. co-operative learning, Johnson & Johnson, 1994; Kagan & Kagan, 1994). In a collaborative context, studying and learning can be seen as a process of exploration and problem-solving and as a communal and dialogic, social event. In doing research with others, the student gains personal experience of the acquisition of scientific knowledge. According to Dewey (1943), purposive studying and meaningful learning occur through collaborative exploration. In the course of the collaborative learning process, the student's responsibility for and organisation of his or her studying expand to become communal rather than individual responsibility. (Vahtivuori, Wager & Passi, 1999, 269–270; cf. Eteläpelto & Tynjälä, 1999.) Collaborative learning is seen in practice not only in the student's work but also in the teacher's pedagogical thinking and in the way instruction and guidance are implemented. In a network environment, collaborative activity is also significant when planning teaching, as experience has shown that it is more difficult to change the course of instruction in the teaching–studying–learning situation itself. (Tissari et al., accepted.)

4 Methods and Approaches

The research strategy in the HelLa Project combined qualitative and quantitative research approaches. The research design was ethnographic in nature (Hammersley, 1990), the aim being to gain as rich and comprehensive a picture of the research focus as possible. The data collection methods comprised two network-based questionnaires (N=55 and N=38), interviews of students (N=5) and teachers (N=5), and recordings of the network-based discussions regarding the course assignments (N=109, 400 pages). Different forms of analysis were used: content analysis, statistical comparisons and descriptions, and narrative analysis. The observations, analyses and interpretations presented here are based on the students' responses to the two questionnaires, the views and experiences presented by teachers and students in the interviews, and the recorded discussions. (Tissari et al., accepted) Narratives were considered as referential memories and experiences of the students. They were constructed to texts in reflective discussions and interaction between different actors of network studies.

A sociocultural or contextual approach is based on theories of Vygotsky (1978). Our approach is based on psychological and methodological reflections geared towards an internationally-growing trend of research. Our theoretical background thinking is grounded in the intersubjective ideas rooted in the zone of proximal development and in the results of cognitive anthropology of communities outside of the schools. (See Lave & Wenger, 1991.) Learning is bonded to different contexts, cultures and situations that are based on collaborative activities (Miettinen, 2000, 281). In this study, socioconstructivism and a sociocultural approach have opened possibilities to study the activities of groups and network communities as well as learning and studying as a social development with all successes and stumblings.

5 Results

In what follows, we will present some findings and related interpretations of the three case studies where the application and some salient characteristics of pedagogical models are concerned. We will examine the views of students and teachers on the pedagogical models that were applied in the national pilot courses and on what they considered to be the central characteristics of high-quality network-based teaching and studying.

5.1 Some Salient Characteristics and Principles of NBE

Our analysis of the courses revealed a number of salient characteristics and principles of network-based teaching, studying and learning. In the views of the students, the foundation of the courses lay in 1) shared and integrated expertise, 2) the active involvement of the teachers, 3) teaching and guidance as support for network-based studying, 4) a sense of community, dialogicity and 5) the prominent role of discussion. Other essential elements of network-based courses at the university level are that they are theoretical, research-based, and critical in nature; argumentation plays a significant role in them and, in addition, they are problem-based, student-centred and purposive. (Tissari, 2004b; Tissari et al., 2004a, 108; Vaattovaara, 2004; Vahtivuori-Hänninen, 2004.) The above-mentioned characteristics can be regarded as crucial principles in any university pedagogy and are thus not elements essential or unique to the network context only. Network environments and groupware offer a variety of opportunities for developing the capacity for criticism, argumentation and reflection, for example, and also support problem-based and student-centred activities provided that interaction and students' network-based discussions are guided in accordance with the principles of problem-based and exploratory learning. With different uses of pedagogical models we can create a new culture of studying and teaching in network environments. Those cultural practices are not functioning only as individual methods or as tools of learning. The purpose of using pedagogical models is to give devices which would help to commit oneself to collaborative, communal and experienced-based purposive studying with critical reflection.

5.2 Collaborativity, Dialogicity, Critical Thinking and PBL as the Characteristics of High-Quality NBE

In the views of the teachers and students, the most worthwhile characteristics of pedagogical models and principles in the design and implementation of NBE were those that supported collaborative activities, dialogicity, critical scientific thinking and problem-based studying. By adhering to these principles and models, the teachers and tutors felt that they were able to support the students in understanding the relevant subject matter thoroughly, in assessing information critically and in producing new knowledge. (Tissari et al., 2004a, 108; Vahtivuori-Hänninen, 2004, 33–34.) The teachers indicated the following as characteristic of the successful design and implementation of NBE: 1) consideration of the situationality of the teaching, 2) support for communication, interactivity and dialogicity (including written communication skills), 3) planning and modelling, 4) clarity and simplicity of materials and guidance, 5) reflectivity, 6) trust in the students, and sincerity and commitment on the part of those giving guidance (Tissari et al., 2004a, 108–109; Vahtivuori-Hänninen, 2004, 51–52). The teachers' responses stressed the situational nature of teaching and studying and the need to support communication. These are features that have not been sufficiently prominent in earlier models. The network teacher needs a rich array of written communication skills if he or she is to encourage genuine dialogic and collaborative interaction. In NBE, students must also be given opportunities to reflect on their studying and the subject matter. (Tissari et al., 2004a, 108–109; Vahtivuori-Hänninen, 2004, 33–36.)

5.3 Commitment and Grouping

According to the views presented by the students on the web questionnaires, commitment on the part of teachers and students to the teaching–studying–learning (TSL) process is an important condition for high-quality NBE. The students stressed the importance of their own proactive involvement and commitment to such study but also pointed out the importance of teachers and tutors as sources of support in studying and learning. (Tissari et al., 2004b, 91–93; Vaattovaara, 2004, 65, 71.) According to the students, working in groups contributed to the working atmosphere, which was considered open but hectic in the courses studied here. Optimally, collaboration was inspiring, encouraging and challenging even though one did not know the other members of the group beforehand. The students indicated that successful commitment and a sense of community depended crucially on whether the student was truly interested in the educational use of ICTs or merely in completing his or her own projects and course work. (Vaattovaara, 2004, 71.)

5.4 Collaborative Learning and Reciprocal Teaching Models and the Importance of Dialogue

The research brought to light how pressures for individual achievement and anxiety about one's level of knowledge being revealed were both reduced in collaborative learning, where the goal was a jointly agreed outcome and, optimally, combined expertise. In NBE, as in other forms of teaching, a teacher's pedagogical proficiency comprises his or her expertise and skill. Under optimal circumstances, the skills of other experts and the peer support that become available on the network can bring numerous new perspectives on the subject matter at hand, making possible the co-construction of knowledge (Tella & Mononen-Aaltonen, 1998, 62). However, the students pointed out that it is very challenging and demanding to plan a teaching-studying-learning environment and the associated expert culture that supports socio-cultural dialogue. (Vaattovaara, 2004, 68, 75.)

5.5 Experience-Based Knowledge and Participation in Discussions

In discussions considering the learning theoretical basis, the students emphasised different aspects: noticing the student as individual, collaborative working groups, social construction of knowledge and assessment. In narratives teachers' conceptions of learning and pedagogical proficiency seemed to relate with the personality of the teacher. The best memories of thoughtful and reflective studying and learning were those experiences, when the students were treated like 'students', but also as equal human partners or group in discussions. (Vaattovaara, 2004.) University teachers should approve that the student's knowledge can differ from theirs: it may happen that throughout discussions and an exchange of opinions and experiences, the students find answers that are not promoted or inspired by the teacher (see Naskali, 1998, 130).

5.6 Use of Pedagogical Models in NBE

On the basis of the teachers' experiences and the open-ended items on the questionnaire administered to the students, three different ways of using the pedagogical models could be distinguished: 1) planning of instruction on the basis of the model; 2) combination of models; and 3) a varied use of the models depending on the TSL situation. The value of the pedagogical models comes then to the fore in practice. The models can be understood as representing the middle ground between the teacher's theoretical thinking and practice: they do not directly describe the reality of teaching and studying but provide teachers with a tool to set out the structure of their course in advance. The teachers felt that the culture-bound nature of the models (*ethos*) should be better taken better into account (Tissari et al. 2004a, 108–109; Vahtivuori-Hänninen, 2004; Tissari et al., accepted.)

6 Conclusions

This article has analysed some key results of three case studies of the HelLa Project with regard to the conceptions of teachers and students of certain salient characteristics of NBE and of the application of pedagogical models in NBE. This study shows that the models were applied to the teaching process but not necessarily consistently or even consciously when planning and implementing the courses. On the other hand, a number of specific characteristics of teaching and studying could be regarded as important points of departure for the course. These factors prompt the questions which pedagogical models, characteristics, and principles are most applicable as a foundation for teaching and guidance when considering the goals and contents of the good quality net-based course and purposive studying. Teachers and tutors articulated their pedagogical thinking and educational rationale clearly. It would also be fruitful for the teachers to co-operate with the students when applying different models, principles and practices in a network-based course, for this is one way to promote development of students' thinking and metacognitive skills. Particularly in the case of the Finnish Virtual University network-based courses on the educational use of ICTs, it seems worthwhile to assess what kinds of models and principles are applied and how successful they are, in as much as one aim of the courses was that the students should become familiar with the pedagogical potential of ICTs. Purposive studying, i.e., the setting and pursuit of goals, as well as the evaluation of the extent to which they are achieved, is not only a precondition for meaningful learning but also a necessary point of departure in helping students master the knowledge and skills they need in educational uses of ICTs, and in order to become teachers and tutors capable of developing and evaluating their own work on a continuous basis. (Tissari et al., 2004a, 108–109; Tissari, 2004b, 100–102; Vahtivuori-Hänninen, 2004.)

Educational institutions must respond to the new educational goals as well as to the changing challenges of society. One purpose of using pedagogical models is to present choices and means which draw on learning theory and on didactics, and through which students become committed to purposive studying both communally and collaboratively. One aim of the models might be to combine expertise in the way that would encourage the students to take more responsibility for their studying and learning through peer support. Pedagogical thinking means that the approaches chosen are continuously reviewed by the teacher and the student alike. Teachers' choices can be seen as linked to choices of pedagogical models and applications through their educational and professional socialisation and their role as experts (see Vaattovaara, 2004, 77; Vahtivuori-Hänninen, 2004). These choices in turn are connected with the students' own educational experiences and conceptions of learning. However, it is every bit as important that we continue to study what reasons students and teachers give for the choices they make in different teaching and study-related situations (see Kansanen, 1996, 45–46; Jyrhämä, 2002). The position of the teacher and the student can also be examined by considering the teacher as a social actor and the student as a participatory actor—in constructivist terms, a person who actively constructs knowledge.

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The features of playfulness in the pedagogical model of TPL – tutoring, playing and learning

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The aim of this study was to develop a theoretical and pedagogical model for planning and evaluating play and games as learning tools. The model is also useful for evaluating playful learning environments (PLE). This research is a part of the Let's Play project in which purpose is to design and construct playful learning environments for primary schools. The pilot projects of PLE are located at Rovaniemi, Finland.

We utilised theories of playing and learning, including definitions of mature play, and empirical data collected during the Let's Play project. The data particularly highlight children's view on playing, playful environments and embodied experiences. The data was collected via participatory observation. It revealed the playing worlds of 6-year-old children (N=49). Children, inspired by short frame stories, created playing worlds by drawing and discussing. More data, collected by the story-crafting method, produced everyday experiences, desires, fears and events (N=161). Further data, collected by interviews and observation at a sporting environment and qualitatively processed, revealed how children and educators (N=58) experienced playing when directed by pre-plotted stories and sensory system.

The concept of *playfulness* comprises six salient features; *embodiment*, *collaboration*, *action*, *narration*, *creativity* and *insight*. Playfulness refers to activities, environment and personal traits. These six features of the TPL model comprise the processes of tutoring, playing and learning. **T**utoring means both teacher action, peer support and environmental factors that support, guide and encourage children. **P**laying is defined as actions that afford learning. **L**earning occurs through embodied experiences. The TPL model can be used for designing and evaluating playful learning environments and providing their actional content.

Keywords: Playing, tutoring, learning, playfulness, learning environment

1 Introduction

In this article we define the pedagogical *TPL model* that represents the processes of *tutoring, playing and learning*. We also introduce the concept of *playfulness* and its six salient features. We offer the model for use in the practice of primary schools, where playing is integrated into curricula and daily practices. Playing is understood to cover both playing and a variety of games, including digital games. The pedagogical TPL model interlinks with the Let's Play project, where three doctoral theses have examined how playing is utilised in the processes of learning and growing and what kinds of qualities playfulness requires of the learning environment.

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Learning environment is defined through different views (Core curriculum for pre-school education in Finland 2000; National Core Curriculum for Basic Education 2004). First, it is a physical environment; in this case, built on the yard of a school. Embedded technology is a part of the physical environment. We see physicality in another way; environments offer possibilities for physical activities. Second, the environment is an entity of mental elements, where the significance of emotions should be considered. Third, the environment is an entity of social relations, where collaboration and joint activities of boys and girls should be taken into account. The fourth view emphasises environments as cultural constructs.

Classrooms as learning environments afford limited possibilities for physicality and activity, which are required for learning. The active role of learners will expand when PLEs are taken advantage of. Then playing is comprised of physical, mental, social and cognitive activities that involve the whole body. The pilot playful learning environments are located at Rovaniemi, on the yards of two schools. It is significant to note that, along with our research, the extent of playing will increase since playing and environments that offer playful activities continue throughout the schools. We find that the traditional constructivist view of learning is inadequate because it stresses knowledge constructing and does not sufficiently take into account of the significance of emotions in learning and other activities. Emotional, cognitive, social and physical realities should be integrated (Norman 2004). They are included in our socio-emotional cultural view that is based on socio cultural theory (Vygotsky 1978). They are also contained in the features of playfulness, which is topical for designing learning environments. In addition, it is a meaningful concept in evaluating the quality of learning environments and the activities that are implemented in playful learning environments. We examined the concept of playfulness from different perspectives and have found six salient features. They are *embodiment, collaboration, action, narration, creativity* and *insight.* Our examination is based on theories of playing and learning and on our empirical data from: 1) creative sessions, 2) test playing and 3) story-crafting, which are briefly explained below.

1) Creative sessions. The first empirical data, which represents the playing worlds of children, was collected during autumn 2003. Six and seven-year-old children (N=49) in small groups (2–5 children) drew and discussed the features of their ideal playing world. The data created stories and so-called playing worlds (Hyvönen & Juujärvi accepted article; Hyvönen & Juujärvi 2004).

2) Test playing. More empirical data was collected at the Santasport Centre where technological applications are based on the interaction between a sensory system and the environment. We created 16 different plotted stories and transformed them into playful actions. Children aged 6–10 and adult educators (N=58) tested them and a memory game that is played by hopping on the floor. (Hyvönen et al. in print.)

3) Story-crafting. Another set of data comprises 161 stories by 5–10-year-old children, collected by the story-crafting method. (Hyvönen & Marjomaa 2005). In the story-crafting method, a child freely tells a story without any hints from adults who merely listen very carefully. In addition to listening, the adults must write the story down in the presence of the child – exactly as it is told. Then she/he reads the story to the story-teller who has an opportunity to change or retell her/his story. (Karlsson 2003.)

We have listened to children's voice. Through this data, we get close to their unique culture that they construct through stories and playing (Corsaro 1992, 2005; Karlsson 2003). It is important to listen to children's voice once we take playing into the school context where measurable cognitive achievements are often emphasised. What does TPL and playfulness imply in the school context? In the following chapter we describe the process of the TPL model.

2 TPL pedagogical model that embodies processes

The pedagogical TPL model is composed of tutoring, playing and learning. In addition to these elements, the features of playing that refer to action and environment are included in the model (Figure 1). The structure of TPL is based on the model of Teaching-Studying-Learning (e.g., Uljens 1997; Lehtonen, Ruokamo, & Tella 2004; Tella & Ruokamo accepted article) where teaching represents teacher action, studying student action and learning, as a neurobiological event, subsequently takes place for some time (Uljens 1997; Lehtonen et al. article submission to NBE 2005). In the TPL model, tutoring replaces teaching, and playing replaces studying, while playing conveys learning.

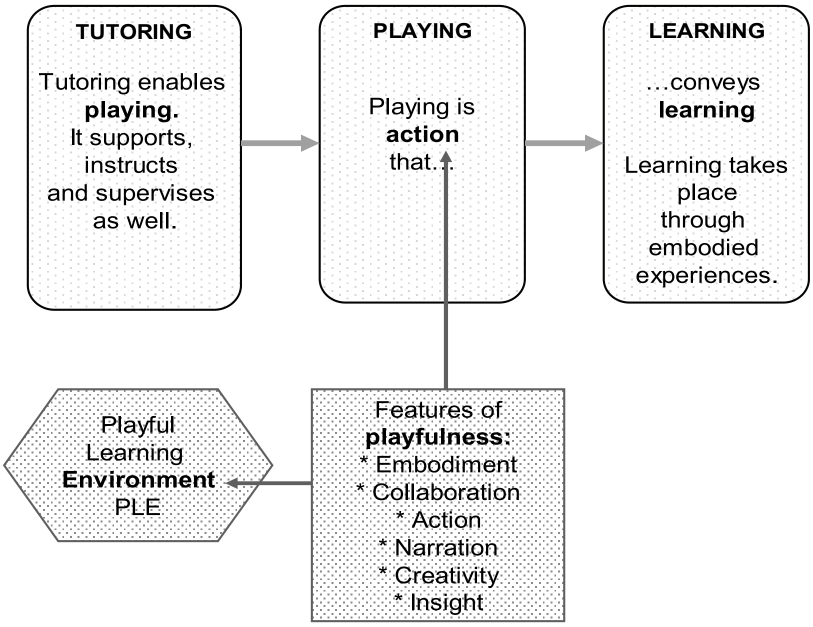

Figure 1. The elements of the TPL model and the features of playfulness that refer to action and the environment

Figure 1. illustrates the elements of the TPL model and its salient features. Tutoring (T) primarily implies teachers' and educators' planned and intentional action when they transform children's environment and also tutors' and guides' playful activities with children. In addition to teachers and co-learners some tutoring tasks can be performed by technological applications, like agents that are implemented in the environment. Playing (P) is a form of activity that is expected to provide learning (L). Six salient features of playfulness are embodiment, collaboration, action, narration, creativity and insight. They indicate the quality of action and the environment.

3 Tutoring, playing and learning in the TPL model

In this chapter we examine tutoring, playing and learning in the TPL model. Tutoring is seen from two points of view: teachers' intentional tutoring and environment that affords tutoring. Secondly, we compare playing to digital games. Finally, we discuss learning that emphasises bodily experiences, zone of proximal development (ZPD) and mediating artefacts.

3.1 Tutoring

Intentional tutoring can be called education that implies pedagogical and intentional actions whose aim is to influence a child (Kivelä 2004). These actions can focus on a child or her/his environment once an educator transforms the environment in order to provide learning and growth (Sutinen 2003). Hakkarainen (2002) states likewise that an adult affords playing and learning by creating suitable environments and situations. Consequently, a child can be an active learner that examines, inspects, wonders, constructs and asks questions. Teachers and other tutors should support and help children in this process. Children usually do not have enough knowledge about the events, different roles and language involved in these roles. Teachers' duty is to guide children to find information and to expand their repertoire of roles. In addition she/he should encourage children to use verbal and body language and embodied expressions, and helps them in designing playful activities. Designing games and studying different roles and contexts are important parts of the learning processes.

Another view of tutoring deals with environments that afford tutoring. Tutoring is involved in the concept of *affordance* (Gibson 1979), because it manifests processes that bind children and teachers together with the environment. Once we are interested in playfulness, we expect that the environment, technology and people afford playful action and learning. Affordances alone are not sufficient, but allowances are relevant, because affordances do not actualise until allowances do. Allowances are information and cases of principle, if participants perceive them, are led by them and are capable of utilising them in playing. Studies have shown how people adjust their action to suit their environment and how they orient themselves towards relevant attributes in their environment (Gaver 1996). Environments with embedded technology should enable adaptation according to participants' goals and needs. An environment with embedded technology guides tutors or participants by providing information about its attributes. In addition, it expands interactivity by offering feedback that guides ongoing activities. Feedback may occur as verbal, auditory, visual and tactile sensations. Feedback is not only reflection but it actually gives topical information for children about their ongoing activities. In the following chapter we examine more closely such activities, namely playing.

3.2. Playing

According to Callois (2001) play is free activity: it is not obligatory. At school playing is not as free as it is in kindergarten and preschool; playing brings, however, more playful freedom to school context and offers children more physical activities than traditional learning methods. According to Callois and as in our definition, playing is seen as separate activity: circumscribed within limits of space and time, defined and fixed in advance. The demand of uncertainty (Callois 2001) takes place in creativity that is encouraged in playful processes. Make-believe and rules are always present in playing, but the definition of unproductive (Callois 2001) is not pertinent at school. Playing and games are creative processes where children may produce something else than imaginative things, e.g. handicrafts, piece of arts, posters, stories or songs. We see that playing is not limited to the actions that can be seen as playing, but also planning, preparing and ending are part of the activity of playing. For example, the preparation of role-playing may take more time and effort than actual playing.

Playing and games share similar characteristic but also have differences. In the following, we compare the characteristics of playing with those of games, as discussed by Ermi et al. (2004) and Manninen (2004). Such comparison of characteristics is a rough guideline and, by itself, does not cover the different varieties of playing and games.

Games have 1) *pre-planned structure*. In playing, the initial structure is often planned in advance but it is not fixed and can be altered during playing. The test playing at the sports centre was based on a pre-planned structure that was entered into a computer program. It was our experience that this limited children's options for constructing a plot. Games have 2) *rules* that must be observed in order to make progress. Playing also has rules but they may be adapted during playing. One can state that socially conditioned rule change in playing is an indication of players' creativity and insight. Games have 3) *conflicts* and the goal of game play is to control them. Playing, as well, may involve conflict. Cognitive conflicts are productive moments of negotiation that serve the goals of insightfulness, for example. It is necessary to solve social conflicts in order for playing to continue. Games tend to measure 4) *achievements and failures* (winning and losing). This may be the greatest difference between playing and games since in playing the process itself is in primary focus. Though challenges and winning are important in games, it is important to bear in mind that how to devise a winning strategy and means to achieve the goals are significant as well.

In games, or rather in the activity of games, 5) *a combination of luck and skill* is necessary. This is usually not central in playing. Games are required to be 6) *interactive*, the significance of which is emphasized and altered in situations where the participants do not have eye contact. In playing, children's interaction is frequently close and intensive. Games are also supposed to be 7) *physical*, which implies applications of physical interfaces, among other things. Playing is a physical activity, and the body may be characterised as the "interface" of playing.

Event though the TLP model emphasises the significance of playing and games, they are not automatically beneficial processes. The *play evaluation continuum* introduced by Johnson (2004) illustrates the character of different games and forms of play and their influence on the growing child. This involves evaluating activity according to whether it promotes the child's divergent thinking, imagination and creativity, whether it supports the child's personality development and enhances social interaction and social cohesion. On the other hand, the negative effects of activity are also evaluated: whether playing or a game is psychologically harmful to the child, other children or the environment. For performing this evaluation, teachers and other educators have a key role.

3.3 Learning

The fundamental idea of the TLP model is that learning occurs through physical experiences. We refer to Johnson (1999) according to whom experiences, concepts and thoughts are realised neurologically but never independently, solely neurologically. Neural networks only develop in interaction with the environment, which requires that the entire body must be seen as a system of perception, experience and thinking, i.e., interaction (Johnson 1999).

According to theories of cultural history, or social development, learning is viewed as social activity where the interconnection of language and thought is crucial. Although the cultural historical model, while emphasising language and thinking, fails to pay enough attention to embodiment and the emotions involved, the concept of *zone of proximal development* by Vygotsky is significant from the points of view of learning, playing and embodiment. The zone of proximal development describes a domain where the child is able to function well when supported by someone more capable. In group activity the zone of proximal development refers to action where the members of the group create, through interactively constructed support, what would be impossible for them in isolation. Frequently, playing makes it possible for children at different stages of development to learn emergent skills and understand emergent knowledge. (Vygotsky 1978.)

In the TLP model, learning can also be examined through the symbols presented by Hakkarainen et al. (2004), of which knowledge creation describes learning as social effort to comprehend a topic and develop it in an innovative knowledge community, in this case through playing and games in school. According to the symbol of knowledge creation, mediating factors, in addition to interaction of individuals and communities, are significant for the learning process, for they promote organisation and actualisation of knowledge. Such mediating factors include physical structures of a playful learning environment, information and communication software as well as the practice of playing and games. Through support of the mediating factors, children's creative and logical thinking develops during playful activity (cf. Ko 2002) because this involves negotiation on the meanings of objects and issues. This implies that thinking is made visible and understandable – issues are assigned meanings, interpretations and designations. What is interesting is that, in playing, the process itself is significant and that the outcome of the activity may be open-ended. Although we emphasise, in connection with this process, socio-emotional group construction of knowledge and creativity, no single theory of learning is sufficient for explaining the learning process of children. Children learn in many different ways. For example, trial and error may lead to learning motor skills or training social skills. It is a question of holistic learning where it is equally important to learn social, motor, emotional and cognitive skills.

4 Six features of playfulness

In this chapter we examine the features of playfulness in more detail. They are used to plan playful activity for basic education and to assess both activity and learning environments. These six features are chosen on the grounds of (i) our three datasets and (ii) current theoretical views of playing and socio-emotional learning. The features are interconnected and somewhat overlapping. The examples from our empirical data cited in the text serve to reinforce our understanding of the significance of these features for children and tutors. The role of playing and games in activity is crucial, and playfulness describes the quality of activity and learning environments. Playfulness may also refer to the characteristics of participants. Playful individuals are guided by what is completely novel to them. Consequently, innovation, spontaneity and creativity correlate strongly with playfulness (Dunn 2004). The concept of playfulness stresses the idea that activity itself is significant and that the function of playfulness is not only to induce performance of tasks related to learning. The concept emphasises the nature of a process where playing and games are elements of such a process but their role and format are determined in everyday practice.

4.1 Embodiment

The significance of embodiment is apparent in the view that human neurobiological systems and body function together, in interaction with each other and with the environment and other people. As the human mind is also embodied, abstract thought is not isolated from the sensory-motor system but, on the contrary, is based on it. (Johnson 1999). The concept of embodiment refers to what a person experiences, knows and feels in her/his body and how she/he interacts through her/his body with other people and the environment (Hyvönen et al. 2003). The body phenomenological view (see. Burkit 1999; Johnson 1999) emphasises the quality of experiences, which stresses emotions because they afford us valuable information about the state of our bodies and their relation to ongoing activity, such as playing and games.

Different manifestations of embodiment, especially experiencing emotions, are obvious in our research data, for example in the playing worlds of children (creative sessions), that express elements of caring, horror, excitement, satisfaction, aggression, humour and security, among others. Also the story-crafting data reveals the significance of emotions, especially in peer relations. Concerning emotions, children express their embodiment in many ways, for example, by adopting views on moral issues, by showing caring or lack thereof, by determining objects of desire and by telling stories of both fearfulness and empowerment. Children also address hunger, cold, illness, death and embodiment, among other things. During the test playing at the sports centre, an overweight child was overjoyed to realise that he was the heaviest and the strongest: *I made it through with arm strength, I'm the heaviest and I'm the strongest of all. I'll be coming back.* (test playing). So the limitations may become strengths in some sense.

Embodiment is related to one of the characteristics of mature play by Bodrova and Leong (2003) that emphasise bodily and verbal interaction. Also games provide a channel for experiencing forms of embodiment. Role games can be compared with role play because they involve the gamer or player as if claiming the body of another. The roles enable different positions, for example, so that a player is alternatively the recipient or provider of help or the maker or executor of decisions. This was clearly reflected in the creative sessions of playing worlds because each child had two roles, that of a planner and that of a player. While children created play environments they also played in the environments so created. It is easier to have emotional experiences when functioning within various roles than when being one's own self. Moreover, role play trains the ability to perceive and interpret emotions and intentions of other players (Bendelow & Mayall 2002).

The emotions and the so-called manifestations of embodiment of various types can be viewed as significant factors in the processes of tutoring, playing and gaming, as well as that of learning (Lehtonen et al. in print). Emotions and the tendency to assess experiences on the basis of their pleasantness and unpleasantness are not only background factors for action, inclination to study and motivation but influence, parallel to Damasio (2001) how one plays, whether one plays at all and whether one remembers the issues processed during play. We do not only learn from our environment and our own actions but, especially, from other participants. That is why we examine, as the second feature of playfulness, collaboration, which is required for conveying, assessing and comprehending models and for accepting oneself and others, among other things.

4.2 Collaboration

In the context of playfulness, collaboration refers to different manners of social cohesion and cooperation and collaborative construction of knowledge. Collaboration has a special role in role play and role games. According the definition of good play (Bodrova & Leong 2003), collaborative action requires both major and minor roles. For example, test playing at the sports centre included, in addition to police officers, people in need of help, people and animals in traffic and other police station personnel. It was interesting to observe that both boys and girls acted collaboratively, helping each other, in situations where group members needed to look after each other. Our data also suggests that, in the collaboration of girls and boys, girls and boys have an opportunity to learn from each other cultural skills corresponding to the opposite gender.

From the point of view of collaboration, it is important to circulate roles so that each player is given an opportunity in her/his turn to experience so-called 'momentary mastery' and thus practice, by assuming roles, different skills and actual social interaction, which she/he might not be able to experience otherwise. Roles also enable children to practice the language, intonation and vocabulary appropriate for different situations. Stage plays and stories in their various forms constitute important expressive training. Collaboration is important also when rules are agreed on and observing them is practiced. All playing has rules, including role playing (Vygotsky 1978), and it is important to come to an agreement so that all can accept them. The importance of rules comes up, if they are broken: breaking rules also interfere playing and games (cf. Huizinga 1980). During the test-playing at the sports centre we observed how essentially how rules correlate with the logic of action applied. The following quote demonstrates that the rules were defective and were not understood identically be all. *Janitor cats-play was nice and it had Sepsu that was peering about but it was a little annoying that he was peering at me all the time. It was no wonder that Markus got past her.* (test playing). The rules of good play are clear, and observing them during playing or a game trains the child to understand that she/he cannot act solely according to her/his desires in social interaction. (Bodrova & Leong 2003).

According to creation sessions, the imitation of other children and especially humour afforded collaborative ideation among children. In addition, spontanious and funny ideas flourished. The fun in these ideas was based on comical rules that are known implicitly. From the adult viewpoint this kind of humour represents mostly slapstick comedy, but is valuable because it gives impetus to collaboration. Girls manifested a little bit different humour than boys, for example imagining with upside-down –world. However, humour is important channel to encourage collaborative thinking and acting among both gender.

In connection with interaction and shared rules, we also refer to collaborative thinking and language that is used to construct knowledge and understanding (Mercer 2000). Language is not only a channel for conveying information but a system of collective thinking (cf. Corsaro 1992). Through language, an intellectual network is set up; in this network experiences and problem-solving processes become meaningful. (Mercer 2000.) The playful activity of the story-crafting data – expressed via language – took place in social context with peers and family members. Children collaboratively created the emotional environments in small groups, as was the purpose of the creative sessions/in creative sessions.

4.3 *Action*

We define action primarily as physical activity that, in view of the other features of playfulness, invariably is experiential. Learning through playing (Roussou 2004) or learning by doing (Dewey 1957) are points of view that are emphasised in playfulness. Dewey (1957) downplays individualised knowledge construction in the classroom that tends to increase competition among learners. A competitive setting, in turn, decreases collaboration. Competition should be replaced with options for active pursuits, experiential action and knowledge about the significance of activity. (Dewey 1957.) The test playing at the sports centre demonstrated that children tolerate deficiencies and weaknesses that occur during the development of the environment and its technology as long as there is meaningful activity. Price and Rogers (2004) confirm that physical activity and interaction with physical environment strengthen commitment to and activity in learning. Active play involves physical exercise, as in the case of the play scenario of *Janitor and three cats* (test playing) that was based on a short adaptable frame story, rules and surprising turns of events. After playing, children reflected on collaborative action, as the following quote illustrates. Antti is praised by his friend who received help from him in the game. *Antti, you were really nice. When I was over there and you touched that I could get out of that tube and move over.* (test playing) One can state that when activity is meaningful for children it also engenders discussion among them.

According to the story-crafting data, action is a factor that consolidates girls and boys. Their mutual forms of action are concentrated in adventures and treasure hunts set at sea, on islands, in space and in wilderness. Actional format was prominent during creative sessions, involving volcanic mountains, caves, waterways and forests. Although in these data action is primarily connected with nature, built environments with various equipment and playhouses occupy children's minds. What is again significant in them is that they make experiential action possible, and this should involve active physical interaction with a physical learning environment. According to Price and Rogers (2004), an active learning environment requires that children are aware of and understand the physical and digital worlds, learning experiences are authentic and there is collaboration. The challenge is to offer children options for such activities that would facilitate ever more physical interaction with their environment. Action becomes goal-oriented through narration, which we examine as the fourth feature of playfulness.

4.4 *Narration*

In playing and games, plotted stories are created and acted out, which allows a multiple means of creating narration, for example, with rhyming, gestures, music or pictorial collages. The playing can involve role play, stage plays or experiential adventures. Coherence of content is fundamental to plotted playing. Collaborative playing pursues, specifically, in addition to collaborative construction of creativity and knowledge, understanding of one's self and others. Narration also serves to reinforce memory since, for example, a photograph of a day's activity may retrieve a story acted out during playing. According to Crossley (2003), we combine isolated factors, whereby a photograph may produce a complete story. A plot constructs a comprehensible whole and thus enables remembering. In teaching we should pay more attention to acquiring narrative thinking because its vital role in our daily lifes. In addition to understanding, remembering and learning facts, narratives teach humanity, like social interaction (McEwan and Egan 1995). In story-crafting and creation sessions it could regularly be seen that children operated with relations, both with humans and animals.

A characteristic of good play is related to play duration, which is related to the plot. Playing may be of short or long duration, sometimes continuing for months or even years (Hakkarainen 2002; Karimäki 2004). Good playing is not confined to short periods of time but can always be continued, which often happens when the themes and the plot have been developed by children themselves. During playing that maintains the same themes for long periods of time children create imaginative situations, introduce new roles in the playing and invent new meanings for objects and the environment. (Cf. Vygotsky 1978; Hakkarainen 2002.) The players have the option to negotiate on play themes, which need to be sufficiently flexible for introducing new roles and subplots while playing is in progress. Themes can combine different environments and participants – this occurred during the creative sessions for playing worlds by preschool boys. Home, ocean, castle, pond, president, tortoise and protected tigers were combined. The processes where boys created plotted story provided scenario which can evidently seen also by Huizingas (1980) viewpoint: playing makes and keeps order and harmony.

During the test playing at the sports centre children constructed, after an actional play scenario, a plotted story on the strength of five assisting words. In the actual playing, the task was to find the following five words: magic, map, crab, flag and quicksand, and then tell a story where these words occurred. It was interesting to note that, in the beginning of the story, the children were external narrators but as the plot unfolded they continued narration through the roles that they had constructed. Stories actually are an effective means of self-expression and facilitate expressing different, occasionally conflicting experiences (Wortham 2001). Telling stories both requires and demonstrates creativity, which is the fifth feature of playfulness.

4.5 *Creativity*

As knowledge is constructed collaboratively (Hakkarainen et al. 2004), creativity is similarly constructed according to our observations. Here one needs to pay attention to imitation and humour because they can free up thinking and imagination and generate an atmosphere conducive to creativity. This occurred during creative sessions where humour assisted meandering into unusual and even unconventional fantasy and allowed the creative process to begin. Imitation, in turn, appeared to be constructed so that a core idea was developed together through fantasy. (Hyvönen & Juujärvi accepted article; Hyvönen & Juujärvi 2004.) Imaginary situations, equipment and environments constitute the context of good playing (Hakkarainen 2002; Bodrova & Leong 2003). For example, the testing environment of the sports centre was transformed through imagination during playing into an apartment block teeming with cats, a bogey mountain full of deadly mushroom or a city with heavy traffic.

On the basis of these examples, one can state that there are creative individuals and processes, products that indicate creativity and environments that support creativity (Uusikylä 2002). For our research, it is important to identify such factor in the learning environment that foster participant creativity and facilitate their creative processes. Allowing an atmosphere of creativity alone promotes attaining theses goals. Allowing such an atmosphere also implies accepting diversity and requires encouragement from families and schools. In the context of allowing creativity, one must also assess the competitive settings of learning environments because competition tends to inhibit creativity. (Uusikylä 2002.) Instead of competition, creativity has been made one of the goals of the information society. In addition, well-being and enriching interactions are included in the ideals and goals (Himanen 2004).

4.6 *Insight*

Insight refers to problem-solving situations and to making observations and conclusions. According to Jarrett (1998), playfulness makes people “play” with a problem and thus enables them to solve it. Playfulness also refers to the ability to wonder and ask novel questions. Playing that requires and fosters insight includes various types of adventure and role playing where players encounter novel issues and situations. Insight and narration are combined in action so that problem-solving tasks and situations are included in the plot. Children, then, recognise in their action, through the story, the content as an intact whole. This is important for collaborative action in order to maintain the idea of a story in interaction with other children, which requires that the participants are able to negotiate (cf. Roussou 2004). Although the essential collaboration of players and gamers often promotes thinking and creative learning, the effect may be the reverse in some situation. This happens, for example, when children are instructed to do problem solving and not given feedback (Tudge 1992). The significance of feedback is also emphasised in view of individual differences among children as, for example, in problem-solving situations contained in a game some children employ sophisticated models for solution while others proceed by trial and error. (Ko 2002.)

During the test playing at the sports centre we observed that so-called defects may become positive experiences from the point of view of insight. Both the computer system and the ready-stored play scenarios were new to the children and partly highly problematic; the occasional clumsiness produced by the scenarios and the software increased interaction and cooperation among the children so that they were forced to solve problems together during playing and support each other when facing problematic situations. The question *‘What was the funniest thing of the test playing?’* mostly generated answers where *physical exercise* was considered as the funnies element. In addition, various problem solving tasks was described as being cheerful, as the following excerpt shows: *When you had to look for those codes* and *it was fun when you were looking for animals*. (Test playing.)

5 Conclusions

In this article, we have defined a pedagogical frame of reference, the TLP model, which is constructed of the processes of tutoring, playing and gaming as well as that of learning. In addition, we have defined the concept of *playfulness* and the six salient features that describe playfulness, namely *embodiment*, *collaboration*, *action*, *narration*, *creativity* and

insight. Our theoretical frame of reference can be utilised in educational practice, for designing learning environments and activities for them and in theoretical examination of playing, gaming and learning. The goal of the pedagogical TLP model is to guide basic education practice to pursue more actional and embodied directions. Constructed outdoor learning environments suitable for playing and gaming can be utilised, in addition to the daily work at schools, for after-school clubs and meeting points of three generations – children, parents and grandparents.

In the future we will utilise the data [containing many voices collected during our research] for more detailed analysis and planning of learning environments and activities suitable for them. We will also make a more detailed study of the options for applying technology in learning environments. Our goal is to make technology familiar through games and playing, as well as to enhance the interaction among families, schools and the environment. This could be facilitated by various applications of information and communication technology that enable to different environments and individual

involved in them to remain in contact. The significance of the applied technology arises from social and creative experiences and the mastery of one's own world, which is also linked to processes of empowerment. Consequently, schools should consider what applications of information and communication technology are specifically oriented towards children's needs (Druin & Inkpen 2002). We expect that information and communication technology should, as defined by the TLP model, support playing, gaming and active collaboration that is based on children's natural need and disposition to exercise, act, investigate and carry out. What are needed here are educators and teachers whose personality is playful, who are innovative adopters of a learning environment that utilises information and communication technology and who creatively invent new content (Dunn 2004).

The article to come we will report on the developmental history of playing, games and technology related to learning environments and examine playfulness in more detail from the points of view of affordance and allowance because they allow attention to be paid in children's environment to those factors that allow or hinder good playing or games.

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Playfulness and game-based learning

Scripted game environment as an aid in vocational learning concerning surface treatment

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In school contexts much hope is placed on CSCL (Computer-Supported Collaborative Learning), and in working life organizations on CSCW (Computer-Supported Co-operative Work). Especially in vocational education there is a need to call attention not only to collaborative learning processes but also to co-operative working methods in order to develop students' skills for collaboration and co-operation in their future jobs, which are likely to call for group work. This study involves a design experiment, which comprises the design process of the Mustakarhu game environment, description of the script developed for this game, as well as the empirical study with multiple data collection methods, data analysis, results and conclusions for further work. The empirical experiment was organised among vocational students (N= 20) divided into five groups of four persons. A qualitative analysis was carried out using data classifications. According to the findings different levels of the game create possibilities for motivative learning. A major benefit of the virtual environment was the possibility to visualise the design process in a manner that would have been impossible in a traditional classroom setting. The game process also brought up a new form of interaction, as the students were able to use visual communication.

Keywords: CSCL, virtual game, scripting

1 Introduction

In school contexts much hope is placed on CSCL (Computer-Supported Collaborative Learning) (Koschmann, 1996), and in working life organisations on CSCW (Computer-Supported Co-operative Work) (Dourish & Bellotti, 1992). Part of the current research on collaboration and co-operation in virtual environments derives from the earlier work on group-based learning approaches (Strijbos and Martens, 2001). Even though co-operative working and collaborative learning are related and have partly shared roots, the processes are different. Differences between CSCL and CSCW can be found: For example, in school contexts different methods and rewards are used, there is a teacher who structures the activities and goals, learners are novices in the study field, whereas co-operative work situations are often arranged between experienced professionals. (Stahl, 2004.) Collaboration and co-operation differ from each other also in terms of task position and coordination. In collaborative situations participants are mutually engaged to coordinate their efforts to solve problems together, while in co-operation each participant is responsible for a portion of the problem solving according to the division of labour. In co-operation the task is split into subtasks and further coordination may be unnecessary. In such settings learners also often produce separate solutions, whereas in collaborative learning constructing a shared solution is essential. (Roselle and Teasley, 1995; Dillenbourg, Baker, Blaye, and O`Malley, 1996; Weinberger, 2003.)

Especially in vocational education there is a need to call attention not only to collaborative learning processes but also to co-operative working methods in order to develop students' skills for collaboration and co-operation in their future jobs, which are likely to call for group work. Even though the need for that kind of activities is increasing, they are not without problems. Group work is especially challenging in virtual environments where the team members are often

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separated in space and time, which easily hampers their communication. On the other hand, at their best virtual environments provide a shared forum not only for content issues, but also for bringing people together to meet, exchange ideas and access a variety of online resources (Holmes, Lin, & Bransford, 2001).

In recent years the need for computer-supported virtual activities has been increasing (Beuschel, 2003). The main idea of collaborative learning is that through collaborative knowledge construction, co-ordination of different perspectives, commitment to the joint goals, and shared evaluation of group activities a group creates something that exceeds what any one individual could achieve alone. At its best, CSCL may generate learning characterised by benign dependence between participants (Bereiter, 2002; Stahl, 2003). However, researchers have pointed out various problems with CSCL. Collaboration seems to be a very complex phenomenon, which includes elusive and unpredictable elements (Dillenbourg, 2002; Arvaja, 2005). Latest studies have pointed out that collaboration does not emerge automatically when a group of people is operating at the same virtual environment. (Arvaja, Häkkinen, Rasku-Puttonen, & Eteläpelto, 2002).

In co-operative interaction certain design structures are traditionally used to facilitate group performance, whereas collaborative interaction relies rather on "natural" interaction between team members usually without such predefined interaction structures (Derry, 1999; O'Donnell, 1999). Recent studies have indicated that some amount of structuring may help teams to achieve effective collaboration. Structures that guide collaborative processes are called collaboration scripts (Dillenbourg, 2002). Such scripts are intended to facilitate collaborative learning processes and guide learners' activities. In scripted collaboration, the participants are supposed to follow directions and undertake shared learning tasks (Weinberger, 2003). Recently, two different types of scripts have been identified in CSCL. Firstly, scripts may instruct learners in how to deal with their task (epistemic collaboration scripts) in the virtual environment. Secondly, scripts may tell the participants how they should interact with the other group members (social scripts) in the virtual environment. (Weinberger, 2003; O'Donnell, 1999; Weinberger, Fischer, & Mandl, 2003).

One important factor of scripting learning is that the scripts must lead to pedagogically reasonable practice and the environment itself must support the idea of scripting in the first place. Studies have indicated that scripting interactions is a natural idea in game design, as games are often based on different levels of activities. And those way virtual game environments may be one way to meet CSCL needs. Different kinds of scripts can be employed for higher game levels that may be reached by solving problems set in the game. For example, the higher level may offer a new scope for action or give access to more tools that help the player succeed in the game. The aim of learning games is to use scripts and different game levels in a way that supports learning and pedagogically reasonable aims (Hämäläinen et al., 2005).

Generally, the aim of an "edugame" is to provide students with complicated challenges related to the learning task (Kiili, 2005). In all kinds of games it is typical of good gameplay that the story keeps the player motivated throughout the game (Costkyan, 2002). Thus computer games are often associated with the image of motivational learning (Ulicsak, 2005). Still, enhancing motivation should not be considered from the viewpoint of extrinsic reasons of gaming, such competition involved in the game. Rather, developers should concentrate on scripting learning tasks to the game story, so that the game world brings some added value to learning. Scripting edugames is attempting possibility to vocational task learning, because it is often based on a set of authentic working-life tasks and competencies built step by step, where different professionals have to manage teamwork.

2 Research tasks

The Mustakarhu-study is a part of the ECOL (Ecology of Collaboration) research project (which aims to examine collaborative learning as a motivated and co-ordinated activity) and also part of a larger project carried out at the Jyväskylä Vocational Institute of Technology to highlight scientific and mathematical applications. This study includes design experiments conducted in authentic educational settings. The first research task was to develop a game environment to simulate the work context of the vocational design process of surface treatment. The second task was to describe the game and design process by means of a script description model developed in MOSIL (Mobile Support for Integrated Learning, Kaleidoscope Network of Excellence). Finally, the third research task was to describe what kind of effects the scripted virtual game environment brought to specific vocational learning of authentic design process of surface treatment.

3 Research methods

This study involves a design experiment, which comprises the design process of the Mustakarhu game environment, description of the script developed for this game, as well as the empirical study with multiple data collection methods, data analysis, results and conclusions for further work (Bannan-Ritland, 2003). The empirical experiment was organised among vocational students (N= 20) divided into five groups of four persons. A specific laboratory environment was constructed in order to capture all the required data from the experimental game sessions. During the experiment the students played the game session and had a stimulated recall interview immediately after the game. Data was gathered by various means drawing on video feed of each group, audio recording of spoken dialogue and/or logged chat conversations during the game, logged player activities, observation notes and stimulated recall interviews.

4 Data analysis

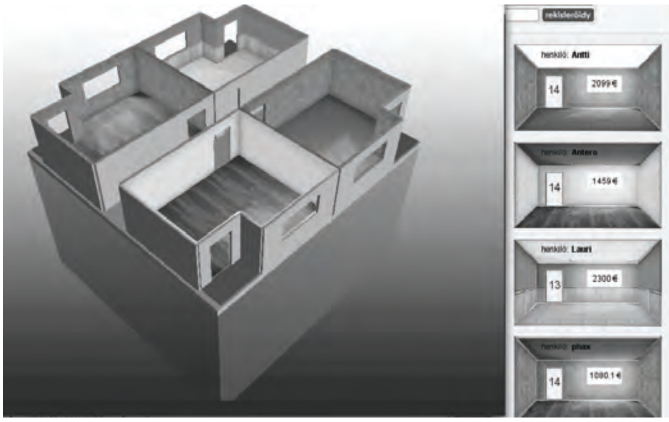
The empirical data was analysed afterwards. The analysis was partly theory-driven (Berger & Calabrese, 1975) and partly data-driven. After the game experiment, all the data were verified, interviews and conversations conducted during gameplay were transcribed and observation notes were sorted into relevant categories. A qualitative analysis was carried out using data classifications. The first classification was based on the key points scripted into the game environment and the expected interaction processes. In the second classification, groups were identified to find out what kind interactions and individual activities the players used to solve problems and how important these were for gameplay. And finally, the analysis focused on how the environmental elements affected collaboration. Cross-comparisons of sets of research materials collected by various methods were performed to improve the reliability of the research results (Cohen & Manion, 1994).

5 Design framework and instructional design of Mustakarhu game

In future learning the benefits provided by new technologies should be utilised more extensively. In discussing learning and computer games we should take into account the theoretical knowledge and needs of learning as well as the existing possibilities of game development. In this study there was an attempt to develop a new virtual space for collaboration and vocational task learning (Dillenbourg, 1999; Dourish, 1999). The technical implementation of the game environment was based on the theory of CSCL. Epistemic collaboration scripts (Weinberger, 2003), with some social modes were applied to make learning more efficient. The aim of our study was to use scripts and different game levels in a way that supports pedagogically reasonable aims.

The design draws on the features of illustrative environment provided by the virtual game. It was recognised in the game development that it would not be reasonable to plainly transfer learning from a classroom setting into a virtual environment (Arvaja, 2005). The game environment was expected to offer learners some added value, especially because the use of distributed games, in particular, is justified by catering for such aspects of the curriculum and learning tasks that have been traditionally difficult to teach (Charles & McAlister, 2004). In vocational learning the need for both collaborative and co-operative processes is based on authentic problems of the working life, and the design of the game thus followed the relevant curriculum. The leading idea in the game design is to simulate the work context of a vocational design process, which involves a vocational task to design four different customised hotel rooms. The philosophy behind the game design is to offer the kind of game-play in a virtual environment that allows such practice that would otherwise be almost impossible, or at least very costly, to arrange.

Mustakarhu is a virtual 2D/3D online game for four players. It can be defined as an epistemic task-centred computer game. Game-play emphasises collaboration and co-ordination between the players. The teacher has an active role in after-game reflection, but does not intervene during the actual play. Due to the limited duration of the experiment, the content of the game caters for approximately 45 minutes of goal-oriented activities. The role enactment and player-to-player communication is supported by chat or voice-over-IP speech systems, which allow free dialogue between the players. The development of the Mustakarhu game and the related empirical study was a joint effort between three parties: the University of Jyväskylä, the Vocational Institute of Technology, and a small company called Korento OY.



Picture 1: View of the hotel rooms during the play

6 Mustakarhu script

The scripts are aimed to encourage students to make decisions together. The game includes three different types of puzzles; some can be solved individually, but others require effort and commitment from the whole team for successful completion. So, different modes of collaboration and co-operation are required in the play. During the game students are expected to design the rooms, calculate the areas and costs of the materials (within a budget of 4000 euros as a team), answer to a quiz about materials and finally make a report about the design process. The script of the Mustakarhu is described in the following two tables, which are based on a script description model developed in MOSIL* (Mobile Support for Integrated Learning, Kaleidoscope Network of excellence). Table 1 gives some specifications and background information on the game (name of the script, authors of the game, objectives, target audience, range of application, context, locus of representation, granularity, coercion degree, duration, environment and design principle).

Table 1. Background information on the game.

Features	
Script Name	Mustakarhu-game
Authors	Hämäläinen, Koutaniemi, Mannila
Reference	-
Objectives	Epistemic tasks of design and surface treatment of the hotel rooms Learning and practising collaborative learning mechanisms
Target Audience	Vocational education students
Expected range of application	Different vocational content domains
Context	Design task for four different hotel rooms made to order. Students are expected to design the rooms, calculate the areas and costs of the materials in collaboration (within 4000 euros budget as a team), And finally make a report about the design process.
Locus of representation	External
Granularity	Medium – The script encourages students to make decisions together.
Coercion Degree **/ Degree of freedom -> moderate**	Medium/ High – The design task gives guidelines for activities, which are predetermined. Problems are set in strict order, but teams may create different ways to solve problems. Subtask need to be solved in the previous phase to be able to move on to the next level.

Duration	45 minutes
Environments	2D and 3D-game (on-line) Mustakarhu is a virtual 2D/3D game for four players. It can be defined as an epistemic task-centred computer game. The game simulates the work context of a vocational design process, which involves a vocational task to design four different customised hotel rooms. The role enactment and player-to-player communication is supported by chat and voice-over-IP speech systems.
Design Principle	- The design principle is to model the work contexts of vocational design process - Use the features of illustrative environment provided by the virtual game - Contains authentic work-problems - Game-play emphasises collaboration and co-ordination between the players. - Includes individual puzzles and puzzles that are designed in a way that the effort and commitment of all players is required for successful completion.

The game comprises epistemic tasks of design and surface treatment of the hotel rooms, which entails learning and practice of collaborative learning mechanisms. The game includes sets of vocationally oriented problems (13 tasks), of which six are mathematical problems. The second part of the script description model consists of a storyboard with information on expected collaboration (Table 2). As the following table shows, the game integrates individual work to collaboration (e.g., in Phase 6); the costs of floor materials for each room need to be calculated and the sum affects the joint team budget. The extent of expected group processes varies during the gameplay.

Table 2. Storyboard with expected activity outlines.

StoryBoard	
Phase 1	form a team of 2-4 members - for designing customised hotel rooms
Phase 2	choose a room for each player (collaboration)
Phase 3	negotiate the rules for the game – you have 4000 euros budget as a team (collaboration)
Phase 4	calculate the area of the floor (individual or collaboration)
Phase 5	choose the materials for the floor (collaboration)
Phase 6	calculate the costs of the floors (individual or collaboration)
Phase 7	calculate the area of the walls (individual or collaboration)
Phase 8	choose the materials for the walls (collaboration)
Phase 9	calculate the costs of the walls (individual or collaboration)
Phase 10	calculate the area of the ceiling (individual or collaboration)
Phase 11	choose the materials for the ceiling (collaboration)
Phase 12	calculate the costs of the ceiling (individual or collaboration)
Phase 13	quiz of the materials (individual or collaboration)
Phase 14	make a final report for the customer (collaboration)
Phase 15	Reflection situation

All five groups followed the scripted task order and completed the game successfully. The scripting was integrated behind the design task of the hotel rooms. The scripted game environment enriched task learning and enabled aspects that would not have been possible in traditional classroom settings. As far as the results are concerned, all five groups

came up with a reasonable and feasible plan for four different hotel rooms. Data analysis revealed that the students' game processes varied a great deal despite the scripted environment. The groups differed in terms of the outcomes of the design process, the time spent on the game, and the degree and amount of collaboration shown.

7 Effects of the virtual game environment on learning process

Afterwards the students felt that the game environment had offered added value by visual outlining. The design process was also more motivating this way than the traditional pencil and paper method. A new form of interaction emerged during the game, as all these players used some “visual communication”. They spent long periods of time comparing different materials. During that time they did not speak or write, but they were highly concentrated on browsing through different options for materials until they found good ones. The students found this new learning environment as a positive experience, and especially they appreciated the illustrative presentation of materials. Another advantage of the virtual environment was that it was easy to experiment with different materials and immediately see the actual results of their choices. The game featured a 3D model of the hotel rooms to illustrate the overall task. In analysing the data it turned out, however, that besides this illustration point of view, some players used the model as a chance to take a break when the cognitive load started to build up too big.

The time spent on the game varied from 30 to 50 minutes. Within all the groups playing was intensive. The players found the authentic tasks challenging. Especially students with some work experience were excited about finding similarities and differences between the real and virtual world. The players seemed to feel safe in the virtual environment, and observation notes confirmed this subjective finding. On a more general level, some of the players found that the gameplay was somehow like playing for fun. For the future learning games student wished more challenging tasks, such as determining the thickness of paints, and also the possibility to return to the tasks afterwards to make changes.

During the game, students used different methods to achieve and maintain collaboration. Scripting guided team members towards shared problem-solving. Within all the groups, the game encouraged players to various kinds of negotiation situations (especially in calculation tasks). As seen in the following excerpt players negotiated not only about the actual tasks and problem solving but also about the game functions.

Minna: everybody OK if I take this laminate?

Anna: yeah, go ahead, Minttu [a nickname]

Minna: :)

Eve: suits me, I'll take the tiles.

Henna:

Anna: jeez, what's this linoleum?????

Eve: dunno.

Anna: can I take that plastic covering?

Henna: hey come on, where on earth did you guys find that material point..!!!

Anna: well where are you now then, Henna?

Henna: this is just a mess!!

Eve: on the previous page there was some continue box, click on that

Anna: calculate that area that how many square meters there are and click the calculate button.

Excerpt 3: An excerpt from students' chat conversation during the game

Co-operation took place on an equal basis and data analysis indicated that that the game essentially guided the team members to make sure that everybody was able to go on. The players felt that peer support during the game was important and they did not want teacher's guidance at that time. The players appreciated each otter's presence and possibilities to ask for help. After the game the students felt that they had been able to help each other and observation

notes and log data confirmed this finding. Groups solved problems in mutual understanding and conflict situations during the game were rare. There were no cognitive conflicts, but as seen in the following excerpt of interview the time used for material choices could become an issue.

”Pia: It's that,(.) may be but I wouldn't have needed (.)like more that time, so that (.)as one anyway (.)as one realised that the others are already moving on e, [Heidi: yea] [Interviewer: yes] or are already ahead, so that you got the feeling that now I, too, must (.)[2: it's not like that] keep up with like that.”

8 Discussion

This study indicated that at their best epistemic scripts have potential to make learning more efficient in virtual game environments. Different levels of the game create possibilities for motivative scripting. A major benefit of the virtual environment was the possibility to visualise the design process in a manner that would have been impossible in a traditional classroom setting. The game process also brought up a new form of interaction, as the students were able to use visual communication, as well. The findings indicated that this game environment also offered a setting for different modes of interactions and encouraged teams to collaboration. This study supports the finding that in scripting one must be aware of the risk of over-scripting (Dillenbourg, 2002). Scripts should not be made too strict, because then there would be no space for students' own constructions. In addition, there is an evident need for features that allow easing up the learner's cognitive load between tasks.

According to findings, edugames can to enrich learning and pedagogical use of technology. Designing pedagogically meaningful virtual environments for the learning of specific contents is a challenging task, which calls for close co-operation between the technical game developers and specialists with pedagogic and field-specific expertise. Such design teams can take into account the needs of learning, possibilities of technical applications, and latest research findings. Especially in vocational education where learning is based on authentic tasks, better ways to visualise such learning tasks are needed to answer the motivational challenges. Edugames have potential in this respect. Illustrative presentation of occupational situations through game-like applications seems to be one potential way to improve vocational learning and to respond to the changing needs of working life.

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Group Investigation, Social Simulations, and Games as Support for Network-Based Education

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The aim of the study was to clarify the conceptions of teachers and students on pedagogical models and practices. A particular object of interest was the pedagogical models, which enable the utilization of collaborative learning as well as social simulations and games in network-based education (NBE). Our principal proposition is that game-based social simulations and group investigation enable experiential and collaborative NBE. The research strategy was to combine qualitative and quantitative research. The research design was ethnographic. The object of research was Finnish Defence College Leadership and Military Pedagogy Course and the students and teachers in the course as the research group. The course was implemented in an network environment under planning in cooperation between R5 Vision (Tieturi Vision) and the Finnish Defence Forces. In data collection, privilege participant observation, thematic interviews and web-based questionnaires were utilized. The data was analysed by means of statistical methods and qualitative content analysis. According to the results, the pedagogical models supported the design and implementation of NBE. In order to succeed, the beneficial exploitation of simulations and games in NBE required a careful and clear motivation and planning stage. The social relationships and the players' backgrounds impacted the success of the game-based social simulation. The group investigation model incorporated in the implementation of collaborative learning was regarded as an operational mode applicable for leadership training. This research is part of the MOMENTS (*Models and Methods for Future Knowledge Construction: Interdisciplinary Implementations with Mobile Technologies*) research project connected with the Academy of Finland's Life as Learning programme.

Keywords: Network-based education (NBE), pedagogical models, collaborative learning, social simulations, games.

1 Introduction

The role-playing games and social simulations played in the net environments represent a part of the everyday life of students as well as our culture (Kangas, 1999; Järvinen, 1999; 2003; Prensky, 2001; Mäyrä, 2002). Simulations and games have been beneficially exploited to a considerable degree during the last few years in many connections, not only in entertainment but also in education and research. Particularly in the field of sociological research, computer simulations have shown their strength in the resolution of various social problems. In imaginary but realistic and safe circumstances (cf. Duijn et al., 2003), the social simulation which has occurred is seen to enable the examination of complex real-life problems (e.g., Daré & Barreteau, 2003; Smith, 1999). At best, it is possible through social simulations and

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games to combine experiential richness and emotions in collaborative studying and learning (e.g., Kankaanranta et al., 2004).

Collaborative learning has frequently been strongly in the fore when there has been discussion on the development of teaching. Together with action, many kinds of purposive studying and meaningful learning-related processes in network environments have been created. Various results from experiments have been obtained on the appropriateness of collaborative learning, depending on their quality and research formats. In addition to successes, innumerable types of challenges and disappointments in practical application have been reported. (Hakkarainen ym., 1998; Vahtivuori, Wager & Passi, 1999; Häkkinen, 2001; Lipponen, 2003; Marttunen & Laurinen, 2004).

In the case study presented in this article, pedagogical models and practices benefiting from collaborative learning and social simulation as well as games used in NBE were studied. The goal of research was to obtain information in regard to the functionality in the net environment of social simulations in addition to group investigation. (See Vahtivuori, Lehtonen & Torkkeli, in print; Vahtivuori-Hänninen, 2005; Vahtivuori-Hänninen et al., 2005; Vahtivuori & Lehtonen, 2003; also Tella et al., 2001). As the net environment, R5 Generation Learning Platform was employed. The platform was designed and customized by R5 Vision (currently Tieturi Vision) and the Finnish Defence Forces in cooperation with the Net-based Military School, which is part of the defence forces' education portal.

The research target was the combined leadership and military pedagogy pilot course of the Finnish Defence College in autumn, 2003. Those studied (N=30) were teachers (N=2) at the National Defence College and second-year students studying to become commissioned officers (N=28). The course was designed on the basis of two pedagogical models: 1) the Group Investigation model (Sharan & Sharan, 1992) and 2) the Learning through Simulations model (Joyce et al. 1997). The goal of course realization was to enable genuinely collaborative and experiential studying on the net. What is meant by collaborative learning in this respect is activity marked by mutual trust, interaction, dialogue, combined experiences and sharing of the same, as well as a research-oriented approach to the operations targeted (Vahtivuori, Wager, Passi 1999, 265–278; Vahtivuori-Hänninen et al., 2005; Vahtivuori, Lehtonen & Torkkeli, in print). Consideration is given in this article to the implementation of the course integer under study and the research findings from the developmental perspectives of collaborative learning and, the social simulations and games.

2 Theoretical points of departure

2.1 Pedagogical models

The starting point for research is the concept that teaching activity is based not only on practical experience but also on some more or less theoretical reference framework or pedagogical model. Joyce & Weil (1980) have determined a pedagogical model as a plan or model by which it is possible to, among other things, direct the planning of instruction and design teaching materials. By relying on a theoretical reference framework and his/her experience and intuition, the teacher arrives with each situation at a certain operational format or solution.

In studying the teachers' pedagogical thinking, it is noted that the teachers use, as the basis of their decisions and activities, what is more everyday information emerging from intuition and experience than, for example, the research information obtained during their period of training (Kansanen et al., 2000; Jyrhämä, 2002). Nevertheless, in each TSL situation the teacher has more freedom of choice and skill to choose the best and most effective pedagogical solution, when s/he has the know-how to more strongly obtain support from theory and pedagogical methods in lieu of intuition. In our view, by investigating, applying and developing pedagogical models, it is possible to find means for the design of research-based, reflective and high-quality NBE.

2.2 Collaborative learning

The teaching experiments conducted during the last decade have indicated that it is possible to create mutually shared activity in a net environment. At the same time, it has been possible to create favourable social situations and contexts for studying. Collaborative activity resting on dense interaction—for example, combined research-related chats in small groups—have produced favourable results (e.g., Tella et al., 2001). A problem has frequently emerged from the fact that activity on the web easily remains superficial. In addition, as it is being created it easily becomes directed away from the target itself. In such an instance, collaborative activity promoting studying and oriented towards the general object of studying as well as real dialogue does not see the light of day. Indeed, what is required is conceptual segments by which activity occurring on the web can be planned, organized and directed in such a way that a clear enough control model emerges—i.e., a pedagogical model.

According to Panitz (1996), collaborative learning is not merely a working method but something more profound: the philosophy of interaction and one's personal way of life. In our view, it is best implemented as an integrated research and problem-solving process in which interaction and real dialogue enjoy a pivotal position (Vahtivuori et al., 1999, 269–270). We contend that the requirements for the success of collaborative learning in a net are active participation, commitment, making thought processes visible and comprehensible, and mutual interpretation processes (Vahtivuori et al., 1999; also Hakkarainen et al., 2004; Marttunen & Laurinen, 2004).

2.3 Social simulation, simulation game or role-playing game?

In both the international and the Finnish literature, social simulation and game-based simulation as well as role-play or the conceptual definition of playing are complex and diverse (e.g., Tompkins, 1998; Järvinen, 1999, 175–176; Prensky, 2001). Some of the terms used the most in the literature—partly with overlapping meanings—are simulation, social simulation, game, role-play and role-playing simulation.

On the general level, simulation can be defined as the copying or imitation of a certain actual situation, instrument or system and the dynamics and causal connection relationships linked with the same. If, in addition to the simulation, the goals of activity are included, it may also be regarded as a game. Some researchers (e.g., Crawford, 2003) place both social simulations and games into the same category. In social simulations, there is an attempt to simulate, most often dynamically and in a reliable fashion, complex real-life situations, when again through sociodrama or simple role-play one may investigate certain rather strictly limited everyday behavioural models (see Crookall & Oxford, 1990). Playing games has traditionally been social in character, an activity going on between at least two people (Järvinen, 2003). Role-play is fictional, short, rather simple in construction and flexible in its realization. What is central is also the competitive starting arrangement. Järvinen (1999, 176) crystallizes the nature of game-play and the playfulness inherent to games in the following: ”A goal for the player is set, the achievement of which is slowed down by setting challenges and obstacles. In order to separate them from freer forms of play, games have pre-agreed rules.”

In this article, we shall approach simulations and role-playing games as the copying and modelling of an everyday situation, problem or collaborative process. We utilize the term game-based social simulation (c.f. Brougère, 1999; Lehtonen, 2004b; Ruben, 1999; Vahtivuori & Lehtonen, 2003; Järvinen, 2003; Lehtonen, 2005). We employ the concept in this respect to describe a social activity in particular and the simulation of collaborative problem-solving by means of group investigation and game-playing. (Vahtivuori, Lehtonen & Torkkeli, in print)

2.4 Social simulations in teaching, studying and learning

The basic motivation behind the use of game-based social simulations is the desire to learn to manage a situation. Crawford (2003) states: “The desire to play and have fun is a built-in mechanism within us, which the developers of computer games use to advantage.” Some benefits of teaching, studying and learning (TSL) which utilize social simulations and games may be regarded as 1) functionality based on one’s own experimentation and 2) emotionality. (Lehtonen, 2004a; Lehtonen, 2004c; Lehtonen, 2005; Vahtivuori, Lehtonen & Torkkeli, in print). In merging both functionality and emotionality, social simulation becomes strongly experiential studying/learning:

1) **Functionality and studying/learning by doing.** By means of social simulation, it is possible to individually study by concretely doing. (See Lehtonen, 2004a; 2004c; Vahtivuori, Lehtonen & Torkkeli, in print)

2) **Emotionality and the reduction of situational distress.** Simulated action often arouses the same types of feelings as in the real situation. However, simulation allows for the possibility to safely experiment (e.g., Kankaanranta et al., 2004; Lehtonen, 2004a; 2004c).

3) **Development of problem-solving skills.** The use of social simulations in teaching helps in examining familiar matters—for example, everyday social processes—from quite new and fresh perspectives as well. It is possible by their means to support and develop problem-solving skills (See Lehtonen, 2004a; 2004c; Vahtivuori, Lehtonen & Torkkeli, in print).

3 Research background and implementation

The simulations, games and various practice programs have been the typical mode of action and already an important part of military training for many decades (e.g., Prensky, 2001, 295–316). In Finland, the defence forces have benefited from simulations and game-playing for a long time, especially in education for leadership, decision-making, strategy and tactics.

A broad planning group participated in the design and material production of the Leadership and Military Pedagogy (3 ECTS) pilot course, which has been the object of the study. The group was comprised of specialists not only with respect to content but also the technology employed, and the theoretical foundation and practical implementation of NBE.

The goal of the Finnish Defence Forces was to develop their own NBE and obtain experiences from the utilization of the net nevironment employed in the instruction of students basic examination. At the same time, there was a wish to gain experiences in teaching which break subject boundaries, in which the planning and realization of instruction is carried out in cooperation with a 'multi-professional team'. The starting point for course planning was real leadership and training situations encountered in the work of students studying to become commissioned officers, as well as the merging of leadership and military pedagogy-related scientific explanation models. Previously, the corresponding courses were implemented as separate lecture courses which included a book examination.

The course was designed and realized on a theory-derived basis of the two previously described pedagogical models. In the group investigation tasks and social simulations, the students projected themselves into leadership and training situations they encountered as officer candidates and modelled the same. As a group investigation task, e.g., the development of a conscript as a leader and trainer during the leader period was discussed.

The course was arranged into two contact units—orientation and debriefing, plus one net-based unit. During the orientation phase, the students got acquainted with the working method and net environment through collaborative learning practice. The students, after motivation and content presentation as planned by the teachers, split up on the basis of their interests into five groups with their own research tasks. The groups designed a problem-oriented case study for working life based on their leadership and training experiences as aligned with a broad arrangement of tasks. One of the groups constructed, formed its own case, four social simulations or role-playing games simulated on leadership and training situations. The group began carrying out the task and combined its experiences from various detachments and branches of defence by planning a personal role for each participant. Game-playing and simulation were realized in text-based form, aided by net environment discussion forums and chat tools (see also Kangas, 1999). On the basis of the experiences, perceptions and impressions gained from game-playing, the group reported on its assignment in writing. During the entire studying process, the teachers provided feedback on the groups' process and written production and, at the same time, reflected together on what was learnt. (See Vahtivuori-Hänninen, Vuorento & Torkkeli, 2005)

During the NBE unit, the students received support and guidance from the teachers. Each day, the teachers wrote about the tasks and programme for the next workday in a letter of command as well as commenting on students' questions. Versatile digital source material was available for use by the students from the net material on video excerpts linked with the theme. In the collaborative learning, the R5 Vision's (Tieturi Vision) training portal was incorporated as the discussion forum. This tool provided both group-related and common forums, an editor for the production of web-based material and an ePortfolio for the collation and storage of material.

4 Pedagogical models supporting planning

4.1 Group investigation model as an application for collaborative learning

The group research of Sharan & Sharan (1992) can be regarded as a model authenticating the theoretical principles of collaborative learning in practice (e.g., Vahtivuori, Wager & Passi, 1999). The group investigation model emphasizes the significance of grouping on the basis of the target of one's personal interest. The creation of new information and expertise together, collaborative problem-solving, mutual feedback provision and interpretation process are regarded as important. There are four basic principles in the model: 1) investigation, 2) interaction, 3) internal motivation and 4) interpretation. Group investigation can progress in practice through six stages from selection of the study theme and grouping to operational assessment and analysis. However, the phasing of group research is not pivotal, nor in any way bound: the more important significance is found in the model's four basic principles. (Sharan & Sharan, 1992, 18–19; Vahtivuori, 2001.)

4.2 Learning Through Simulations model

The object of research having been in course planning and implementation, the Learning through simulations model—which segments the instructional usage of the social simulations—was also applied. This model was chosen because its application has been incorporated previously in military training. The model progresses step-by-step via four collaborative working stages. These stages are: 1) the establishment of orientation and context, 2) familiarization by participants, 3) simulation or game realization stage and 4) the mutual debriefing stage (Joyce et al., 1997.)

5 Research task and question

The research task was to clarify the conceptions of teachers and students with respect to collaborative learning, in addition to pedagogical models connected with social simulations and games. The central research guestion was, how are the pedagogical models which support collaborative learning, social simulation and playing games implemented within the network environment.

6 Methods and data collection

This research was implemented in the Leadership and Military Pedagogy pilot course jointly arranged in the two departments of the National Defence College during autumn 2003. The objects of the study were educators (N=2) as well as students in their second-year course (N=28) who were studying to become commissioned officers. The instructors were military majors from the National Defence College and experienced educators who had earlier been involved with multi-mode education.

The research strategy was to link both qualitative and quantitative methods in the collection of data and analysis. The research orientation was ethnographic. The research target was examined in its natural operating environment by means of privilege participation observation during the entire course (Hammersley, 1990). The research process was planned, and it progressed simultaneously with course planning and implementation. The objective was the achievement of dialogue-based mutual understanding with the community members being studied. So-called 'privilege participant observation' included, among other things, the working method incorporated during the orientation unit, collaborative learning, the group investigation presentations and simulation models as well as acquainting the students with the net environment and the tools to be used. In particular, the operations and reflections of the teachers and students were the target of privilege participation observation during instruction. The students' studying process, instructors' activity and the discussions were documented in the net environment. All contact meetings and the students' final reportage were recorded on video and notes were made of the same. As data-gathering methods, also interviews and a web-based questionnaire were used after the close of the course.

In the analysis of data, statistical analysis methods and qualitative content analysis were utilized. The web-questionnaire containing 98 variables, which was directed towards students, was analysed with the SPSS 11.5 program. The variables were analyzed and the sum variables were produced from the same: 1) quality of teaching and guidance (M=3.6; SD=0.54), 2) pedagogical quality of course (including e.g., game-based activities) (M=3.8; SD=0.49), 3) collaborative character of course (M=3.8; SD=0.59), 4) interaction of course (M=3.7; SD=0.69), and 5) functionality of learning platform (M=3.6; SD=0.78). In addition, the connections of the sum variables to each other were examined. A separate statistical report was produced from the analysis. This article discusses some results of the sum variables 2 to 4.

The qualitative content analysis was made up of the five working stages: from acquaintance with the text data (transcribed interviews, web and feedback discussions, open replies in questionnaire) to the creation of the six main categories (designing, implementation, teaching and guidance, collaborative learning, games and simulations and, usability of the platform). These gategories were mirrored to theoretical models, the observations, and interpretations derived from the data. Statements and conceptual entireties were incorporated as the unit of analysis. In this article, the results and reasoning presented rest primarily on 1) the analysis of the instructors' interviews, 2) the statistical analysis of the students' web-questionnaire and 3) the content analysis on the feedback discussion. Next, we shall present some preliminary results briefly from the perspective of the collaborative learning, games and simulations.

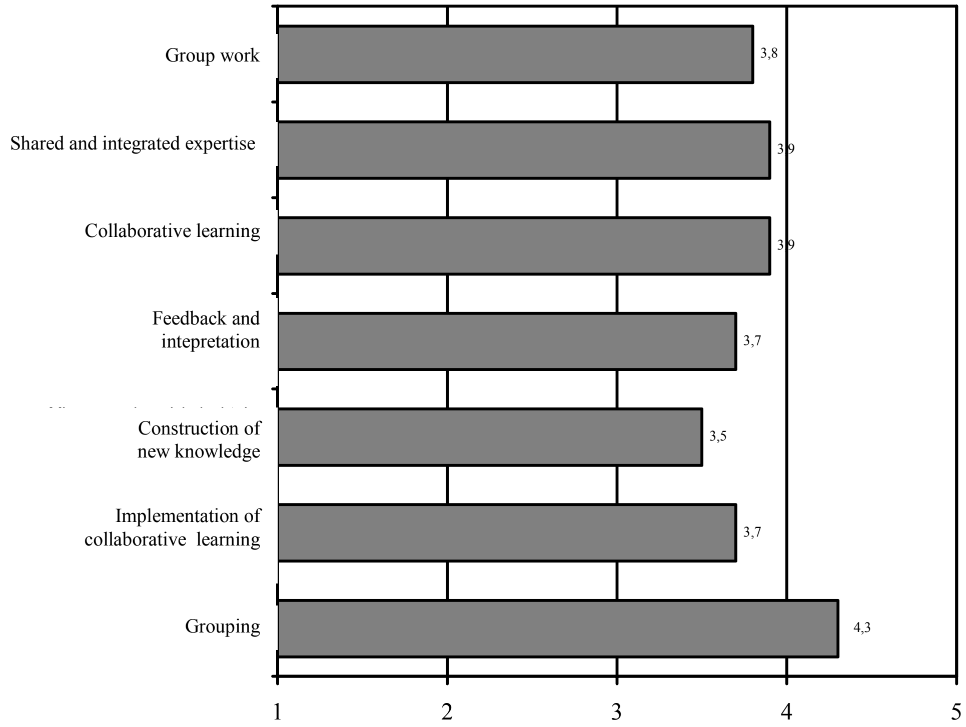
7 Some preliminary results

7.1 Collaborative learning and group investigation

A pivotal observation was that it is possible by means of the used pedagogical models to support the designing and implementation of multi-professional NBE between several actors in a quite hierarchical operating culture. The planning group familiarized itself with the group investigation model, and the students were well introduced during the orientation unit with the model and its basic principles and stages. Studying in keeping with the model was realized mainly in the activity of the students in accordance with their own analysis. In the web-questionnaire the collaborative learning was surveyed with seven questions (see table 1). A sum variable (Cronbach α = 0,746) "quality of collaboration" (M=3,8; SD=0,59) was gathered from the questions[1]. According to the students and teachers' interviews, the course was found collaborative. Specifically, the voluntary grouping linked with the model, which has not been in keeping with the organization's presiding cultural tradition, appeared to have been very successful.

[1] "How well did the grouping succeed in the beginning of the course?" (M=4,3; SD=0,90), "How well was collaborative learning implemented in the course?" (M=3,7; SD=0,92), "To what extent the study community built new knowledge during to course?" (M=3,5; SD=0,83), "To what extent there were feedback and mutual intepretation in your group?" (M=3,7; SD=0,10), "Collaborative learning" (M=3,9; SD=0,83), "Integrated expertise" (M=3,9; SD=0,95) and "Group work" (M=3,8; SD=1,09)

Table 1. Variables describing the collaborative character of the course (Vahtivuori, Lehtonen &Torkkeli, in print).



The tight schedule in particular taxed the depth of pivotal problem-solving and the research stage going on in accordance with the group investigation model. The teachers reacted to this as a problem from the perspective of the quality of learning and acquaintance with content. The approach was nevertheless regarded as appropriate. Collaborative learning was experienced as motivating and inspiring and, in addition, it was considered applicable to the net environment for the content to be learnt as well as leadership and the study of training skills. According to the interviews, it is crucial for the teachers to come along at a very early stage to the design process to ensure successful collaborative planning and implementing of the NBE.

7.2 Game-based social simulations

The progress of the social simulations and games played by the students proceeded mainly in accordance with the pedagogical model, utilizing the simulations incorporated in the planning. A smaller student group than that anticipated obtained benefit, adapting a game-based approach to its studies. If there is a wish that the types of game-based social simulations now realized can be genuinely utilized for benefit in the future as a support for teaching, the challenge lies particularly in the effective planning and realization during the orientation phase. Social simulation and role-play in a net environment appear to require, time-wise, a careful and sufficient pre-orientation, i.e., background provision and a motivational phase that is sufficiently long. More ready concepts and instructions on the teaching usage of games and simulations were also yearned for as support for desiging.

The implementation of game-based social simulations ideas require emotional courage and dedication from the students. This would appear to be, from the perspective of social simulation, a central influential factor for learning. The social relationships between the students and the backgrounds of the players exerted an impact on the success of role-play. The players knew each other, and they had previous experience of role-playing and methods for empathy. This enabled the successful implementation of the game. In particular, community and sociality emerged as team play and with the game being shaped in accordance with their own preferences.

The final results, especially concerning the used pedagogical models, guidance, and functionality of the learning platform have been and will be reported in a more detailed manner, e.g. in the following articles (for a more detailed treatment, see Vahtivuori-Hänninen, Lehtonen & Torkkeli, in print; Vahtivuori-Hänninen, manuscript)

8 Conclusions

The military context of the defence forces was a natural place for an experiment in collaborative learning and new kinds social simulation modes, as well as game-playing. Collaborative learning was experienced as motivating and inspiring for the study of leadership and military pedagogy in a net environment. The organization of studying in accordance with the model helped to distribute ideas. In studying in line with the group investigation model, no special problems emerged: this was due to the fact that the students knew each other from before. Game-based social simulations and role-playing on the basis of the data can be regarded as an interesting vehicle of reflective teaching and purposive studying, which has been beneficially utilized rather minimally in its currently implemented form. In the future, this could be a valid way to develop student-oriented teaching. At the same time, the amount and strength of rich experience obtained via emotions and feelings can be increased. In the instruction-related use, the pivotal aspects of simulations and games were 1) goal orientation, 2) pre-planning and acquaintance with the background and 3) the relationship of simulation with the students' own real-life experiences. Role-play and social simulation encouraged the students towards functional action, risk-taking, independent thinking and creativity. Through the aid of the data analysis and experiences gained from the course, a new implementation model will be developed for the support of NBE in the defence forces. As a product of research-related continuing analyses, there is a theoretical model as well as practical instruments for designers, implementers and developers. One of the future challenges is to explore, how the use of pedagogical models, practices and reusable learning objects based on games and social simulations help to design experiential TSL processes and to combine emotions better in NBE.

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Vahtivuori-Hänninen, S. Game-based Reusable Learning Objects and Pedagogical Models in Designing NBE. (Unpublished manuscript)

Digital Games to Support Education in a Playground Context The Challenges for Design –

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This article presents the challenge of designing digital games in a playground context to support mathematic education. The subject is addressed from the points of view of pedagogy, game design and usability. Issues include the way in which digital games can support teaching and how the playground as a context differs in terms of digital games compared to traditional games. A theoretical model for game design is presented at the end of this article. When creating a complete and useful design theory, practical implementations must be taken into account.

Keywords: Digital game, educational game, usability, game design

1 Introduction

In this article, I introduce my theoretical model for designing digital games to support mathematic education in a playground context for first and second graders at Finnish comprehensive schools. Digital games to support education are those that include pedagogical goals as well as specific game goals. In my theoretical model, I consider the task of designing from three points of views:

1. What kind of challenges does a playground present when designing a digital game?
2. How should the pedagogical goals be applied for first and second graders at Finnish primary schools when designing a digital game to support education?
3. Which features cause enjoyment and entertainment in digital games to support education?

As an operational environment for digital games, the playground presents challenges for user interface design. Traditional digital games cannot be applied on the playground. The typical actions on the playground differ from the culture of action of traditional digital games: physical exercise and its enjoyment are typical on the playground, while playing digital games is more static because they require that the user at least watch a screen. The aim is not just to relocate traditional game consoles to the playground, but to find solutions that make it possible to integrate digital games within a physical playground. The goal is to add value to the teaching and studying of mathematics by means of games, but still retain the sensibility of gaming. The playground context provides a fluent combination of play and learning and involves more operational features for learning (cf. Hyvönen & Ruokamo, in process). In this article, I also consider the pitfalls of designing and realising existing digital educational games and look for features that add enjoyment and entertainment to traditional digital games (video and computer games).

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2 Background

2.1 Background of the research

Traditionally, teaching at Finnish comprehensive schools has mainly taken place in the classroom and children are generally sitting still. However, the Finnish Ministry of Education has emphasised the meaning of play in its teaching curricula for 2000 and 2004. In addition, many education professionals have pointed out the importance of play within teaching (Kief & Casperque, 2000; Resnick, 2003; Price & Rogers, 2004; Lindquist, 1998; Hakkarainen, 2002). However, adding play and playfulness to classroom teaching is not a simple task. The use of school yard playgrounds as natural play-based learning environments gave impetus to the research and design of new learning environments in the Let's Play Project, which started in September 2003.

My research is a part of Let's Play, a collaboration with the SmartUs project. SmartUs is a partnership that began in 2003. SmartUs produced two pilot models of intelligent technology-aided playgrounds that support play, learning, physical and motor skills development as well as creativity – one for primary school and another for preschool teaching.

3 Methods

A lot of literature on computer games is available nowadays. However, recent game research does not meet the needs of game designers and vice-versa. It is a long way from the noble theories of game design to practical applications. For this reason, I intend to put my game design theory into practice in the future. However, in this article, I am going to introduce only the first part of my theory without presenting its practical execution. Since design methods of traditional digital games cannot be applied directly to the playground, I will create a new applied design model for this purpose.

The methodological and theoretical basis of my research lies in media and interface design. With the Let's Play Project, I also add a pedagogical perspective to my research. The target group of my research corresponds to preschoolers and primary school pupils, the target of the pilot models to be executed, but I have limited it even further to first and second graders.

When analysing the structure of my research, I faced one problem: it is impossible to consider design only at the theoretical level. A scientific design theory must be created in conjunction with collected data, its analysis and practical application. (see also Routio 1998 and 2000.)

I am applying the media scientific design model of Mauri Ylä-Kotola (1999) to my research case:

In their general form, technical norms implement a certain aim *A*, a belief in a specific situation *B* and reach their goal by means *X* (Figure 1). Goal (*A*) is to design a digital game for the playground to support the teaching of mathematics to first and second graders. The belief in the situation (*B*) states that the successful implementation of a digital game depends on 1) *The playground as a context for the digital game*, 2) *the educational goals of teaching mathematics to first and second graders at Finnish primary schools* and 3) *enjoying the digital game*. The goal will be reached by using the following means (*X*): 1) researching the special requirements of the playground as a context for digital games, for example, user interface design compared to traditional digital games. 2) Finding out the educational goals for teaching mathematics to first and second graders. 3) Analysing the features that ensure an enjoyable game experience in that context. (See Ylä-Kotola, 1999, 52-53.)

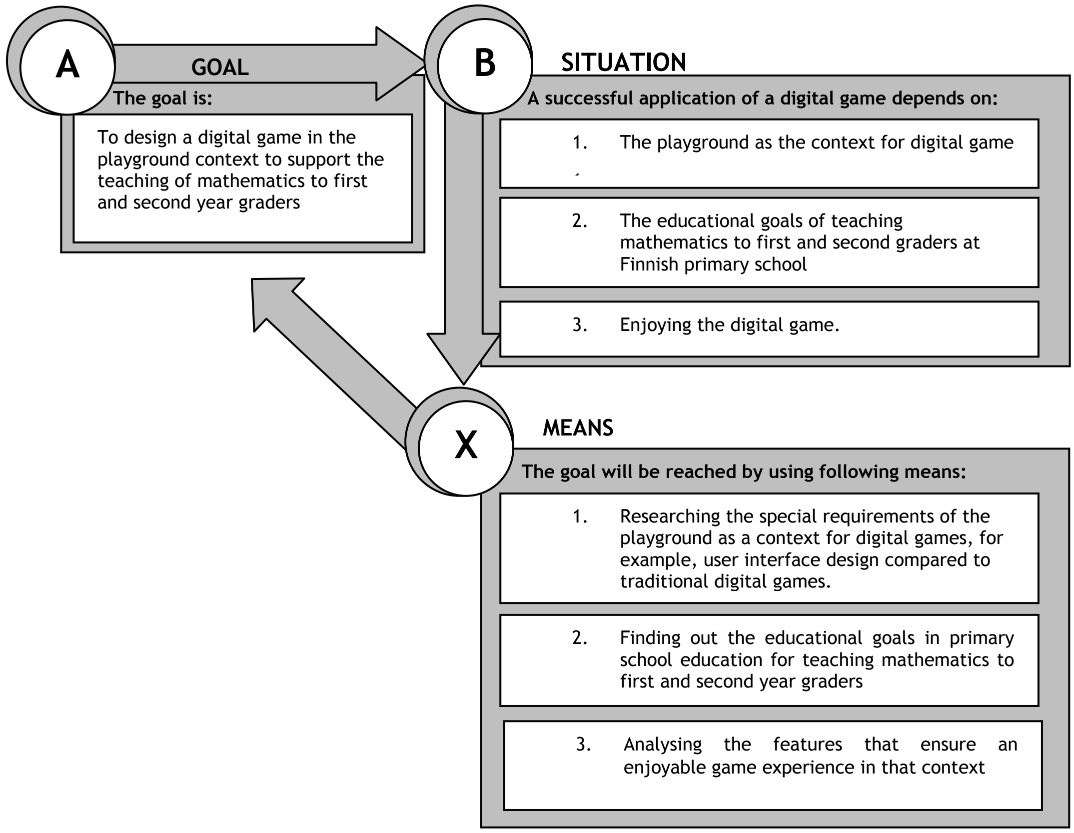

Figure 1. The structure of a design method

4 Challenges in Using Digital Games on the Playground

4.1 Playground as a context for digital games

The playground as a context for digital games involves different challenges than those related to traditional digital game design. Weather conditions, wear and vandalism are all practical restrictions in terms of design. However, I will not attempt to observe design from these angles. I am interested in the typical culture of action in the context of the playground, and in how that information could be used when designing an user interface for a game. In this context, *user interface* refers to the tool that a player uses to control the game, like a keyboard and mouse for a computer game or a control unit included in play equipment as part of a new playground concept. In recent years, user interfaces of games have developed significantly. Along with traditional solutions like the keyboard, mouse and joystick, other solutions like body user interfaces have appeared and are already available for use by most consumers. Body user interfaces are those controlled by broader body movements. (see also: Kuivakari et. al. 1999). Some new body user interfaces include the Eye-Toy (Sony), a USB-camera positioned above the television that reacts to the player's movements and dance pads (Logic 3, Red Octaine), used for a game in which users dance upon a digital carpet. For future user interfaces, it will be possible to offer more "natural" manipulation: interfaces are becoming more imperceptible and a more natural part of controlling games, like steering wheels and pedals in a rally game. Widespread wireless technology also offers more opportunities for new interface innovations.

While considering the playground as a context for a digital game, it becomes evident that the typical and unique culture of action on the playground is related to the joy of playing and competing. To maintaining this culture of action, game operations must comply with the typical action models of playing at the playground. User interfaces must be as natural as the action specific to the play equipment; therefore, games should also be closely integrated to the play equipment. In addition, applied technology and digitalisation should be as imperceptible as possible. A well-designed interface provides usability without using applications through a specific interface. When the user experience is pleasurable, users get the impression of efficiency and usefulness and feel that they are in control of the situation. (Ermi 2002; Jäppinen & Kirvesmäki 2002; Lankoski et. al. 2002.) For example, in order to discover user-friendly solutions on the playground, it is impossible to put up computer displays that reduce a player's mobility, since this is not characteristic of playground activities.

User interfaces at the playground must differ radically from traditional user interfaces of digital games because they should support the activities of a child. Therefore, different body user interface solutions should be considered. At SmartUs, we have tentatively considered solutions based on touching, weighing or pulling, which are easy to include in most play equipment, because jumping and climbing are two typical forms of action in the playground context. It is still unclear how feedback will be provided, but changing symbols, lights, voices, letters or numbers in play equipment are possible options. When aiming to increase user-friendliness, usability testing is crucial. Even though end-users are not able to design user interfaces themselves, they are able to tell which parts of the interface seem functional. (Jäppinen & Kirvesmäki 2002.) Therefore, I am eventually going to test my user interface and game solutions on end-users as well.

While the target group of the pilot playground is children, individual differences – not only age and sex, but also lifestyle, knowledge and skills – make the task of designing difficult. Therefore, it is wiser to approach design by considering the motivations and meanings of actions involved in operating; these become apparent for people in the form of aspirations and preferences. Human activity varies according to the situation and is based on several factors, including previous experiences; therefore, familiar elements and forms of actions from other contexts should be utilised when designing new solutions for user interfaces. (Jäppinen & Kirvesmäki 2002.) When adapting digital games to the playground, it is also important to consider the common features of traditional digital games and to especially perceive common playground activities.

4.2 Digital games on playgrounds to support the teaching of mathematics to first and second graders

The Finnish comprehensive school curriculum for first and second graders as defined by the Finnish Ministry of Education (2004) form the basis and the requirements for the pilot models of playgrounds and also for any digital game executed in that context. The aim is to maintain the joy of learning and enthusiasm. Work is based on the child's level of development, enhancing verbal development and willingness to learn new things. Learning by playing is essential when activities take into account the child's need to learn through imagination and play (PEOS 2004.) I also keep this in mind when designing digital games to support education; such games should provoke the learner's curiosity, interests, independence and motivation. The activity should be meaningful and challenging from the child's point of view.

According to the present concept of learning, knowledge is a mental representation that humans construct in their minds. Since learning is understood as a learner's own active construction, it requires active involvement. (Malinen et. al. 2004) A teacher can neither learn mathematics for the pupil nor transmit his or her knowledge to the pupil. Activity is often seen as an inevitable addition when a solid basis for comprehension is created. (Leino 2004.) Since concreteness is essential when teaching mathematics, the physical playground is an excellent place to concretise concepts. Digital games on the playground can adapt the environment to reflect each pupil's needs.

Playing educational games and taking advantage of information technology is considered suitable at preschool and primary school when combined with other exploratory and operational work methods. Through playing and games, a child takes an active role in learning, but ludic activities also support the child's positive attitude to mathematics and other subjects. It is easier to understand and manage mathematical concepts when they are integrated within action. Learning methods should also enable children's individual progress. Through digital games on the playground, students can rehearse basic numeracy; in addition, drills performed through games are easy to tailor to each pupil's skill level, which also helps to prevent unnecessary frustration. Narrations and illustrations created as part of mathematic lessons ease the understanding of verbal tasks – when children realise that the task is actually a story that can also be drawn or performed. (Ikäheimo et. al. 2004.) By closely linking the mathematic lesson with the storyline of a game and elements familiar to children, it is easier for them to understand everyday mathematic phenomena. When a child has the freedom to pay attention to the mathematic phenomena of their environment and to also utilise these notions as a basis for understanding mathematic concepts, better results in learning are achieved.

In the 1990s, so-called ”edutainment-games” appeared on the market these have developed a slightly bad reputation. The goals of edutainment were to make the time children spent playing video games more "useful" and to make learning more fun and entertaining. Edutainment-games have been accused of "sugar coating" bitter pedagogical issues

– one is entertained as long as the bitter poison is swallowed. (Resnick 2004). However, it is questionable whether leisure activities should really be so "useful" and whether inventing ways to cover up boring pedagogical contents with fun games is the best solution. Instead, we could observe children's spontaneous play, which includes lots of different learning skills. Since a child's natural way of observing the surrounding environment already involves mathematics, it is important to maintain this attitude and to build new concepts based on it, instead of replacing those with the "ready-made" mathematical models constructed by teachers. (Haapasalo 2004.) The problem with existing digital games for education is that pedagogical contents are often not relevant to the game itself (Kangas 2003). In traditional digital games, activity is generally focused on the inner world and story of the games. Therefore, pedagogical contents should be presented as part of a story and not as a series of disconnected tasks. (Ermi ym. 2004, 81.) Chris Crawford (1982) evaluates learning as a crucial part of motivation in all games, albeit unconscious to some extent. Getting acquainted with new issues, being in control and learning itself are pleasurable. On the other hand, however, games are most enjoyable when they are interpreted as entertainment.

4.3 Enjoying a digital game

Unnatural completion is often a problem in digital games for education. In a good game, the activity in itself is rewarding and entertaining; the goal is not just the final result. The functions of the application should be presented so that it is possible to perceive continuation and consistency. (Ermi 2002.) A game experience is more rewarding and entertaining if players are deeply immersed in the game and motivated by the action. The ideal game experience, which should also maximise the skills and knowledge absorbed from the game, resembles a *flow*-experience (the optimal experience), as defined by Mihaly Csikszentmihalyi (1990).

Interaction between an individual and his/her environment plays an essential role for motivation. The features of the environment where the individual interacts reveal the sensibility of his/her experiences (Jutila & Niemelä. 2000). Children's interests are naturally directed towards activities that they still cannot fully control. Games and play are typical forms of interaction among children. Children do not need to be forced to play, because plays and games are imagined situations that are motivating in and of themselves. (Helkama et. al. 1998.) In order for playing a digital game to be enjoyable, motivation should spring up within the player (Sinnemäki 1998). A game should offer enough challenges and opportunities without being too difficult, especially when the individual is just learning how to play. If the final result remains unclear well into the game, the challenge is multiplied and motivation is sustained. (Caillois 1961; Ermi et. al. 2004.) From the player's point of view, it is frustrating when the possibility to succeed is lost at the very beginning.

In digital games, the goal is often for the player to be submerged in the game world. The phenomenon in which the existing world is blocked during the game experience is called *immersion* (Huhtamo 2002; Stuart 1996). Immersion can take place rationally based on the activity that the game requires, or emotionally by getting the player involved with the game's storyline and identifying the player with the game character. Functional empathy, which is based on methodicalness and rationality as opposed to emotionality, often ensures greater success in the game. If the game's functional and intellectual proposals are too challenging or if the player sees a game figure mainly as a tool that enables interaction (see also Weinbren, 2002), then the emotional force of immersion may be relatively minor. On the other hand, however, the play on fantasy and reality is also pleasurable. Emotional immersion by involving the player in the game's narration or identiying the player with the game's character offers the player the chance to use his/her imagination and enjoy the fantasy of the game. By empathising with the game world, storyline or figure, the player can experience the actions of the game figure. (Ermi et. al. 2004.) In the context of identifying, the concept of transportation can also be used (Lombard & Ditton 1997). Then the player feels transported to the game world and senses that game events happen to him/her. In that case, the player's emotions are substantially stronger.

The experience of *flow* only occurs if a person is motivated by the action performed. An immersive game experience resembles the state of flow defined by Mihaly Csikszentmihalyi (1997; 1990; 1988). Flow has been considered an indicator for successful user interface or game (Pilke 2000; Järvinen et. al. 2002; Ermi et. al. 2004). In the experience of flow, according to Csikszentmihalyi (1990), the individual loses all sense of time and place and concentration heightens. This withdrawal is highly pleasurable. To offer rewards, flow requires sufficient *challenges* – a balance between executable task and skills. To maintain flow, the challenges and skills of the individual must develop in relation to one another and must motivate learning and development. The activity performed should correspond to the needs and goals of the individual but should also be self-rewarding. (Csikszentmihalyi 1988.) Flow does not require unlimited possibilities and freedom; on the contrary, if an activity does not have a clear goal, it might even inhibit the experience. (Csikszentmihalyi 1990). In a certain sense, this reflects limited interaction. At their best, digital games are excellent at providing flow: the game's activities offer sufficient diversity, flexibility, a proper level of challenge, clear goals and immediate feedback. In addition, the player has the possibility to progress by degrees to become a more skilful player. (Csikszentmihalyi 1990; Ermi ym. 2004; Pilke 2000.)

Does the optimal enjoyable game experience – whose activities are both entertaining and self-rewarding – necessarily require flow? Specifically, a challenge related to the different game goals and player skills has been established as a prerequisite for a successful, riveting game experience (Ermi et. al. 2004). When the user focuses on the task at hand, cognitive capacity rises and the user experiences a strong sense of pleasure. When this state has been reached, intellectual achievements become easier, so understanding and decision-making become more efficient and pleasing. (Pilke, 2000.) An optimal digital game to support education should spark the flow experience.

5 Conclusions

I consider the design of digital games in the context of the playground to support the teaching of children in the following theoretical model from three points of view (see figure 2.): (1) *context*, (2) *game functioning to support teaching* and (3) *entertainment*. When observing the model from the context of a digital game, *usability* is the main goal. When user-friendliness is the aim, the *user interface* of the digital game should support the typical *culture of actions* of the playground – the joy of playing, gaming and physical exercise. This goal can be reached by searching for body user interface solutions integrated with playground equipment. When considering digital game suitability to support teaching, *learning through playing* is the main aim. This depends on the *educational goals*, their purpose and on how the game *adjusts to the player's level of skills*. In this case, educational goals include the teaching of mathematical concepts like numbers and quantities to first and second graders. By using typical solutions of levelling, traditional digital games can easily be adapted to the skill levels of the players or learners. Different player profiles can allow the game to adapt to each player's needs. The entertainment offered by digital games is the third point of view of my theoretical model. The most important goal in this perspective is the optimal gaming experience or (in other words) *flow* experience. Even digital games intended solely for entertainment require commitment and *motivation* from the player: the game has to be fascinating. When the game activity is *challenging* enough, game *immersion* is possible. To a certain extent, immersion resembles a flow experience, which is so to speak an even more optimal gaming experience. Through the flow experience, it is possible to maximise the achievement itself and the pleasure derived from it, but also the assimilation of skills and knowledge. In this way, flow influences both education and entertainment. When the goals of all perspectives of the theoretical model are reached, the result is a digital game that is enjoyable, entertaining, user-friendly - and suitable for education.

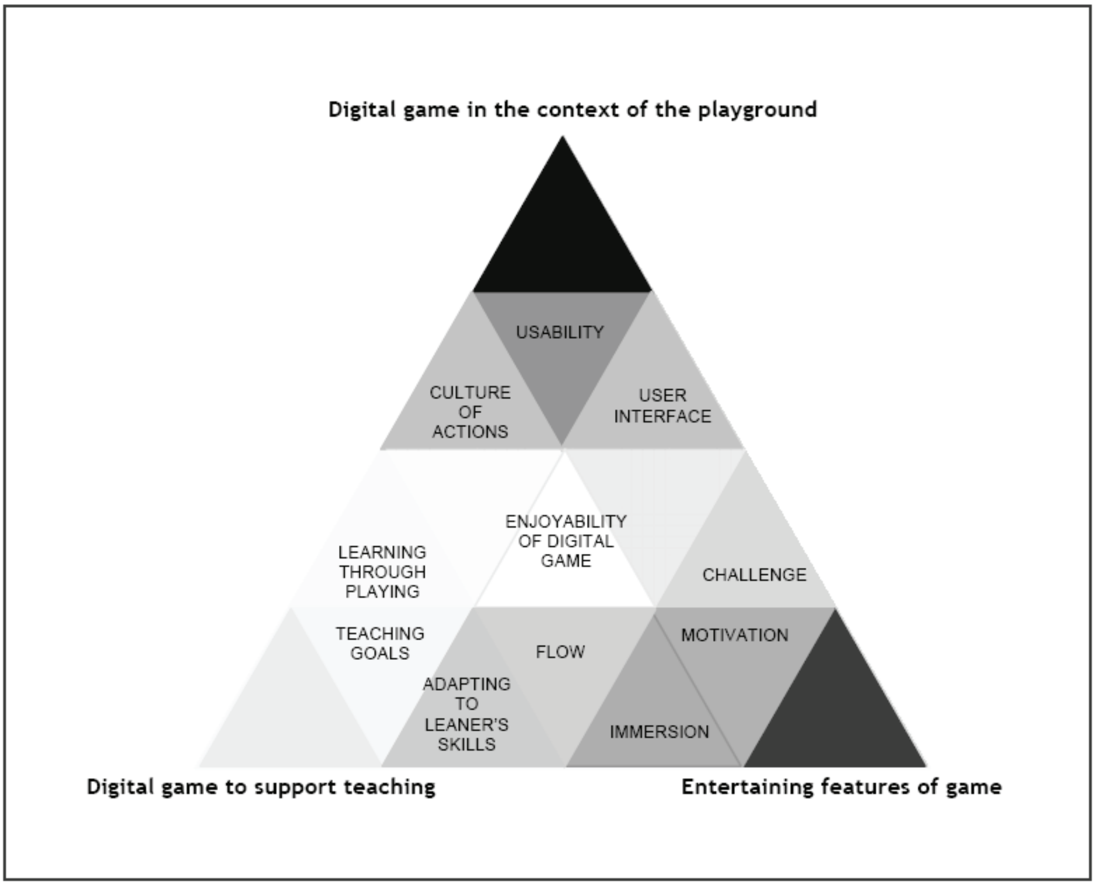

Figure 2. A theoretical model to design a digital game to support teaching and executed on the playground.

It is worth considering how entertaining educational digital games should be in general. Digital games to support teaching are not meant to compete with games designed solely with entertainment in mind. Instead, the goal is to

reproduce the features of entertaining games that could be utilised for educational games as well. The goal is not to totally replace traditional education methods but to discover and develop new methods that reflect the spirit of our age and to serve learners better. As I mentioned before, there is a long path to tread from theoretical models to practical design. Therefore, my intention is to put my theoretical model in practice in my future research and thus further develop the model.

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Emotionality in TSL processes

Intention, Imitation, and Common-Sense in Network-Based Collaboration

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This article discusses network-based collaboration in teaching-studying-learning (TSL) processes. It clarifies the background of emotional and social connections between students from perspectives of educational sciences, philosophy, computer science, and neuro-sciences (MIT-research). Especially, on the theoretical level, the mechanisms are explored which enable emotional and social connections, and shared intentions and feelings in empirical research. Both the research of mirror neurons and the conceptions of 'common-sense' and 'mental infrastructures' offer explanation for 'meeting of minds' whereas 'augmented cognition and reality' afford more possibilities for network-based collaboration.

Keywords: Network-based collaboration, intentionality, imitation neurons, mental infrastructures, augmented cognition

1 Introduction

The meaning of *common-sense* as a contextual basis for collaboration and mutual understanding is significant; it is an interconnected network of implicit beliefs about the world and our relations to it. We use common-sense every day in

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teching-studying-learning (TSL) processes, for it is a common background in interpreting others as rational beings. *Mirror neurons* support our ability to "read one's mind" and empathise other's emotional states; they foster high learning levels, moreover their role is important behind-the-scene, where empathy, social skills, cultural rules and deciphering facial cues are constructed by predicting, mimicking and understanding actions of others.

Mental infrastructures are highlighted in this article. Although all the people are not-alike and they think about different things, they have similar mental infrastructures, they think in the same general ways, and their thinking shares the general characteristics and structures of the human mind. This enables people to empathise and even understand each other. The discussion about *augmented cognition* and *augmented reality* continues the topic of network-based collaboration. Several methods of augmenting one's cognition are considered in the article, as well as human's cognitive functions and technologies that are needed to extend human cognition. The concept of 'augmented reality' is examined from two viewpoints: (1) classical approach that meets some difficulties while utilising it in network-based collaboration, and (2) the conception of 'extended AR' that gives an opportunity to support people's collaboration in network-based environments.

In the next chapters, we first examine the status of *intentionality* in distant tutoring. Secondly we discuss the *imitation* based on the functioning of *mirror neurons* as one key factor in network-based *collaboration* and interaction. Finally we clarify the meaning of mental infrastructures and 'augmented' cognition. By this article and these topics we find answers to following questions: How do virtual university students judge intentions and feelings, how they assign goals or beliefs to the others? By means of what do mental representations refer to something outside the mind? What is the status of mirror neurons in network-based collaboration? What are the things called 'mental infrastructures'? Is it possible to augment one's cognition? Is it possible to apply the concept of Augmented Reality (AR) for the purposes of supporting network-based collaboration?

We find it important to discuss more closely collaboration and interaction in network-based settings because as both teachers and students we have experienced that there are mechanisms that support collaboration and also construct and maintain mental connections that require 'meeting of the minds'. In reading one's mind, the most essential factors are the following ones: imagination, ability to empathise, and emotional reciprocity (c.f., Chayko, 2002; Damasio, 2000/1999.) In the creation and maintenance of the socio-mental connections, the human memory and the experienced emotions are central, because in network-based collaboration people bring about emotional states by means of different symbols, pictures, rituals, speeches, texts, 'mental images', and, especially, thought. Within these emotions, a 'shared state of feeling' is brought about, collaborators are supported (or, 'hold up'!), and their states of mind are being simulated. This means that in dialog, the connections between distant collaborators are strongly both emotional and cognitive. (Chayko, 2002; Damasio, 2000/1999b; Siegel, 1999.)

One possible explanation for, or - at least - a sound basis for description of, the 'meeting of the minds' is offered by the research of *mirror neurons*. Most probably, distant collaborators are able to emphasise by the means of mirror neuron systems described within neurosciences and interaction research. In other words, they are able to consider situations from another person's perspective and interpret and express bodily feelings via textual interaction, too. Important parts of text based communication, besides written text, are qualities such as rhythm, intensity, nuance, and the length of replies. (Lehtonen et.al. in print)

According to Auyang (2000), the locus of cognitive science is not mind but mind's infrastructures or mechanisms underlying mental phenomena. Almost the same may be expressed by saying that brain processes are located on neural level. Properly interpreted, results on infra-structural slowly enhance our understanding about human mind and neural processes it is related to. Mistaking infra-structural processes for mental phenomena, however, leads to confusion and obscurity. Further, we cannot hope to explain how mind emerges from the self-organisation of infra-structural processes without clarifying what it is that emerges.

2 The status of intentionality in distant tutoring

In respect to network-based learning environments, it is important to carefully define the concept of 'intentionality'. Logico-philosophical considerations of intentionality combined with socio-constructivism have effects on the practical decisions of how to achieve co-operative zones of proximal development (ZPD) (Vygotsky 1978a) or scaffold learning (see e.g. Bruner 1985; Wertsch 1985) in network-based surroundings.

Social interaction between learners as subjects and their intentionality takes place in groups, the members of which live at a distance from each other. Just placing students in different groups does not guarantee collaboration as we very easily may find it to be. Special support scaffolding is needed but still social interaction and its background processes in different levels of human activity will be the key to collaboration: if there is no social interaction, focused interaction with the attending persons then there is no real collaboration (Garrison 1993). We take it seriously, that certain pitfalls occur without careful scaffolding. These pitfalls in socio-constructivist network-based surroundings are, for instance, taking social interaction for granted and restricting social interaction to cognitive processes (Kreijns et al. 2003). To understand the process, it is important to understand that the interaction happens in system having multiple levels of processes which may be understood only by seeing them as a hierarchical process where the deeper level success is a base for higher level success and vice versa.

Scaffolding here shares the features of expert tutors: intensive interaction, rapid feedback, highly personalised and situationally contingent guidance, encouragement and the elicitation of responses from the student in the form of explanations, suggestions, reflections and considerations. Qualitative scaffolding, that emphasises the intentionality of learner, avoids offering ready-made information, direction, error corrections or answers (Salomon & Perkins 1998; Lehtonen et al. in print). Special attention is needed to pay on tutors' competence to motivate, recognise and understand group processes and the qualities of linguistic socialisation in network-based environments.

The question concerning the status of intentions in teaching-studying-learning processes is "By means of what is a mental representation or an 'interpretant' (Peirce) or symbol (Vygotsky) directed to something (or, 'referring' to something)?" And the answer is "By some conceptual sub-model". According to Peirce, both sensations and concepts are mental representations. The almost same idea has been defined also by L.S. Vygotsky (1978a) by defining symbols and concepts as tools for mental activity, which may be constructed from external sources. As a matter of fact, distinguishing between sensations and concepts originates from scholastic philosophy. Vygotsky's perspective is an interesting one: he sees symbols and concepts as tools, as a mediating mean in a similar way we have tools for helping us to act with the concrete world. In addition to described, it was probably Raymond Lull, who for the first time drew a difference between *intentio prima* (sensation) and *intentio secunda* (concept). This paper will concentrate on the latter notion combining it to Vygotsky's idea of symbols and concepts as tools for mental activity. We shall use the more familiar term 'mental' instead of 'non-physical' keeping in mind, however, the essential difference between a concept and its *intension*, the former belonging to the realm of 'transcendence' (or Popperian World 3) and the latter belonging to the realm of mental phenomena (or Popperian World 2) (compare, esp., Marjomaa 2004; Popper 1992, p. 180 ff.).

In order to be able to clarify the status of desires and feelings in network-based collaboration we engage us to the kind of a framework, within which an intention is interpreted as being a 'perspective' that consists of an *intension* (of some concept, proposition, or structure as tools and non-psychical material for the activity) and a conceptual scheme (composed of some interrelated concepts, propositions, or structures - see Marjomaa 2004).

3 Mirror neurons as one key factor in network-based collaboration

We are interested in the mechanism behind common-sense realism. What actually is this "sense"? How is it possible to "read other's mind" or have mutual understanding with other participants in network-based learning, where interaction is constructed merely by symbolic interaction ways, as by textual usage. How do virtual university students judge intentions and feelings, or assign goals or beliefs to the other? Also cognitive empathy, correspondence in social learning and social conformity are topic questions, which may be explained for some amount on the first theory level by mirror neuron systems and mirror neurons. Even though mirror neurons are located in the central nervous system, we consider students as intentional embodied subjects 'along the lines presented by Daniel Dennett (1996).

Mirror neurons were found in the 1990s by Rizzolatte and Gallese (1998) and their colleagues at the University of Parma. Mirror neurons are called imitation neurons as well, for early findings, for these neurons explain monkey's ability to imitate other monkey or the trainer. In brief, according to Motluk (2001) mirror neurons are active when their owner performs certain task and same neurons fire, when their owner watches someone else performing the same task. According to Wesson (2001) it also happens in the face-to face -studying context (cp. "joint attention" and "shared feelings"). A student watches a teacher or when he watches another student in a co-operative learning setting, mirror neurons must be active in a similar observation-execution matching system. When student watches another student perform a task or even starting to perform that action, mirror neurons fire vigorously.

"To read one's mind" can be seen as a social ability based on deeper level internal personal brain functions, and, more exactly, as the ability to comprehend, what other person thinks, what are his/her feelings, beliefs, intentions and what are his/her actions of others. Anyway reading someone's mind, or a theory of mind, is an ability that we adult persons have, and we are pretty good at representing the specific mental states of others. Motluk (2001) emphasises, that we are able to understand complex mental states, too. When you hear, that students have missed their files, you share the hurt and harm. This means, that modalities, that make mirror neuron systems and mirror neurons to activate, are not merely watching the real activity, but also hearing about episodes that has happened to another person. As for example Damasio (2000/1999a; 2000/1999b; 2001/1994) states an imaginative reconstruction of actual happening will result a similar type mental state as actual situation. This ability is engaged with common-sense realism, with second-order representations and ability to make comparisons.

Mirror neurons support our ability to "read mind" and they foster high learning levels, moreover their role is important behind-the-scene, where empathy, social skills, cultural rules and deciphering facial cues are constructed by predicting, mimicking and understanding actions of others. During verbal discourse, even anticipating another person's words as they complete a sentence seems to be associated with these neurons, states Wesson (2001).

The theory of Goldman is called "simulation theory" which construes mirror neurons based on the idea that people understand what is going through the minds of others by mentally mimicking what the other is thinking, feeling or doing - in essence, putting themselves in others' shoes. In interaction between the sender and receiver should be common understanding about what's passing between them. Rizzolatti and Arbib (1998) agree, that mirror neurons explain some features how this is achieved on neural level (Motluk, 2001). Ramachandran (2000) found that "denial" syndrome or anosognosia is due to damaged mirror neurons (c.p. e.g. Damasio 2001/1994). As we adapt his words, when a student wants to make a judgement about others student's movements, she/he has to run a kind of "mental simulation" of the correspondence movements. Without mirror neurons it wouldn't succeed. Virtual university students are running these "mental simulations" frequently, for they study physically separated, but are connected with different kind of network-based environments.

The identification in any social learning presupposes a notion of correspondence between students. Nehaniv & Dautenhahn (2002) offer the pattern as follows: if the demonstrator and imitator have similar bodies, e.g. are animals of the same species, of similar age, and of the same gender, then to a human observer an obvious correspondence is to map the corresponding body parts. Besides body parts, there is also obvious correspondence of actions. Furthermore there is a correspondence in sensory experience: audible sounds, visible objects and colours and so on evidently seem to be detected and experienced in similar ways. In our case, in the network-based learning environment each student has continually both demonstrator's and imitator's role; student's bodies are similar and in addition to the structure, their bodily expressions are all posed similar way – by textual telling. So far we know, that it is feasible mediate and perceive bodily voices, especially intentions by that textual way. We'll carry on our research to find out which are those various accurate bodily voices that are explained by mirror neurons.

Nehaniv & Dautenhahn (2002) ask, what should "matching behaviour" mean, when bodily correspondence is not obvious? By bodily correspondence we mean social interaction of students that we consider as whole entities so that mind and body are inevitable and inseparable from each other (Dennett 1996; Damasio 2001/1994). We don't interpret the emotion and intentions posed in student's texts as physical fact, as if they were hidden at the bottom of consciousness; rather they are visible types of behaviour. This behaviour (correspondence actions) reinforces the coherence of students. Our conclusion is that conformity is strong enough to yield unpleasant arguments of occasional student. Besides, solid social conformity may prevent developing fruitful dialogue among students.

4 The relation between mental phenomena and mental infrastructures

According to Sunny Y. Auyang (2000), the locus of cognitive science is not mind but mind's infrastructures or mechanisms underlying mental phenomena. The almost same may be said by saying that the brain processes are located on neural level. Properly interpreted, results on infra-structural enhance our understanding slowly about human mind and neural processes it is related on. Mistaking infra-structural processes for mental phenomena, however, leads to confusion and obscurity. Further, we cannot hope to explain how mind emerges from the self-organisation of infra-structural processes without clarifying what it is that emerges. By mental phenomena, we mean the activities described by common-sense mental and psychological terms such as experience, feel, care, concern, recognise, err, believe desire, think, know, doubt, choose, remember, anticipate, hope, fear, speak, listen, understand, and intend. Infrastructures presuppose what they support; they are integral parts of a larger system where they play certain roles. Thus the mental infrastructure presupposes the mental level. Cognitive scientists delineate infra-structural processes according to their functions in mental life, such as their contributions to vision, memory, or speech comprehension.

Although knowledge about the mental infrastructure illuminates the structure of mind, its light is indirect. Infra-structural processes lack understanding and feeling. Therefore they are qualitatively different from mental processes (c.f., e.g., Auyang 2000, Damasio 2001/1994). To explain mind directly, we have to show how the two kinds of process are causally connected, how a process on the mental level emerges from the self-organisation of many processes on the infra structural level. Cognitive scientists call this the binding problem, which demands an account of how myriad unconscious processes combine into the unity of consciousness. Auyang (2000) says that many "regard its solution as the Holy Grail, as it will answer the question of how our mental and physiological properties are related. Unfortunately, the knights are still out and it is unlikely that they will return soon with the Grail." On recent years some attempts have been made to build a model of it. We refer especially to the work of Antonio Damasio (2000/1999a; 2000/1999b; 2001/1994).

In a previous study, Auyang (1998) found examples from various sciences showing that emergent properties are never easy to explain, and the connection between levels is a bridge that requires firm anchors on both levels. In tackling the binding problem, we have to first consider the problem of spelling out the basic peculiarities of the mental level. What are the phenomena that we expect the science of mind to explain? To answer these questions, according to Auyang, we must turn to our everyday experiences.

Scientists and folks in the street think about different things, but they think in the same general ways, and their thinking shares the general characteristics and structures of the human mind. These characteristics, to which Damasio and Auyang summarily refer as mind's openness to the world including the person's body, are the topics of their analyses, because they provide the basis of a big picture of mind (Auyang 2000, Damasio 2001/1994).

Seeing, believing, hoping, and deciding are some of the most common mental activities that everyone engages in every day. They are equally fundamental to empirical scientific research, where they are generally called observing, hypothesising, predicting, and explaining. All cases share the common characteristics that our observations and beliefs are mostly about events and states of affairs in the world that is physically outside us. It is common sense that reality goes in its own way independent of our thinking, so that hopes can shatter and predictions fail. We are aware of our own fallibility, so that we often doubt our eyes and judge our beliefs false. Scientists, too, as Auyang correctly notes, make falsifiability an essential criterion of their hypotheses and theories. Auyang advocates common-sense psychology and brings the cognitive science under everyone's consideration. People see; Cameras do not see but merely register light. See, believe, doubt, hope, and act are parts of the mental vocabulary that expresses what most people mean by mind and embodies common-sense psychology or folk psychology. Common-sense psychology is indispensable to understanding of each other and ourselves; everyone knows and uses it intuitively. It is ordinary and not glamorous.

According to Auyang (Auyang 2000) as cognitive scientist and Damasio (Damasio 2001/1994) as neurologist, the basic structures of our mind lies not in *qualia* or intelligence or feelings hiding inside the head nor located totally in brains. It lies in the intelligibility of the brain and the whole body as part of the process as well as world and the encounterability of objects. The double- or triple-sided structure that encompasses experiences and intelligibility, subjectivity and objectivity, Auyang calls mind-open-to-the-world. It is what the closed mind lacks.

According to Auyang, openness is the mental capacity by which we experience things, care for other people, and turn the blind and indifferent environment into an intelligible and meaningful world. Mind can be open to the world only because it belongs to persons who are physically part of the world. People with open mind are neither pure thinkers nor mere brains; they are fully bodied as Damasio states, manipulating things purposively and communicating with other people through various physical objects, through physical media. Therefore Auyang maintains that the open mind belongs not to the brain, not even to a person in isolation, but to a person radically engaged in the natural and social world. The mental level where the mental phenomena occur is the engaged-personal level.

5 Augmenting human’s cognition and reality

In this chapter we examine augmented cognition and augmented reality. The word "augment" is used in cases where we need to specify something that needs to be increased, incremented or supplemented. It is also used in the sense of "strengthen" or "reinforce". Speaking about *cognition*, the term "augmented" implies spreading or extending human's perception of the world. The concept of Augmented Reality gives the technological basis for extending the reality that is perceived by the person and can be considered like an instrument for augmenting human's cognition and like some kind of facilitator that supports people's collaboration in network-based environments.

5.1 Augmented Cognition

According to L.S Vygotsky (Hung & Der-Thang 2001; Wertsch 1985; Vygotsky 1978a; Vygotsky 1978b) and Schmorrow (2002), there are three basic methods of augmenting the human condition. As a species we have already implemented two of these methods with varying degrees of success. First, humans began extending the body thousands of years ago by cultural inventions mediating means for human activity by material tools and purely conceptual tools as concepts, models and theories. Extending the body started through the use of clothing, hand tools, vehicles, and weapons. Second, humans began extending perception with eyeglasses, telescopes, and, more recently, with hearing aides, cameras, electron microscopes, night-vision goggles, and now retinal and cochlear implants. But the conceptual tools were as important as the material ones, the invention of technical means were much based on conceptualisation and modelling technological processes and nature for building those technical means as well as conventional inventions to use and understand those phenomena which could be seen by new means. However, it has only been within the past decade that the technologies needed to extend human cognition, as well as conceptual means have emerged. Augmenting cognitive functions such as perception, comprehension, insight, and memory overtly transcend the traditional boundaries of the slowly evolving human mind and body.

Schmorrow & Patrey (2001) remind that one of the shortcomings of traditional human-computer interaction is its failure to be tailored specifically for human cognition. Human cognition has particular virtues and limitations; designing interfaces to maximise the virtues and bolster the limitations could produce substantial gains in information management capability. These cognition-centric design principles strive to move beyond mere human-computer interaction and towards human-computer symbiosis – a catalytic marriage between the heuristic-driven, context-sensitive powers of human cognition and the detail-oriented, data crunching might of computer computation.

This symbiosis becomes feasible due to progress made during the "Decade of the Brain" in expanding the understanding of brain mechanisms and introduction of novel non-invasive assessment tools (such as fMRI), the ongoing "Cognitive Revolution" in behavioural science producing advances in the science of problems solving, reasoning, and decision making, and the growth of digital technologies in pure computing power, miniaturisation and ruggedisation, data mining sophistication, and evolving advancements in robust input/output devices.

According to Schmorrow & Patrey (2001), these advances produce four significant content domains: multi-modal interaction, shared context, interested management, and a new generation of human factors issues. Traditional computer systems rely almost solely on visual information (with a meager auditory component) – future systems will be inherently multi-modal, relying on all sensory and motor processing channels for receiving and conveying information. Traditional computer systems also are restricted because humans and computers operate within different contexts – computers are wholly unaware of cues that humans give the highest priority or how to capitalise on those cues to help humans better process information. Similarly, computers lack the ability to truly 'serve' the user and determine what information in an environment should be omitted, what should be highlighted, and what should be portrayed with accuracy (and what determines sufficient accuracy). Finally, the advent of these new tools in the human and computer domain requires a new generation of human factors design issues be addressed.

5.2 Augmented Reality as an instrument for augmenting the cognition

Augmented Reality (AR) is a technology that allows seeing objects in network-based surroundings superimposed on real world objects (Augmented Reality 2004). The difference between AR and VR (Virtual Reality) is that VR immerses user inside a virtual world that completely replaces a real one. In AR the situation is different: virtual and real can be seen in the same space and ideally couldn't be distinguished (Bonsor 2001). Augmented reality adds graphics, sounds, haptics and smell to the natural world as it exists.

Contemporary AR systems are able not only superimpose graphics over a real world in real-time, but also change those graphics to accommodate a user's head- and eye- movements, so that the graphics always fit the perspective. There are several areas where AR systems are used. They are collaborative work and design, medicine (e.g. surgery), education tools, games, robotics (for remote control and maintenance), architecture and interior design, military applications (battlefield AR systems – BARS) and some others.

There are three components that are needed for an AR system to work: head-mounted display (HMD), tracking system, and mobile computing power. Consideration of each of them separately leads to understanding that in practice it is quite difficult and even impossible to use such systems in supporting learning and human collaboration processes. The reasons are the following ones:

1. Need to wear displays. Advanced AR system offer its minimal-size approach like only eyeglasses (or even contact lenses), but its cost is so high that it seems to be impossible to use it. Moreover, there are no commercial products (at least now).
2. Mobile computing power: there is not enough computing power in available now wearable AR systems for creating 3D graphics.
3. Low accuracy in registration (ability to view virtual objects from any point).

4. Bulky hardware (if you use HMD, cameras, pocket PC, … it's difficult to pay attention only on what you want to do, but not on how to utilise all this stuff).

The idea is to extend the augmented reality concept in order to make it applicable for supporting people's collaboration through network-based environments. The aim is to create such kind of interface that follows the person (but not vice versa, when the person needs to reach the network-based environment in order to make the interaction possible) and acts as a facilitator in any kind of task.

There is a variety of ways of using AR in a natural way for such kind of purposes. Keeping away from displays and other wearable devices one can imagine the space with several special projectors that allow transforming any surface into a projected touch-screen. People can interact with the projected image by only touching the surface. Users can work together and looking on the wall or table or floor, or any surface they want. (Such kinds of devices are already commercially available, e.g. *Everywhere Display* (IBM research, 2004) by IBM).

Another way of bringing AR features to collaboration process is to support the way of working and learning based on user profiles represented in the form of *Avatars* (any kind of creature). Avatar features and representation can be adjusted by the user; can be dependent on the user location in the world and inside the physical working space. Such kind of user representation supports everybody's awareness about everyone who is "in process", i.e. about those who are "in flow" and can support you in your work, your cognitive processes.

Such kind of features allows every participant to know at every moment what is happening in a network-based environment even if she is not at her computer. People are immersed into the atmosphere of "everyone presence" that motivates participation and stimulate community spirit.

6 Conclusions

In previous investigations (Hyvönen et al. 2003a; Hyvönen et al. 2003b.), we have shown that intentions and emotions of virtual university students come across strongly and are easily interpreted even though the students are not face-to-face, only 'the minds meet'. This means that we do not subscribe to the view that body language is not used in the network-based learning although it cannot be seen. This kind of a 'meeting' is extremely bodily occasion, the affects of which to motivation and progression (or, interruption) of studies can be clearly observed. For the 'meeting of the minds', the students searched for a common context, which showed to be such as, for instance, the same kinds of personal trait - we talk here about *shared emotions*. We found very interesting the feature that also the kinds of 'negative trait' such as, for instance, envy, served for a 'bridge' in the 'meeting of the minds' (Hyvönen et al. 2003a; Hyvönen et al. 2003b).

According to Chayko (2002), the same place of birth, for instance, is sufficient for the connective factor. This shows that the bridge for the meeting of the minds needs not to be relevant for the object of study nor in any ways 'current'. Building up the 'bridge' is closely connected to the questions, to which we searched for the answers, in this article. In this respect, the meaning of common-sense as a contextual basis for collaboration and mutual understanding is significant, because as Forguson & Gopnik (1988) state, common-sense is an interconnected network of implicit beliefs about the world and our relations to it. We use common-sense everyday in teaching-studying-learning processes, for it is a common background in interpreting others as rational beings.

In this article, we have discussed neuro-biological explanation, especially the functioning of mirror neurons, which is extremely significant in teaching-studying-learning processes in network-based settings, because their function is not only the imitation of seen movements, but also the supplying of intentions, emotions, and social context from peer to peer. In order to speak meaningfully of objective likeness of humans' intentions, emotions or of common-sense, we need to form a compact conception of relations between mind, body, and the outside world including other bodies and minds. In this article, we take Dennett's, Auyang's, and Damasio's conceptions for granted: although all the people are not-alike and they think about different things, they have very similar mental infrastructures, they think in the same general ways, and their thinking shares the general characteristics and structures of the human mind. This enables people to empathise and even understand each other.

We find it relevant to discuss about augmented cognition and augmented reality because these conceptions allow the considerations of new possibilities for collaboration and interaction from a new and fruitful point of view. We admit that there are quite serious restrictions in utilising AR concept and technologies for the purposes of network-based collaboration, but the AR approach we proposed in this article can be used successfully for the facilitation of network-based interaction.

In future, we'll focus more closely on mechanisms on different levels. The first level is neural level where mirror neurons have an essential role. The second level is the level of persons, where we are interested in their interaction and in intra-personal experiences as well as in network-based settings. In addition, we'll carry on the research where we consider the significance of emotions in teaching-studying-learning processes (see Lehtonen et al. in print).

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Learnt without joy, forgotten without sorrow! The significance of emotional experience in the processes of online teaching, studying and learning

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This article examines the significance of emotion for the processes of teaching, studying and learning. The goal is to demonstrate on the basis of both theoretical examination and empirical data that emotional processes are crucial for human learning and should be taken into account in online teaching and learning as well. Emotional factors during studying influence in several ways whether one studies, how one studies, whether one learns and whether one remembers what one studied. We also examine online group dynamics in online teaching and studying from the point of view of shared emotional states and online conveyance of emotions. Emotional situations related to studying are also examined from the point of view of cognitive and emotional load and via the concepts of situational anxiety and situational pleasure. The examples in the empirical data were collected during 2002–2003 from online courses of the Cornet project. The data was analyzed by classifying the data referring to emotionality with nVivo program under special themes described in this article. The data contain student essays "I as a learner" during the "Education, organisations and culture" study unit (N=12) and students' study-related email messages during the "Learning organisation and small group dynamics" study unit (N=28).

Keywords: emotions, emotionality, feelings, network based education, teaching-studying-learning,

1 What do emotions imply in the processes of teaching, studying and learning?

A feeling is a state of mind with a connection to both psychical and somatic experiences and strongly anchored in physical experience and bodily feelings (Damasio 2001/1994; Ihalainen 2004). By emotion we refer to mental activity that is comparable to perception, thinking, language and learning, which also produces feelings (Damasio 2001, 2001/1994; cf. Nathanson 1992; Tomkins 1962, 1963, 1991, 1992). Emotions are consciously or unconsciously generated processes with negative or positive tone that help estimate the significance of situations and actions and their value for one's self (cf. *information theory of emotions,* Simonov 1981; cf. Nathanson 1992; Tomkins 1962, 1963, 1991, 1992). According to the contemporary view, emotional processes are located not only in the evolutionarily old parts of the brain, the so-called limbic system, but emotions are found throughout the entire brain (Kernberg 1995; Siegel 1999). One may claim that processes on the emotional level serve to give direction and impetus for such human activities that appear rational. Studying via online networks is no exception to this. (Damasio 2001/1994; Ihalainen 2004; Siegel 1999). To quote Damasio (2000/1999b 257–258), the concept of consciousness can be reversed, consciousness is a strongly emotional experience, *a feeling of what is happening*. Emotions are experienced as episodes and mental states of various types, such as mood, happiness, sadness, hate or anxiety. A large number of emotional processes are barely conscious or unconscious. (Damasio 2000/1999b; Oatley & Jenkins 1996; Siegel 1999). Emotions

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might be considered as processes, with identifiable stages: first events are evaluated for their relevance to what is important to us, then follows an evaluation of the context – what can be done about the event (Oatley & Jenkins 1996). Emotions may be seen as mental stages of readiness for action, setting priorities and prompting plans.

We see the human emotional activity in teaching, studying and learning (Illeris 2002; Uljens 1997) with the aid of theoretical level structure construct based on multiple levels of observation. The emotionality is seen in it on five levels of observation: 1.) The level of subject's internal emotional neural mechanisms (neuropsychology / cognition science), 2.) The level of subjects' emotional aspects of behaviour as a subject, 3.) The social level of shared feelings and emotionality as subject as a member of groups, in joint attentions, 4.) The emotionality in cultural level and 5.) The emotionality in inter- or transcultural level in global-level social interaction between teachers, students and learners with different cultural backgrounds. These highest levels are not more discussed in this article. (see Tella et al. 2004; Lehtonen et al. 2003; Lehtonen & Vahtivuori 2003; Uhari & Nieminen 2001.)

The crucial importance of emotions and social cognition for interaction and collaboration is obvious (Bion 1962; Damasio 2000/1999a, 2000/1999b; Pitkänen 2003; Siegel 1999). A person's emotions and the so-called manifestations of embodiment may be seen as significant factors for the processes of teaching, studying and learning as well. Emotions and the tendency to assess experiences on the basis of how pleasurable or disagreeable they are (for more detail, see Siegel 1999; Simonov 1981; Sinkkonen & Kalland 2001) are not only background factors for inclination to study and motivation but also directly bear on how one studies, what one studies, whether one learns anything an whether what one learns is remembered (Damasio 2000/1999a, 2000/1999b; Pitkänen 2003; Siegel 1999; Virsu 1995). The body, the brain, the intellect and emotions are inseparable parts of us. The physiological-psychological activities labelled as the mind are generated in a functional whole of the body and its environment, not only in the brain or data processing. (Alanen et al. 2003; Damasio 2000/1999a, 2000/1999b; Dennett 1996).

Social interaction on the level of feelings, online group dynamics and the manifestations and interpretations of embodiment must all be paid attention to when planning for online teaching. The present interactive facilities, being mostly text-based, place great demands on interaction. Both the technology used and teaching and studying arrangements influence what emotions are evoked and conveyed by studying and what students experience. Online studying, on the other hand, entails protection afforded by technological conveyance, an option to withhold one's true feelings. This experiential emotional protection may also make collaboration on the level of feelings easier in a group and lead to extended openness, even to an extent rarely encountered in personal interaction.
How are social activity, social ties and communities created when the participants do not meet each other? Personal interaction is not always necessary for establishing social ties but what is necessary is reading or understanding, by various means, the minds of others online, *a meeting of the minds*. Imagination, the ability to empathise, entering into another person's role and emotional reciprocity are essential factors in mind reading for generating a shared mutual emotional state. (Chayko 2002; Damasio 2000/1999b). How is an emotional and social connection made and maintained in online studying? For creating and maintaining socio-mental connections, human memory and experienced emotions are crucial. When interacting, participants evoke emotional states through various symbols, pictures, rituals, spoken sentences, written texts as well as through mental imagery and thinking. These emotions serve to create a shared emotional state, "carry" the other participants and simulate the states of mind of others. For generating socio-mental connections, people utilise a human mode of action called embodiment. In a dialogue, namely, one not only interacts with information but also on the individual level as a member of a group. The connections are strongly both emotional and cognitive. (Chayko 2002; Damasio 2000/1999b; Hari 2003; Ihalainen 2004; Siegel 1999).

Both attachment relations research (e.g. Simpson & Rholes 1998; Sinkkonen 2004; Sinkkonen & Kalland 2001) and neuroscientific research on emotions (e.g. Adolphs 2002; Borod 2000; Pitkänen 2003; Siegel 1999) and mirror neurons (e.g. Gallese & Goldman 1998; Pitkänen 2003; Wolf et al. 2000) provide a possible explanation for the meeting of the minds. Presumably, the participants are able to empathise through interactive and attachment relations experiences in childhood and through the emotion and mirror neuron systems, as described by neurosciences, i.e., can examine situations from the viewpoint of others and also interpret and express bodily expression through text-based interaction. Important elements of this communication, in addition to written text, are the other qualities of text-based communication, for example, the rhythm, intensity and tone of communication and the length of replies. In each case of different multimedia communication, different options come into play, with *voice over IP* giving such communication extra dimensions and *IP videoconferencing* its own, particularly in the domain of nonverbal communication (see more e.g. Lehtonen et al. 2005). In addition, communicative proficiency and learned skills in using these tools for conveying one's communication have a major effect. (Gallese & Goldman 1998; Haapasalo 2001; Hari 2003).

In addition to the concepts of interaction and emotion, it is necessary to examine the concept of learning process. We define learning as a long-term change of knowledge, skills and practice that is based on alterations in the neurological system (c.p. Virsu 1991, 1995). In this connection we separate the concepts of *teaching*, *studying* and *learning* (Illeris 2002; Uljens 1997). Teaching and studying are activities whereas learning itself, as a neuropsychological and neurobiological event, is connected to this process as an expected outcome of activity that is separate in time (Lehtonen & Vahtivuori 2003) because permanent learning requires that the brain has time to reorganise after studying (Haapasalo 1993; Virsu 1991, 1995; Hari 2003; Virsu & Haapasalo 2001).

It is not possible to offer a functional online study unit that is appropriate socially, cognitively and emotionally by applying only traditional methods, for example, transferring lectures and individual traditional tasks on the network (Ruokamo et al. 2002). Learning is engendered in network environments and elsewhere but only through students' own activity, with a significant role played by related cognition, emotions, social practices and culture (Illeris 2002; Tella et al. 2004). In addition to individual activity and the related emotions, it is vital to (Illeris 2002) learning processes (Hakkarainen et al. 2004; Lehtinen 2003; Mercer 2000/2003). It can be stated that the emotions and shared emotional states manifested in social-level activity and computer-aided online interaction both unite and divide people. Feeling is one of the few things that a person can, in the last analysis, share with another person (Damasio 2000/1999b; Siegel 1999; Tamminen 2004). Moreover, a Connet student in our data during the *Education, organisation and culture* study unit wished to share an emotional state when beginning a new course. "*The links seemed to have a connection to Socrates, maybe I can return to the topic after I've checked it out, it would be nice if someone else would be excited about it too*!" (Student 1.) Then, the challenge for teachers and teaching is organising online activity, i.e. teaching, so that it engenders and nurtures lasting learning, where the significance of emotion needs to be taken into account both on the individual and group level..

2 Embodiment is knowing, feeling and interaction

By embodiment, we refer to an entity of experience and interaction that contains the forms of embodiment, *embodied cognition* and *act of embodying* (Damasio 2001/1994; Hirose 2002; Hyvönen et al. 2003; Hyvönen et al. 2003). In other words, knowing and feeling are experienced in the entire body, and the body also serves as an interactive system that receives, interprets and conveys information. The manifestations of embodiment relate the emotional state and the experiences of students and their desires and intentions in the processes of teaching, studying and learning (Damasio 2001/1994; Hyvönen et al. 2003; Hyvönen et al., 2003).

It illustrative that, in the "*I as a learner*" essays (N=12) by the online students of the study unit "*Education, organisations and culture*" in the Cornet project of the Finnish Virtual University that comprised our data, scientific goals were also expressed as emotional goals, as demonstrated by the following example. "*I think it would be even more interesting to know how I could learn to have real peak experiences in science and my studies as well*". (Student 2.) The students' expressions involve both emotions and rationality, which are not opposites (Damasio 2001/1994; Sweller & Chandler 1994). Embodiment and its emotion have frequently been decontextualised in online teaching and studying, perhaps partly because cognitive and constructivist views and the related view on knowledge almost exclusively emphasise knowledge and knowledge construction that is separated from emotion. Views on learning hardly bring up personal knowledge, whose existence, transfer and interpretation are embodied, individual personality or personal life situations. Has decontextualisation been influenced, along with the proliferation of online teaching, by a restricted view of the learning environment? When discussing online learning environments (Tella et al. 2004), one must remember that the environment always is a physical, psychical, social and cultural whole and a cognitive-emotional model of the mind that is generated through personal interaction and enables the participants to produce culture, feel joy and frustration and interact with each other and their environment. (Hyvönen & Juujärvi 2004).

In connection with cognition, embodied cognition and act of embodying, brain researcher Antonio Damasio (2001/1994) states that emotions should be included in the concept of the mind. Yet many scientific descriptions of cognition fail to account for them when analysing cognitive systems. Emotions are frequently viewed as fuzzy matter that cannot share the stage with thoughts and tangible content. The view that removes emotion from the mainstream of cognitive science has its counterpart in the field of traditional brain research – and, we believe, in the field of learning research. (Damasio 2001/1994). Nevertheless, emotions are as cognitive as any other observable content of the mind. Emotions represent an individual-level system that provides us with valuable information about the state of our own bodies and the relationship of ourselves and our bodies with ongoing activity (Ihalainen 2004; Siege, 1999; Simonov 1981, 20–28), such as studying. How this activity proceeds is largely guided by emotions. (Burkitt 1999; Damasio 2001/1994; Siegel 1999). We always assess, in all activity, our knowledge and acts also emotionally, even though we do not always notice it. However, emotional assessment can be perceived, for example, in the following comment by a student. "*I feel that what is involved…*". The system of emotions is, according to Damasio (2000/1999b), a largely unconscious yet important subsystem of our thinking. Simonov (1981, 28) states in his *information theory of emotions*: *Emotions are the integral parameter, which is the basis for decision-making. Emotions reduce all variety of purposes in their simplest forms into only two of them: achievement of positive emotions and elimination of negative emotions* (cf. Damasio, 2000/1999b. 41).

3 What are situational anxiety and mental load?

Situational anxiety is an emotional response to a situation that is perceived as too rapidly changing, difficult and its characteristic features. Anxiety may be seen also in relation to fear; those may be seen in a way compelling feelings (Thompson & Madigan 2005, 162; Huttunen 1997; Nathanson 1992). In strongest forms situational anxiety is sometimes replaced by situational fear and avoidance toward the whole activity or situation (Thompson & Madigan 2005, 162; Huttunen 1997; Nathanson 1992).

A concept developed by us, *situational pleasure*, in contrast, may be understood to be the opposite, an emotional response to a situation that is experienced as easy or pleasant (cf. flow Csikszentmihalyi 1992). *Mental load* as a concept has been derived from Sweller's theoretic model of *cognitive load* (Chandler & Sweller 1991; Sweller & Chandler 1994) by supplementing it with *emotional load*. *Mental load* implies an excessive burden in relation to a learner's emotional and cognitive resources that is caused by the structures and activities of study-related equipment and materials, which diminishes learning capacity. A part of this load is due to learning of the issue being processed and a part to concurrent effects of negative emotions. (see e.g. Thompson & Madigan 2005)

3.1 Situational anxiety and situational pleasure

Feelings of fear and helplessness and experiencing a situation as threatening inhibit learning. On the other hand, the situation itself may be remembered well but what one attempted to study during it is often forgotten. Indications of this have been found within neuropsychology, in particular. (Booth-Butterfield 1988; Cahill et al. 2001; Damasio 2000/1999b; Virsu & Haapasalo 2001). Situational pleasure, i.e., positive emotional substance that is evoked in a situation of learning or other activity, has an effect of supporting, even enhancing, remembering, cognitive functions and learning. (Damasio 2000/1999b; Virsu 1995). This is utilised in different areas, for example, in the entertainment industry where the activity itself is entertaining. The pleasure provided by the senses
and embodiment is an important element in the contexts of learning.

Also text-based interaction affords situations of pleasure. In the following quote, a student searching for materials for his assignments shares through email his joy that was evoked in the domain of music. "*It's a done deal. I'll start typing once it's evening. – I just found a few songs of my favourite band on the net and I can't help spreading the good news around*." (Student 3. Email.)
The above quote also relates how a feeling of solidarity may develop. According to Chayko (2002), it develops from pleasure, which proceeds from a shared emotional state when participants realise that they enjoy the same interests or find that they were born in the same city, etc. The interpretations of similarity may be erroneous yet they engender positive emotions and solidarity. (Chayko 2002).

The fact how easily situations are felt to be a burden or a pleasure is also influenced by the student's earlier experiences and attitudes. In the following, a student relates the significance of emotions and expectations and brings up the manner of interpreting and experiencing integral to his own model of the mind. "*Feelings and expectations too are crucial for the learning process and have an effect on what and how I learn. As a learner I could symbolise myself as a round red ball. Red because I have a positive attitude, which usually has made learning pleasurable*." (Student 4.)

In the following description a student demonstrates the power of emotions and mood in the context of studying. An irritated and frustrated mood lingers about the text. According to the student, a teacher's patronising manner in school expressed underestimation of learners, which affected his mood, behaviour and studies. "*– but in retrospect, in comprehensive school I worked hard and needled teachers whenever they had a patronising attitude toward students. In gymnasium, after teacher authority slackened and the learning environment became uninteresting I ended up being expelled from the majority of biology, psychology, geography and English courses because my criticism reached a peak that was disturbing. – When we were taught the dates of the Second World War, I was reading about the massacre on* *the Tien-an-Mien square and was moved to tears*." (Student 5.) Whether this had an effect on learning in the end, cannot be concluded from the description.

The significance of situational anxiety and fear is revealed in its extreme form when a person faces a threatening situation and concentrates on repulsing danger or escaping to safety. Another outcome may be passivity. Such situations are often accompanied by neurological and hormonal responses, for example, perspiring hands and stuck thoughts. (Adolphs et al. 1995; Cahill 1998; Siegel 1999). Under these conditions one is strongly controlled by emotional assessment and relatively rigid action patterns instead of flexible creativity and conscious problem solving (Siegel, 1999).

It has frequently been observed that the reactions caused by emotional assessment and situational anxiety have effects that inhibit studying, learning and remembering, as well as being linked to study avoidance behaviour (Farnill 2001; Griffin 2000; Siegel 1999). Situational anxiety disrupts studying, especially when one studies something for the first time, and may lead to study avoidance behaviour (Oatley & Jenkins 1996), for example, dropping an online course. In later stages of studying, however, challenges or situational anxiety arising from a learning topic or problem may also have positive effects. In the following, a student describes an insurmountable situation caused by a study unit where the only solution was to leave off the unit. The quote also describes how the expectations and experiences of online studying do not always coincide. "*This simply won't work at all now ... online studying takes up three times as much of energy, time and effort as regular studies. I don't have any other option left except to drop out of it all*." (Student 6. Email.)

3.2 Mental load

Mental load has a crucial effect on alertness and selective attention. For example, an excessive load, deficient materials, equipment or navigational structure or incompetent use of hypermedia may, along with the load caused by subject matter, lead to rapid exhaustion and scattering of selective attention, which is important for studying, towards multiple targets. Moreover, excessively low demands of the subject matter may reduce alertness and diminish motivation (Virsu 1991, 1995), as told by a student (7.): "*I'm restless because I've got a short attention span and easily get bored if learning fails to motivate me. I'd rather have an excessive challenge – the easy stuff doesn't appeal to me*."
Poor network orientation, study counselling and ambiguously compiled and expressed information about study content and goals can cause excessive load and apathy, even though such information is intended to help perceiving cognitive structures. The following quote is by a student who reflects on why students fail to benefit from the study instructions of online teaching. "*The instructions are too long. On the Internet people realised ten years ago already that people always ask the same questions no matter how thorough the FAQ is. This "defect" in those asking the questions is so common that we can't perform massive brainwashing but need to do something about our materials. ... But it's possible to add to confusion. Even a little ambiguity increases the risk of confusion. The control is over there where the material is produced, not where the students are*." (Student 8. Email.)

Furthermore, acquisition of study materials appears to cause what is felt to be an extra load. "*Myself, I spent last week fishing for books and what a gloomy experience it was*." (Student 9. Email.) "*In any case, if you haven't even seen the books it's awfully difficult to know how to write or present anything. If I can't soon come up with a way to deal with this smartly without burdening the rest of the group, unfortunately I may have to stop this*…" (Student 10. Email.)
A crucial factor for mental load is time management. Maintaining the pace on a course designed with a fixed schedule may entail problems. This causes anxiety to both the student and the group. The first of the following quotes is from a message by a student where he reports why it has been impossible for him to be active during a study unit. The second quote relates the life situation in which a student attempts to study. "*Now I've got to send something so that the gang would believe I still exist. I've had many things, war wounds…– Was there deadline for deciding on topics? (Now it comes out how poorly I've been involved, I'm a little ashamed of myself…)*" (Student 11. Email.) "*I need to go again to work today but I'll try to get something done later in the evening*." (Student 3. Email.)

3.3. Factors affecting situational anxiety and mental load

On the basis of our empirical data it can be stated that what is essential in online teaching, studying and learning is that the situation and the activity can be felt to be sufficiently secure. By the feeling of security we imply that a student can rely on instruction and tutoring, technology, scheduling, interaction and peer groups. A secure environment encourages unconventional thinking, creative practices and trial and error (Hyvönen & Juujärvi 2004; Siegel 1999).

An online student must achieve a harmony with his internal qualifications and difficulties and the emotions that they give rise to. Internal qualifications include goals, interest, motivation and will, i.e., *volitional* factors. Inner difficulties, in turn, are related to beliefs about ability, attitudes and various fears. Examples of external difficulties include the so-called accessibility factors or gaps, which occur, for example, when a student does not have use of a computer, necessary software or sufficient support, such as a support person. A significant external difficulty may also be considered to be vague expectations of cognitive activity or online orientation: because of defective instructions or tutoring the student is unable to perceive the entirety of action or content, its subgoals and subactivities. In addition, the terminology used may cause perceptual gaps. “Getting lost” because of faulty orientation (Galperin 1989) is unpleasant and often leads to intense situational anxiety and mental load with numerous consequences. External difficulties and qualifications can be addressed by those planning for and offering study units. In an optimal situation, difficulties are removed and qualifications reinforced so that teaching and studying can have potential to result in learning. (Hyvönen 2002).

In the following chapters we highlight the factors that are related to: 1. pedagogical models and guidance, 2. reliability of technological solutions, 3. reliability of equipment and 4. content. According to our data and experience, these are the most central sources of situational anxiety and factors that affect mental loading.

3.3.1 Pedagogical models and guidance

The structure, goals and methods of a study unit are usually described and introduced by using various online materials and tools. Course planners are not necessarily qualified designers of online materials and tools or online material producers qualified pedagogues. A student who has designed several web sites writes as follows: “*How many online projects employ a “real” professional? There are so many that feel they can produce material that is just fine after a bit of training. The net is perceived too simplistically*.” (Student 8. Email.)

The purpose of online instructions is to enable quick grasp of the structure of studying so that a student can subsequently assess his own needs, goals and time management. If the tools and instructions are not clear enough (*improper orientations,* c.p. Galperin, 1989 (Page et al., to appear), the student may try to find the fault in himself. “*There are many online students who can’t ‘cope with computers’. They may experience this as an oppressive failure. If they are asked how well an online course functions, they may blame some problems on their own clumsiness and think that ‘I should have managed it faster’ or that ‘it’s my fault*’”. (Student 8. Email.).

Tutoring must always be reciprocal and tailored to each student’s needs. Students may feel that they are left alone with their problems if tutoring is delayed or not available. Experience also shows that university students find it difficult to organise groups on their own and that work that is intended to be collaborative will not automatically take place. “*It never became very clear how an online reading circle was supposed to be organised in practice*.” (Student 12. Email.)

The significance of a general orientation period lies in the creation of *a common ground* (*grounding process*) (c.p. Galperin 1989). This is the time when shared goals, rules, meanings, operational principles and fundamental knowledge that are required of everybody will be created and clarified and the necessary tools provided (Mercer 2000/2003). A shared basis of online orientation functions as a cognitive and mental framework between people and technologically-based equipment. The creation of a shared basis particularly decreases mental load, situational anxiety and contributes to the necessary feeling of security. Also modelling can be utilised to clarify a student’s position so that selective attention and study processes will proceed optimally. Such models provide the student with a script and a pattern of thought about what, how and when he should act.

3.3.2 Technological solutions

Situational anxiety and mental load can also be caused by the technological solutions for activity and interaction. Related factors are students’ ability and inability to use information and communication technology and, for example, difficulties in using applications needed for certain courses. The technology must be suitable and usable for a pedagogical context (Mattus, 2004; Tella et al. 2004). For instance, two views have been expressed on the suitability and usability of an online study environment that we have used. Students were critical of a tool that did not intuitively correspond to user expectations about its logic of operation but, through its complexity and inflexibility, lead to situational anxiety and desire to withdraw. The producers of the study unit defended the study environment on the grounds that it taught students by forcing them to face problem solving, i.e., one had to solve the problems involved in using the study environment in order to proceed. Problem solving, then, was seen as an element of the current study unit. Consequently, the key issue is the ability to tolerate mental loading – how far will a student be able to progress in a cognitively and emotionally taxing environment and to what extent does the actual studying of the content suffer from such an environment? An environment or a tool should not be a hindrance but rather an instrument for thinking and problem solving (Fjortoft & Sageie 2000).

3.3.3 Reliability of equipment

Unreliability of the equipment in technological teaching, studying and learning environments, i.e., computers, networks, operating systems and software, causes fear of failure. This was also revealed in a study on the experience of the aged. An interviewee relates "*And then the screen played whatever tricks, every now and then, out of spite, hah. But it did swallow up my text many times and showed some crazy things on the display*." (Hyvönen 2002).
Technological problems can be diminished by improving the reliability of equipment under different conditions of use, providing clear support systems for solving experienced problems and improving the usability of diverse equipment and their suitability for teaching and studying practice. The online communication solutions of the near future, such as IP multimedia communications, are valuable options because of their features that convey emotional factors more comprehensibly. (Lehtonen et al. 2005). On the one hand, the equipment used for teaching and studying has significant potential but, on the other hand, may give rise to feelings that students are unable to keep up with the development. (Hyvönen 2002; Lehtonen et al. 2005; Virsu 1995).

3.3.4 Content

From the point of view of meaningful learning, the goal is offer, instead of make-believe assignments, challenges rooted in real life and real problems to solve. A creative design project for the needs of an actual shipping company on a Connet course is an example of a real-life assignment. The student needed to see where the outcome ended up and whether it had an actual effect in real life.

A Connet student (13) brings up the significance of content while first reporting a failed studying and learning experience at a mathematics lecture and then a successful experience on a psychology course: "*I experienced lectures of a very different type last autumn on a psychology course on new know-how and learning environments. We were encouraged to discuss, we worked in small groups and we were able to choose the topic that interested us for our essays. This course left a much more positive impression…*"

4 Reward and feedback in online teaching and studying

Learning requires tutoring and other forms of feedback for both successes and failures. Goal orientation, situational pleasure and a harmony of mental load, as well as the joy of succeeding derived from learning something new, enable students to keep trying despite failures and occasional displeasure. Studying at the upper limit of one's current skill level, in *the zone of proximal development* [*"at the ladder of challenges"*] (Vygotski 1978), gives students continuous feedback for successes and failures, which is essential for learning (Virsu 1991). Feedback provided by an actual person or generated by a technological system is significant from the points of view of both motivation and actualisation of the learning process. Giving feedback does not only mean one-sided commentary, on the contrary, it is an interactive and embodied situation where emotions are highly significant.
Reward and feedback are two different things. Feedback informs whether the learning process was successful or not and how the activity should be modified in the future. Reward, in contrast, is a form of feedback that offers a deeply emotional experience in the form of pleasure. The systems in the brain that are activated by feedback or reward are different. A reward modulates, i.e. guides, learning in the brain, as is currently understood, through emotional pleasure mechanisms, such as the amygdala. Feedback, in contrast, activates pleasure mechanisms hardly at all. Feedback that opens new views also supports learning new things and creative insight, which means that it also modulates learning emotionally. Although rewarding schemes have an effect on the motivation to learn, one should note that the motivation to learn is predominantly endogenous. How and what each person experiences as rewarding varies greatly. (Virsu 1991.)

A benefit of online teaching is the opportunity for quick feedback and interaction, for *intense interactions*. This interactive nature applies also to the instruments of information and communication technology used for teaching online courses, which at their best function as tools that support the student's thinking and problem solving, as instruments of thought (Lehtonen, manuscript). Students especially expect that online equipment and materials provide forms of interaction that facilitate studying (cf. Prensky 2001). The most natural manifestation of interaction is a dialogue, in some situations of online studying between a technological agent and an actual person. Interaction and activity in online teaching are also defined by to what extent the student can influence the course of his studies via his own activity. One may also speak of social process-oriented and content-oriented, or data-oriented, online studying. Both are needed for practical online teaching and studying, but a suitable balance must be found between the two. (Lehtonen, manuscript).

5 Conclusion

In this article, we have presented the connections on several levels whereby emotions are linked to learning in online teaching and online studying. Emotionality is seen to influence studying and learning in this paper transdisciplinarily simultaneously using different theoretical viewpoints and seen simultaneously on different levels of theoretical research and understanding; beginning from the level of internal neuropsychological / cognition science emotional processes and binding it together with the higher level theories of emotions and social cognition for human interaction and problem solving on ICT mediated environments. The emotionality is seen simultaneously on personal and social (=interpersonal) as well as in cultural and inter- or transcultural level. The perspective is seen to produce understanding where the micro and macro levels theory of human emotional behaviour is been used to support each other's. (see Tella et al. 2004; Lehtonen et al. 2003; Lehtonen & Vahtivuori 2003; Uhari & Nieminen 2001.)

Studying needs to be meaningful and must produce activity that is emotionally and socially as well as culturally appropriate on both individual and group level and takes into account student context, i.e., their life situation. The emotional system has multiple effects, in addition to learning-oriented activities, on whether something is learnt and remembered later. In online studying, the equipment used also provides challenges. The essential factors to be accounted for in planning for and offering online teaching and studying include reducing the students' mental load and situational anxiety, which are influenced by several factors, to a sufficiently low level and creating and maintaining an appropriate emotional environment. These will function not only as sources of motivation but also as supports of learning on the level of neurological systems. A comment by a student (14) "*I just love learning situations where the separate pieces begin to form meaningful wholes in my mind*." refers to the assertion in the title of this article: *learnt without joy, forgotten without sorrow!*

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New media and online video clips

The Role of New Media in the Worldview and Activities of Primary School Pupils

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This article focuses on the worldview of Finnish primary school pupils and on the role of new media in forming their worldview. Children spend a great amount of their awake time with the stimulative world of new media. Along with the more traditional communication channels, the Internet has rapidly gained ground and has become part of children's everyday lives. Communication on the Internet is mostly based on text and visual objects. This holds true with the other means of expression in new media, such as games and mobile technologies.

The aim of this article is to describe the role of new media in forming child's worldview and its effects on children's activities. The theoretical background of this article is based on the analysis of the notion of worldview. This notion is then operationalized with a structural model, which is expected to help us to describe, analyze and understand the various facets of the worldview. Also, this article will describe the world that new media is offering to us and in which children live today in an information society.

Keywords: worldview, the Internet, new media, communication

1 Introduction

The most powerful authorities outside school and far reaching format of communication are visual (Masterman 1991, 12). That was the situation 15 years ago. Children of today can have even more striking effect from digital media. Visual message goes through a person's intellectual reception more easily than written words and it's emotional side is stronger than text. When we add sound to a visual message – often music – we can assume, that the effect is growing bigger and becomes more powerful.

According to Steinbock (1983) reality is not the flow of happenings. But it is neither given to the psyche of a spectator. Reality is a process of growth. A little child is not living in reality (in symbolic order). His world is one of dreams and wishes, an area of omni potency and threatening phantasies (imaginary order). The level of awareness is very primitive with a person who is in a phase of development. The ground created to the conception of a critical view is at this time in the very beginning. We can assume that it is difficult or even impossible to create a critical view to the model of worldview that media offers.

The authorities who control media have possibilities to set orders of importancies and also power and resources to offer explanations and build their own versions of events. This article is taking a task to define the concepts worldview, the Internet, new media and communication.

2 Aims

The aim of this article is to describe the role of new media in forming child's worldview and also how it shows in children's activities. Modern technology and new media offer great amount of information to society. This article is trying to describe how this information is forming the worldview of a child, who is the target of it all. How is this all forming his awareness about himself and society around him. The intention is to have a study later and research the formulation of the worldview of Finnish primary school pupils and look into the role of new media in their activities.

Children spend a great amount of their time with the stimulative new media. Along with the more traditional communication channels the Internet has become more common and a part of everyday life. The communication in the Internet is based primarily in text and visual objects. This holds true with the other means of expression in new media, such as games and mobile technologies. The theoretical background of this article is based on describing the notion of the worldview. This notion is then operationalized with a structural model, which is expected to help us to describe, understand , and later analyze the various facets of the worldview. Also, this article will determine the world new media is offering us and in which children live today. This world we can call information society.

3 Background

3.1 The Notion of the Worldview

In everyday thinking a worldview probably has a meaning of a picture, which illustrates the biological world around people. There is some kind of a scientific worldview on the background. This brings along a complex and problematic concept, because there is no common opinion of a scientific worldview (Helve 1997, 176). Scientific character in this context means what kind of things belong to the worldview. One can explain this with the help of a scientific method (Rydman 1997, 10). According to Georg Henrik von Wright (1997,19) worldview is an assumption of a certain period or community outlook on birth of the world. It is also a construct of the world and comprehensibility of natural episodes. It contains interpretationality and right way of living, too. Martin Heidegger demonstrates this matter with making questions about supplementary concepts which are including this matter and their meanings. He answers himself: - Worldview - what it is? Probably a picture of the world. But what does world mean here? And how about the picture? World is a nomination to entity in its wholeness. (Heidegger 2000, 24). When we are talking about the worldview we have to keep apart two very intimate concepts – a worldview and the view of life. These concepts are often used parallel and often one on the other. After all these two concepts have their own identity. Their implications are quite close. At least they are relatives. Sometimes we can separate these two concepts quite clearly. The result is that view of life means something that one at the moment becomes conscious. It is explicit codified system of a viewpoint, too. Worldview is more implicit (Manninen 1987, 22-26). One can see worldview as a part of view of life, when the super ordinate concept is the view of life (Hirsjärvi 1984, 68; Niiniluoto 1984, 87). View of life insists active taking of an attitude. The worldview is a ground structure, when consciousness of it can be more passive.

According to Juha Manninen (1977, 16- 17) worldview includes following concepts:

1. time and space
2. birth of the world, supernatural and its impact , existence and – nonexistence
3. nature and man's relationship to it, nature as a frame of life
4. the man itself, man's relationship to others
5. urban structure, people, state and factors that define the course of the history

It is very difficult to create any sweeping worldview that is natural to every man. There are a huge amount of worldviews, because it changes and emphasizes always due to different background factors. According to Helve we can talk about different ideologically, religious and political accentuation to worldview and also some doctrine such as materialism, Marxism, liberalism, catholism or Islamism (Helve 1987,13). According to before mentioned, we can come to a conclusion that different kind of cultural factors have impact to formulation of the worldview. Every society creates its own culture (Dundes 1980, 91). Worldview and every category of it is a mental representation. World is existing with linquistic and figurative symbols in our mind (Takala, A. 1982). We have to include norms of the society in the worldview, too. They regulate foremost view of the world, which regulates our deeds (Hirsjärvi 1984, 66).

3.2 Worldview in this article

The structural model of worldview is the theoretical background of this article. Cognitive cycle, an observation process model developed by Neisser (1976) and the model of worldview by Helve (1987, 1997) has been background to the structural model with the theories listed ahead. The structural model of worldview is a gathering scheme. It is the background, which is expected to help us to describe, understand and later analyze the various facets of the worldview.

In the centre of the scheme is the worldview of an individual. This is influenced by the structure of personality and age by Piaget (1988, 23-24) and Bruner (1979, 1987 92-93). Other parts are based on gender (Garrett 1987), life experiences – historical perspective, physical characteristics and intellectuality. We can see media, globality, ideologies, society and ethnics in worldview offered by environment. Along with these ahead listed factors are science and scientific worldview and religion and mythological conceptions. These factors belong to meta level.

The formation of a person's ego and the structure of personality are based among other things on Bruner's thinking. Comprehension system been connected with the formation of a persons ego has an effect on the worldview (Rauste – von Wright 1995, 145). Changes in worldview been based on age find an explanation among other things in the model of periods of life by Piaget. Gender is a thing, which has not been very clearly in view with these clarifications of worldview been cited in this article. In spite of that we cannot leave gender without attention when talking about worldview. According Garrett (1987,vii) the impact of born as a male or a female is essential for the whole life. How people consider and experience an individual, and how an individual considers and experiences others. These are one of the things gender has influence on.

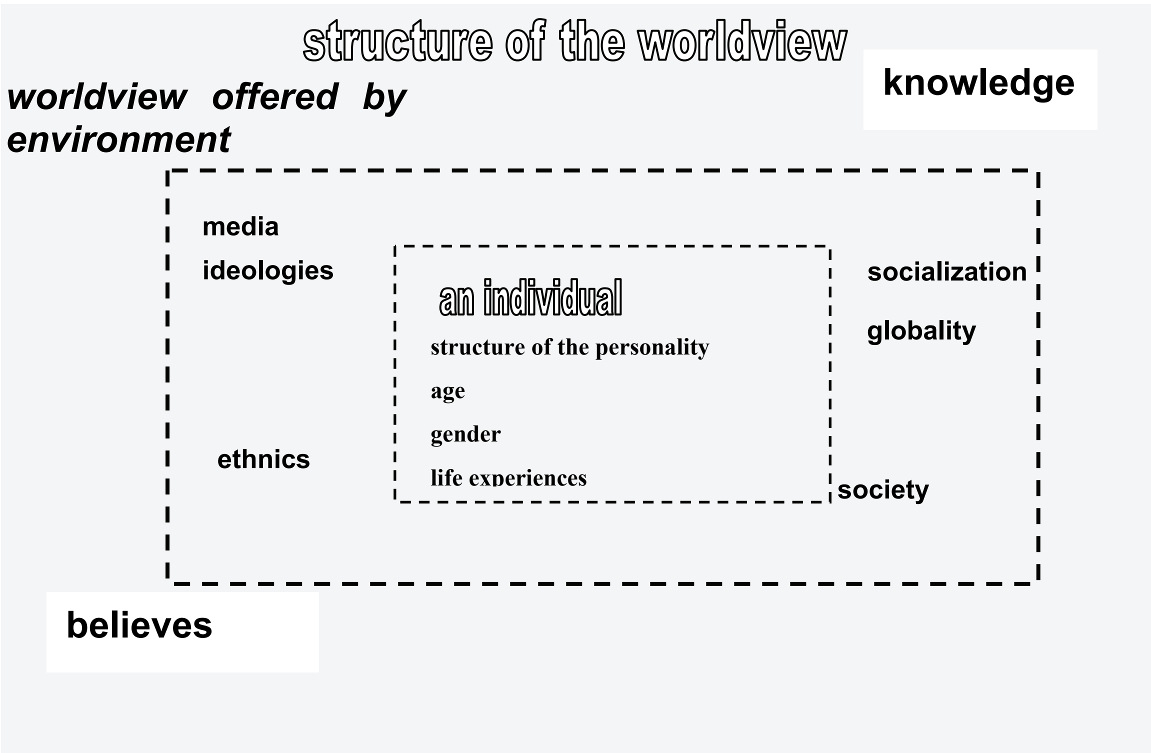
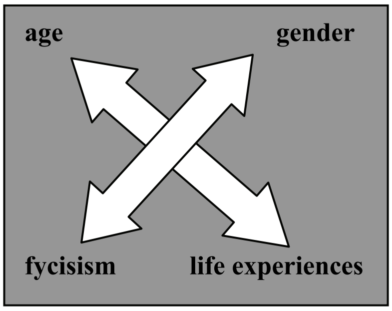


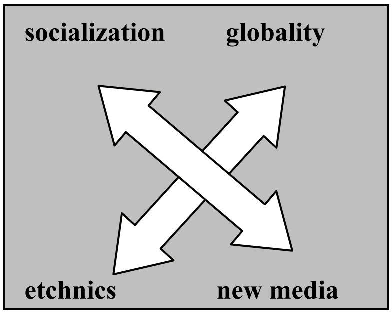
Figure 1. The structural model of the worldview

Life experiences of an individual produce the historical perspective. A person's experiences during life he has lived leave its own traces in worldview. Physical characteristics are in the centre through the life, because we live and experience through our body. Our own body is focus of all experiencies and base we are in proportion to creatures around us (Pesonen 1997 , 43) Our body is first and foremost the position for a person in the world and his first situation in reality (Braidotti 1993, 171). Physical characteristics include persons fysical condition, health, fysical range and functionality of senses. Every one of these has an important part of how an individual can for example move from one place to another. How he is comparative to other people for example with his fatness or thinness, tallness or shortness. Health has an effect on every undergoing through change of emotions and possibilities body gives. Is it possible to see or hear outside world surrounding us? Is there possibilities to move around and how? In spirituality belong intellectual condition and intellectual awareness. Mentally ill person can not identifine world the same way as a

person, who doesn't suffer from for example schizophrenia. Outside a person there are a lot of things that can have an effect. They can be compiled in two main influences. Worldview has necessarily connection to reality people think is possible. That is not been reflected in concepts usually used in studies. They have been reflected in representations of worldview carriers (Knuuttila 1992, 33). Scientific worldview is offered by institutions like home and education - mainly from school. Home and church offers religious worldview. Along with these strong parts media, globality, ideologies, ethnics, culture and society offer their own worldview.

There are three figures, which clarify the relations between the different parts on the worldview. Figures 2, 3, and 4 are made to explain which are relationships of the different opposite matters. These figures can visualize the strength of categories of worldview in relation to opposite sector.





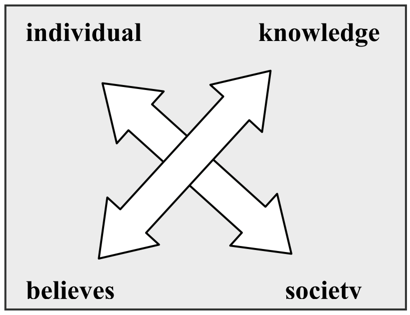


Figure 2. **Figure 3.** **Figure 4.**

This is going to help in understanding the formulation of worldview. Each analyzed person can be placed in these figures. The placing is based to analyzes which later can be made on the collected material.

3.2 New media

New media is a notion, which has been used in the need of describing intermediality in digital media. It has been made able with the new technological innovations, such as digitality, networks and computer-mediated communication. According to Heinonen (2002, 162) attempts to identifying new media through technical details is leading to a catalog of new media features. Development gives us new features all the time. In the period of frantic progress of digital techniques it is difficult or even unnecessary to define this kind of a concept through such devices. One use these devices often different way designers are intended. All this because the need of creation . On the other hand it is very difficult to approach new media only through old contents. Same contents can be performed through digitalization both in old and new media. According Heinonen new media is a relative concept, which has several dimensions. New media has become stable term and is very proper to describe the conversion of communication.

Computer-mediated communication is fundamental characteristic of the new media. According to Heinonen (2002, 167) it indicates that digitally produced contents, which are mediated through network demands and makes possible new kind of devices to both receive and produce messages. Digitalism, networking, simultaneousness, bidirectionality or multidirectionality, updatability, interactivity and filtration with software and filters play a central role in new media (Heinonen 2002, 161). This can be expressed that new media is always placed some ways in the same context with old media. In spite of that we formulate the role of the old media and create new practices (Fidler 1997). Good example of this is, when one uses old television documents in the Internet and mobile world. When we republish old television news in video banks, we can give new possibilities to use old content in new way. This is possible with real-time video flow in new and fast wireless connections. Is this already new media one might ask , when we are performing oldtime material through new devices? Text, speech and moving pictures have already been broadcasted in telephone- and broadcasting networks a very long time. The Net has made able to transmit all these materials simultaneously for the first time (Feldman 1997,3-8). When defining new media, it is important to notice the wholeness. New media is unity of devices and new way of using content. One can always find new aspects in old material and their usage.

3.3 Children in the world of new media

The inner comprehensibility of the computer world offer children possibilities to solve more complex exercises than is possible in physical world (Papert 1980, 130). This innovation of Papert can be used to outline a thought children use computer playfully and without prejudice. When a child is working with a computer his work is merely playing. That can be the reason why children manage to go through with more demanding things, which would be impossible for him to do when thinking of his period of growth. According to Tapscott (1998, 3) children are using computers as earlier generations played with toys. They use technology to playing, learning, communicating and making relationships with other children. Similiar ways as children have always done. Nevertheless it can not be good thing for children's social growth not to have face- to- face contacts with other children. However the digital revolution has created children an

environment, which has dramatically changed and made the growth of a child faster. When they rather can have more control on computers than use them passively, as a result it develops children faster than lifestyle earlier. In such circumstances it is difficult for a child to have a control over the situation. Without any doubt there is a certain need for grown up to take care of the situation. It should be good for a child to have different kind of ways to spend their childhood. They should also have possibility to spend time without computers and the Internet.

Time children spend with new media is not always entertainment. There can be reading, developing skills, solving problems, analyzing and evaluation. In the Internet children can pretend to be grown ups and try some of their thoughts in practice like simulating real life of grown ups like children have always done (Tapscott 1998, 3). It is important for children to work without control. Probably the feeling of the own control is one of the reason to make computer so interesting among other things. With the children the technological and human orientation should be independent, complementary and accomplished to each other.

Announcement, teaching and propaganda have always effect on the receiver of the message. If we keep the aims of values without attention, we can define teaching and propaganda exactly the same way with the same words. Teaching and propaganda are continuous processes of communication with or without linquistic symbols, where the sender of the message has aim to have an effect on receivers knowledge, attitudes or behavior. This means in other words achieve learning in cognitive, affective and behavioristic level (Mowlana 1997, 155). It is not necessarily easy to separate propaganda from teaching in practice with methods we are using. Aims of the activity and acceptability of the deeds will show the difference of these two things.

According to Tapscott (1998, 3) the Network generation refers to the generation of children, who in first years of the new millenium will be between the ages of two and twenty- two. This includes children and youth who use digital media very heterogenically. In other words the Net generation does not include only active Internet users. It also includes people who use digital media every now and then. There are four statements about the Net generation describing how they use digital media (Tapscott 1998, 4-5). Firstly the Net generation can use digital media as entertainment. It is easy to believe and describes present situation well. A great deal of content of the Internet is some kind of entertainment these days. Secondly the Net generation are using computer also for learning. This sector is increasing all the time. On the other hand there is segregation because of inequalities in wealth and social background. Next Net generation use computer for communication. Even in school pupils have different ways to communicate through the Internet. They become used to that kind of ability to communicate. Finally Net generation is using computer to buy things. We are still pioneering with trading things in the Internet, however this activity is growing continuously. Music industry is a good example and one of the first to make money with network business. To download music there is not so much illegal act as before. People use commercial servers, too. The global music industry is still struggling with royalties and their own profit and have not been taken care of the Net music business seriously. Primarily smaller music dealers and uncommercially organizations are distributing music in the Internet. Mainly Tapscott's statements are filled with techno optimism and are essentially from the nineties. There is still something valuable in his thoughts too. Similar thoughts can be seen in other books and press. New media has many possibilities to give to the users and the progression goes forward fast

3.4 Communication and the new media

Tapscott (1998, 56) along with several other writers are arguing new media is more neutral than the old one when talking about values. The reason for this is the interactivity. Even though this argument sounds very seductive, it is important to take an attitude and think over it. Why would new media be value free only because it is interactive? The illusion of neutrality can arise from the unwillingness to adopt a certain attitude towards moral and ethical choices among Net users. They say everything is political. When an individual doesn't take an attitude, that is political, too. As a matter of fact very rare thing in the world can be value free.

Hypertextuality has always been combined with the computer media. This means the associative and linkage based on analogies. Hypertextuality is at the moment still partly untrue utopia, but it could have potentiality to change the structure of our worldview noticeably (Ylä-Kotola, M. 1999) From the postmodern point of view the concept of identity has became more and more unstable. Due to the fact that the hurry, expanse and complexity of the development of the modern society has been greater (Kellner 1998, 264). This can lead up to that the individual subject construed by itself and made in the society of modern individuals, has been disappearing and collapsing. From the technical point of view, one of the most interesting areas of development is called convergence. Several devices say television, computer, mobile phone, camera, video and mobile network communication, are going to or already are combined in the same device. It gives possibilities for a media machine, which is a metaphor for a metahybrid, enabled by the development of the digital technology (Eerikäinen 1995,77).

According Fornäs (2000, 38) interactivity implies merely relationship between media and the user. The media itself can not be interactive. Computer- mediated communication offers so many different potential operating procedures, that they cannot be categorized as interactive across the board. The thing is that different technology includes altered ways of interactivity potential. The same way as individuals have different ways of being inclined to interactivity when using media textures. Different contexts have calls of a different grade to these interactive processes. The border between interactive and uninteractive use of the media is blurred. This is the cause that the difference between producing and receiving media grow dimmer. In spite of the fact that in some more traditional genres of the media they make very explicit deal between receiving and producing. The two main courses in media of today are communication and mediation (Tella 1998).

Mediation forces customers to make more choices. It makes necessary to use other media along using others and among other activities (Fornäs 2000, 40). When media assimilates with the routines of the everyday life, firm determination of boundaries between mediated and direct communication is going to be relative. With the term mediated often refers to those human forms of communication, which are using those transitional or combining inside the communal institutional technologically produced systems (Fornäs 2000, 41). When making choices the user gives every time a value to his selection. But before the product is in the hands of a customer, there has already been made several choices when producing media (Masterman, 1991, 93).

Especially the youth is using media more often estranged or absent minded. Them media is forming uninterrupted audiovisual landscape. They can not live without it, because it would be just like being without the clothes or other visible evidence of their reference group. To get stimulation from the constant flow of the media time after time, it seems to be important for youth and children to observe media casually or intentionally.

4. Conclusion

A child lives in a media intensive world. Environment gives lots of stimulus to a child and big part of it comes from new media. To selecting things and interpreting them is characteristic to observation. Around us there is a huge amount of information but the capacity of human data processing has its limits. One has to read and interpret media actively. The weaker the ability to understand media messages is the bigger grows the possibility that media has significant role in the content of the child's worldview.

The worldview media offers is real from the medias point of view. Media can underline or be silent about things they choose. Media can have strong influence on worldview. New media is actively building and performing reality. Because new media messages are produced, it does not always mean media content is reflected from reality. In the democratic world we can demand responsibility and different tasks from new media in addition to commercial rights it already has. From the breaktrough of the Internet one has claimed there is lot of possibilities to everyday people to make an influence on the form and content of the messages. It is easy to question it and change this kind of a claim to a hope. The great amount of information makes the real interactivity quite difficult to put into practice.

Time children spend with new media is in all probability increasing. Because of that it is especially significant to a child to have possibility to form his own worldview filtering through his nearby people. So the picture of the world surrounding children is not too oppressive.

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Successful and Unsuccessful Use of Online Video Clips in the Stories of Teachers from the Viewpoint of Meaningful Learning

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This paper describes the results of the JIBS Joint Inserts Bank for Schools pan-European research project. The aim of the research was to find out the teachers' perspective on the use of online video clips in teaching, studying, and learning (TSL) processes and to encourage educational workers to gain new perspectives towards the educational use and production of online videos. The research questions were the following; 1) What are teachers' conceptions and beliefs concerning the successful and unsuccessful use of online video clips in TSL processes, and 2) According to teachers' conceptions and beliefs, can online video clips be used to promote meaningful learning with respect to the six characteristics of meaningful learning chosen for this study?

The research data was collected using the non-active role-playing method. The results confirmed that from the teachers' perspective, online video clips can be used to promote pupils' active role and emotional involvement in the studying and learning process. In addition, the constructiveness and individuality, collaborativeness and conversationality, contextuality and guidance of the TSL process can be supported with the online video clips. On the other hand, the unsuccessful stories were unanimous in their message; using online video clips can still be a technically risky business. The results present challenges; we need to support teachers by providing them with pedagogical models and encouraging actual cases of successful uses of online video clips, pre- and in-service training, adequate support services, a more reliable technical infrastructure, and easily accessible, high quality online learning materials.

Keywords: meaningful learning, online video clips, non-active role-playing method

1 Introduction

This paper describes the results of the JIBS Joint Inserts Bank for School pan-European research project. The research project was part of the larger JIBS project [http://www.ebu.ch/en/television/co_production/jibs.php] during which an e-commerce website offering a large catalogue of short video clips for broadcasting professionals was created. The partners involved in the project were the following public educational broadcasters: ARD/SWR (Germany), RAI (Italy), TeleacNOT (Netherlands), France 5 (France), NHK (Japan) and YLE (Finland). In addition, involved in the project were Scéren/CNDP (Centre National de Documentation Pédagogique, France), and British Film Institute (U.K.). The University of Lapland/Centre for Media Pedagogy and the Catholic University of Milan were responsible for conducting the pedagogical research. The project was partly funded by the European Commission and coordinated by the European Broadcasting Union. (Longobardi 2004). This paper reports the research results that the University of Lapland was responsible for.

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2 Research questions and data collection

The aim of the research was to find out the teachers' perspective on the use of online video clips in teaching, studying, and learning (TSL) processes (Uljens 1997) and to encourage educational workers to gain new perspectives towards the educational use and production of online videos. The research questions were the following; 1) What are teachers'

conceptions and beliefs concerning the successful and unsuccessful use of online video clips in TSL processes, and 2) According to teachers' conceptions and beliefs, can online video clips be used to promote meaningful learning with respect to the six characteristics of meaningful learning chosen for this study?

The research data was collected using the non-active role-playing method. The method consists of writing short essays in which the subjects are asked to picture themselves in a certain situation that is described to them (frame story) and then to imagine and write how the situation proceeds or what has happened before it. (A.Eskola 1988, 240). The method can help to define the "situation logic" of interaction episodes. (A.Eskola 1988, 240-241, 251-252). The essays are not necessarily descriptions of reality but descriptions of possible stories: descriptions of what might happen and what is the meaning of different things. The stories that the subjects produce indicate what they know of different things. (J.Eskola & Suoranta 2000, 114, 116-117). In the methodological field, the non-active role-playing method has been positioned among the family of narrative research methods (A.Eskola 1997, 137).

In 6 of the countries involved in the project, the national JIBS member was instructed to select 16 teachers of pupils 7-13 years old for the research. The aim was to try to select mainly teachers that were known to be active and maybe even innovative in their use of audiovisual material. 116 frame stories were mailed to teachers in Italy, France, the United Kingdom, Germany, the Netherlands and Finland. Each teacher was to write a story according to either the positive or the negative frame story version, which are presented below;

> Teacher X is teaching the same grade as you are. One week she/he decides to use online video clips in class. The use of video clips proves to be *an excellent decision/a failure;* the teacher is *very pleased/disappointed* with the learning outcomes and *encouraged/discouraged* by this experience of online video clips in teaching.

The teachers participating in the research were then asked to picture themselves in either of these situations and to spend 20-30 minutes on writing an essay about what has happened before it. Altogether 78 completed stories, that is 67% of the 116 frame stories sent out were received. Italian teachers wrote both a negative and a positive story. In addition, two stories were written collaboratively by more than one teacher. Out of these 78 submissions, 69 submissions were included in the analysis. The 9 submissions not included were written about the use of analogue videos (n=6) or general teaching practices (n=2). One teacher mailed the frame story back with an explanation saying that he couldn't imagine the situation. The age of the respondents varied between 25-59 years and 68% of the respondents were female.

3 Theoretical framework

On a general level, this paper builds on a constructivist view of learning (see e.g. Duffy & Cunningham 1996, 171). The arguments of David H. Jonassen (1995, 2002; see also Jonassen & Rohrer-Murphy 1999); Heli Ruokamo (2000); Heli Ruokamo et al. (2002, 2003; see also Vahtivuori-Hänninen et al. 2004); and Hannu Soini (1999) were selected for producing six characteristics of meaningful learning processes. The arguments of Soini were selected because of his emphasis on the role of emotions in good learning situations. This emphasis was not so explicitly expressed by Jonassen and Ruokamo et al. Out of Jonassen's seven and Ruokamo et al's eleven characteristics of meaningful learning and Soini's six characteristics of good learning situations, six characteristics were selected. This choice does not imply that the remaining characteristics were less meaningful. Instead, the time frame and resources of the JIBS research didn't allow for the analysis of the data with respect to the other characteristics. The characteristics are presented in Table 1. According to these characteristics, meaningful learning is 1) active, 2) constructive and individual, 3) collaborative and conversational, 4) contextual, 5) guided, and 6) emotionally involving and motivating. A more detailed discussion of the characteristics is presented elsewhere (Karppinen 2004, to appear).

Table 1. Characteristics selected from the characteristics of meaningful learning (Jonassen; Ruokamo; Ruokamo et al.) and characteristics of good learning situations (Soini).

Characteristics selected	**Jonassen (1995, 2002)**	**Ruokamo (2000), Ruokamo et al. (2002, 2003)**	**Soini (1999)**
1. Active	Active	Active and self-directed	Autonomy
2. Constructive and individual	Constructive	Constructive and cumulative	-
		Individual	
3. Collaborative and conversational	Collaborative	Cooperative and communal	Collaboration
	Conversational	Conversational and interactive	Dialogue
4. Contextual	Contextualized	Contextual and situational	-
5. Guided	-	Guided	-
6. Emotionally involving and motivating	-	-	Emotionally involving
	Intentional	*Goal-oriented and purposive*	-
	Reflective	*Reflective*	*Reflection and feedback*
	-	*Transferable*	-
	-	*Abstract*	-
	-	-	*Possibility to see things from new or different perspectives*

The chosen characteristics provide a fairly wide and general enough perspective from which to assess TSL processes within different subject areas. Meaningful learning should nevertheless not be understood as a learning process, in which all of these characteristics are met all the time. Instead, if one ore more fail to occur, learning can still be meaningful (see also Simons 1993, 292). Worth noting is also that the characteristics are often intertwined and in part overlapping (see also Vahtivuori-Hänninen et al. 2004, 14) and should therefore be seen as flexible in their nature (Ruokamo et al. 2002, 1680).

4 Results

The stories written by the teachers were firstly analysed according to the themes that could be found in them. The analyzing of themes was guided by the notions of Yrjö Engeström and Reijo Miettinen (1999), David H. Jonassen and Lucia Rohrer-Murphy (1999) and David H. Jonassen (2002) according to which classrooms can be treated as activity systems consisting of different components, e.g. *participants of the activity system and their roles*, *objects,*, *expected outcomes of the activity*, *tools*, *community*, division of labor and rules of the activity. After analyzing the themes in each story, the frequencies were analysed and they are presented in Table 1. The frequency number refers to the number of stories, which included a description of the theme.

Table 2. Number of stories that included a description of a certain theme according to the frame story versions.

Theme	Frame story version Positive n=39	 Negative n=30
Tools		
Technical issues	10	21
Online clip content:		
interviews of experts	1	-
documentaries	13	9
plays, concerts	3	1
feature films	2	-
videos made by pupils	2	-
demonstrations	1	3
other	5	4
not specified	12	13
Teaching practices and expected outcome of the activity		
Learning tasks	31	12
Mode of studying:		
individually	5	3
in pairs	3	3
in small groups	1	1
whole class	7	6
Reasons for using online clips	35	18
Participants and community of the activity system		
Teacher's		
technical skills	-	7
difficulties in guiding the pupils	-	6
preparation of the lesson	4	9
Pupils'		
distraction during the process	-	16
active role	32	4
interest in the media	28	8
initial problems	15	2
Outside school contacts	6	5
Colleagues and other staff at school	8	7

Type of online clip content, **mode of studying**, and **contacts with the outside school environment, colleagues and other staff at school** include similar elements and appear more or less equally in frequency in both negative and positive stories. Therefore they don't seem to be decisive factors in determining whether the process proves to be a failure or a success.

Secondly, the stories were grouped into different types by categories of the main reasons that turned the use of video clips into a failure or a success. The stories were surprisingly uniform in this regard, and two basic types could be constructed from both the negative and positive stories.

Technical issues are the main reason why the use of online video clips becomes a failure in most (n=22) of the negative stories. The role of **the teacher's preparation** is highlighted in several of these stories (n=8), making the message quite clear; the teacher has done all that could be done, but technical problems are ruining his/her intentions. These technical problems result in **the pupils' distraction** in several of the stories (n=11) including a description of technical problems. Technical problems are accompanied by **the teacher's lack of technical skills** in some of the stories (n=5). Another type of negative stories, although less frequent (n=5), was a story in which the online clip content was the main reason behind the failure (e.g. “not entertaining enough”).

Most (n=30) of the positive stories could be grouped into two basic types. In the first type (n=15), **the interesting new media** is in itself able to capture the interest of the pupils, and in the second type the clips are successfully used **to solve two kinds of problems** in class: 1) pupils’ motivation problem (n=12), or 2) technical problems with using the TV/VCR equipment (n=3). The rest of the positive stories (n=9) are built on the same themes, although they don’t have the exact same combination.

A more detailed description of the themes and types of the stories is presented elsewhere (Karppinen et al. 2004). What follows is an analysis of the themes and types of the stories with regard to the characteristics of meaningful learning selected for the analysis.

4.1 Active

For Jonassen, active learning means that learners are responsible for the result (1995, 60). Pupils are in the roles of active learners, encouraged to ask questions, acquire and critically evaluate information and express new ideas and models of thinking (Ruokamo et al. 2002, 1678). In addition, pupils are able to use different cognitive tools (e.g. videos) actively in their learning environments (Jonassen 1995, 63; 2000).

Teachers included a description of different types of **learning tasks** combined with video material clearly more frequently in positive (n=31) than in negative stories (n=12). Very often (n=11) the teacher used a combination of different learning tasks and many (n=6) of these stories described the pupils and teacher involved in an inquiry-based or problem-based TSL process. An unsuccessful use of video clips more often is given to mean just viewing the video and not elaborating on it any further.

The pupils’ active role in the process was highlighted in 32 positive stories, whereas the number for negative stories was only 4. Teachers are thus quite unanimous in their conceptions of what is essential in a successful use of online video clips. The teacher was in the role of a “guide in the side” particularly in the positive stories describing an inquiry-based or problem-based TSL process. Pupils in these stories were making suggestions on topics or studying methods, thus taking part in some of the activities traditionally associated with the teacher’s role.

However, even if the interactive nature of online video clips has been highlighted by many educators (e.g. Marchionini 2003; Asensio & Young 2002, 10), most of the stories in this data don’t describe pupils interacting with the online video, for example, by pausing or reviewing. Worth noting is also that in only 4 stories, pupils were themselves producing online video clips, even if many educators and researchers have argued for giving pupils these possibilities (e.g. Sintonen 2001, 90).

4.2 Constructive and individual

The constructiveness and individuality of the learning process means that pupils have individual learning styles and strategies, and that studying and learning are always influenced by students’ prior knowledge, conceptions and interests (Ruokamo et al. 2002, 1679).

In a large part (n=15) of the positive stories, the interesting new media (Internet) and the tools (video clips) can be argued to be motivating in and of themselves. In some of the stories, the pupils’ enthusiasm is associated with being able to work with media that is associated with fun and outside school activities. Using online video clips can thus be argued to be constructive, since it builds on the interests and previous knowledge of the pupils. References to catering for individual learning styles were nevertheless quite few, although the reported ability of video clips to capture the attention of all the pupils in the stories can be interpreted as catering to different learning styles.

4.3 Collaborative and conversational

Working in learning and knowledge building communities makes it possible that pupils can exploit each other’s skills and provide social support and modelling for other pupils (Jonassen 1995, 60). Different **modes of studying** were used with equal frequency in positive and negative stories. The most popular mode of studying was the “whole class together”, while studying the clips in pairs, in small groups or individually were described less frequently. Especially in the positive stories describing an inquiry-based or problem-based TSL process (n=6), the pupils were described as highly motivated and eager to find the answers, and the process is often a collaborative effort. The reported power of moving images to generate rich classroom discussions (see e.g. British Film Institute Primary Education Working Group 2003, 14) was further confirmed by the data. According to the stories, a successful use of online video clips is integrated with different types of learning tasks, for example discussions.

However, the widely assumed promises of information technology to help teachers and pupils to collaborate with fellow students from different regions and maybe even countries (see e.g. Säljö 1999, 144-145; Cogill 1999, 99-100) are not met in these stories. Out of the 65 submissions analysed, only one story described **collaboration with another school** resulting from the use of online learning resources. Another interesting fact is that **technical support personnel** don't have any role in the process, although the need for technical support has been highlighted by many (e.g. Higgison 2002; Inglis, Ling, & Joosten 2002). In the stories, the teacher is for the most part working solo.

4.4 Contextual

The contextual character of the TSL process was best seen in the **content and topics of the clips**. The clips were about real-world situations or phenomena, that are difficult or even impossible to encounter directly, for example historical happenings or periods, drum solos in rock concerts, birds and other animals, a day in the life of a secondary school student in Latin America, erosion, dripstones, the sea, plays, formation of a drop of water, protected areas and natural parks, the solar system, volcanoes and the mountains. In many of the stories, the online video clips are indeed used to "represent and simulate meaningful real-world situations, problems or contexts" to cite Jonassen (1995, 61-62; 2000, 8-9).

4.5 Guided

The second type of positive stories was a problem-based story (n=12) in which the **teacher's reason for using online clips** was to solve a motivation problem in class; to get the class or even a particular pupil interested in the subject matter and the study methods. Anderson's, Rourke's, Garrison's, & Archer's (2001) concept of teaching presence, and especially its' subactivities of designing the learning process and facilitating discourse (e.g. encouraging student contributions, setting climate for learning, drawing in participants) presented real challenges for the teachers in these stories. The guiding skills of the teachers were really tested as they "wracked their brains" trying to get the pupils interested in the subject matter. In addition, some of these stories included teacher-student or teacher-class relationship problems. Luckily, the use of online video clips proved to be a solution. The teachers in the stories involved the pupils actively in planning the studying process or in the production of video clips. Getting the "bully of the class" to help the teacher in using the clips or even recruiting him as the main character in the video clip production, proved to be a very successful strategy. All in all, it seems that the clips functioned as a means to build a teacher-pupil relationship in an almost impossible situation. One can't help thinking how much these stories reflect the present reality, in which the pupils can be more and more difficult to motivate and guide.

4.6 Emotionally involving and motivating

A growing number of researchers, especially educational psychologists, have argued that emotion is intertwined with cognition, motivation and learning and should therefore be studied more systematically in classroom contexts (e.g. Soini 1999; Meyer & Turner 2002; Op't Eynde, De Corte, & Verschaffel 2001; Liimatta & Karppinen 2003).

Pupils' interest in the media and as a result, their emotional involvement in the studying and learning process, was evident in the positive stories. It was mentioned in 28 positive stories and in only 8 negative stories. In the stories, pupils are watching the clips "with interest", and they are more "attentive", "focused", "motivated", "involved", "excited", "enthusiastic", even "elated" and "fascinated". In some of the stories, pupils' enthusiasm is associated with being able to work with media that is associated with fun and outside school activities. Pupils' positive emotional involvement is, of course, beneficial for the learning process, but doesn't in itself lead to better learning outcomes. For these, different activating learning tasks, other learning resources and the guidance of the teacher are needed.

The effect of pupils' emotions on their learning outcomes is highly subjective. Facing difficulties at an early stage of a problem-solving task may result in hopelessness in one student, whereas another student may feel only a bit annoyed and experience the difficulties mainly as a challenge. (Op't Eynde, De Corte, & Verschaffel 2001, 160-162). Therefore, it cannot be argued that experiencing negative feelings during some stage of the TSL process are necessarily a hindrance for learning. In this data, the negative feelings of the pupils (disinterestedness, boredom, restlessness) were described as a starting point in the positive stories and as a result in the negative stories. Negative emotions in this data thus served as a starting point for a positive process (see also Liimatta & Karppinen 2003). However, to find out more about the dynamic and highly individual role of emotions in the learning process, in-depth study into the function of emotions is needed.

5 Conclusions

Understanding the teacher's perspective is crucial for understanding actual classroom practices, for example why teachers are either willing or reluctant to use online video clips. The research results clearly shed light on the teacher's perspective on the use of online video clips in TSL processes. According to teachers' conceptions online video clips can be used to promote the six characteristics of meaningful learning chosen for this study, that is, pupils' active role and emotional involvement as well as the constructiveness and individuality, collaborativeness and conversationality, contextuality and guidance of the TSL process.

The unsuccessful stories, on the other hand, are unanimous in their message; using online video clips can be a technically risky business. In most of the stories, the failure in using online video clips was attributed either to technical issues or unsuitable clip content. This may result from a self-protective attribution bias on the part of teachers. Behind this self-protectiveness may be teachers' concerns and fears, as well as feelings of inadequacy in the educational use of information and communication technology (Rajala 2004). This presents a real challenge; we need to support teachers by providing them with pedagogical models based on research, as well as encouraging actual cases of successful uses of online video clips. In addition, both pre- and in-service training and adequate support services in the use of educational technology are needed, not to mention the need to develop a more reliable technical infrastructure and easily accessible, high quality digital and online learning materials.

This research process has further encouraged the study of the actual TSL processes resorting to digital or online video clips and to a specific pedagogical model. Models that would seem to be especially suitable for using video clips to support meaningful learning include for example case-based learning and problem-based learning. The TSL processes should be studied both from the teachers' and the pupils' perspective, and most importantly, with regard to the actual learning outcomes.

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Designing and Producing Digital Video-Supported Cases with Students - How to Make it Happen?

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This paper focuses on how a traditional lecture-based university level course on network management at the University of Lapland was developed into a course in which the teacher designed and produced digital video-supported cases with the help of students and both local and inter-university support services. The cases functioned as the learning material for the students enrolled in the online version of the course. The objectives of this project were to develop the teaching-studying-learning (TSL) processes used in Network Management course in order to better support meaningful learning, as well as correspond to a) the requirements in the working life, and b) the mobile studying possibilities afforded by the laptop computers that every new degree student at the University of Lapland has been given a change to obtain. Designing and producing digital video-supported cases with students has clearly proven to be a worthwhile project which will also be implemented in the future realizations of the course. Collaboration with students and the support services contributed to the teacher's professional development, and with respect to students it turned her role into that of an active co-learner. The teacher was able to evaluate how the method helped her motivate and guide the students, improve communication with students, and reorganise study materials in an online learning environment. The contextualness and activeness of the TSL process can be supported by the method. For a more in depth assessment of how the method supports meaningful learning, the student perspective is crucial.

Keywords: case-based learning, digital video-supported learning, e-government, staff development, course development, meaningful learning

1 Introduction

This paper focuses on how a traditional lecture-based university level course on network management at the University of Lapland was developed into a course in which the teacher designed and produced three digital video-supported cases with the contribution of an extensive actor network, including the students. The cases functioned as the learning material for the students enrolled in the online version of the course. This paper describes 1) the process of designing and developing the course, and 2) both the local and the inter-university support services needed to accomplish this project.

The objectives of this project were to develop the teaching-studying-learning (TSL) (Uljens 1997) processes used in Network Management course in order to better support meaningful learning (Jonassen 1995, 2002; Ruokamo 2000; Ruokamo et al. 2002, 2003; see also Vahtivuori-Hänninen et al. 2004; Soini 1999), as well as correspond to a) the requirements in the working life, and b) the mobile studying possibilities afforded by the laptop computers that, starting from 2004, every new degree student at the University of Lapland has been given a change to obtain for a single payment of 300-600 euros. Out of the new degree students in autumn 2004, 85% have used this possibility. The use of

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laptops on the premises of the university is made possible by the wireless local-area network that was built during autumn 2004. When used in a pedagogically meaningful way, the laptops can function as a tool for more mobile studying and learning processes in which computers are used for collaboration and learning with a rich variety of audiovisual learning materials.

Many reasons can be found for transforming traditional lecture-based courses into online courses. One of the most important of them from the point of teaching public administration is the new form of organisations of the state that integrates the interactions and interrelations between the state and the citizens, private businesses, customers, and public institutions through the deployment of modern information and communication technologies (Schedler et. al. 2004, 5). Therefore, the staff in public administration will need skills to operate not only in the Internet but in different kinds of electronic environments. Actually, E-government is the most recent paradigm in the ongoing process of modernizing public administration. If all of these interactions that are supported through E-Government are assigned to the areas of the administrative procedures, four core elements for E-Government can be deduced: electronic Democracy and Participation (eDP), electronic Production Networks (ePN), electronic Public Services (ePS) and electronic Internal Collaboration (eIC). (Schedler et al. 2004, 23-24.)

Discussion about e-governance (Hyyryläinen 2004, 46) closely connects the Network Management course to the modernizing of public administration because it focuses on cooperation among different actors in the service delivery systems. Thus, case-based digital video-supported learning can even be seen as a necessary tool for teaching public administration and management. Courses observing the changes in real working life and studies on the outcome of these courses are important.

2 Network management course

The Network Management course is included in the final phase of Master's studies, just before the students are expected to go to their first workplace or return to working life. On completion of the course the students are expected to be able to; 1) define a network as a structural and functional form of inter-organizational cooperation; 2) understand how organizational management and leadership differ from network management and leadership; and 3) distinguish different types of networks and understand their limitations. Learning objectives of the both versions of the course can be divided into more specific subobjectives according to the cases that the course focuses on.

The above mentioned learning objectives fulfil the demands that are expected to be learned in this course from the subject point of view. But there are also other objectives, which contribute to conveying the ideas of e-government discussed in the previous chapter. These objectives are connected to the skills that are expected of students in working life, such as social skills, self-expression skills, cooperative and interactive skills.

During the academic year 2004-2005 the course had two different versions. Designing of the first version of the course was started in spring 2004 and the course was implemented in next autumn with eight students. These students produced the digital video-supported cases for the online version of the course that was implemented during spring 2005. The students enrolled on the online course used the cases as their learning material. The cases presented in the video were manuscripted and played by the first group of students and the teacher. The duration of the digital video including three cases was one hour. For designing and producing one filmed case students received 2 ects credits. The course itself was 10 ects credits. Nevertheless, it can be said that working hours were not counted.

3 Case-based digital video-supported learning method

For the Network Management course, a case-based digital video-supported learning method was deemed especially suitable since understanding the subject of the course requires empirical examples which link everyday working life and practices with theoretical knowledge. Actually, it would be rather strange if a teacher tried to teach management behaviors, activating and mobilizing of network actors, without connections to real empirical cases. However, collecting empirical cases is a very demanding and time consuming task to a teacher who usually has an extensive experience after a long career as a researcher as well as a teacher. By producing cases together with students for the purposes of online learning environment, a teacher might save time and while creating better facilities to save and upgrade the material. New problems to be used as examples could be accumulated from the previous cases, and new solutions could be modified as a solution. Therefore, a single case could be used to increase the learning material by integrating new perspectives, problems, and analyzing methods into the case.

Finally, the learning material is easier to manage by the teacher. Advantages of using online learning environment alongside lectures could be divided into three items from students' point of view. First, students need more and more working life skills, such as skills in information and communication technology (ICT), trained in small working and discussion groups in an online learning environment, for example. Second, access to material is easier for students. They do not have to queue for books from the library because the various materials are available in the online learning environment. Books can be substituted by other materials or books can be studied in different ways. Third, students feel the learning material meets their requirements and interest better when they can study real-life cases and analyse cases whose context is similar to their own experiences.

Cases are narratives, situations, or select data samplings that present unresolved issues, situations, or questions. Cases challenge students to analyze, criticize, make judgments, and express reasoned opinions. Although the cases can be real or invented, they must be realistic and believable. The included information must be rich enough to make the situation credible, but not so complete as to close off discussion or exploration. Cases are important for bringing real world problems into a classroom. They can be classified into open-ended or finished cases and into real-life or fictional cases. The real-life cases can then be illustrated with original documents, e.g. news articles, videos etc. By investigating the original documents the students can reflect on more than one side of a situation, making the arguments more complex. (CIC Handbook 2004).

Constructivist educators have stressed the need to situate or anchor (CTGV-Cognition and Technology Group at Vanderbilt) learning in authentic, relevant and/or realistic contexts (see Duffy & Cunningham 1996, 179). In accordance with this line of thinking, David H. Jonassen sees contextual learning as that which resorts to learning tasks that are either situated in meaningful real-world tasks or simulated through a case-based or problem-based learning environment. Accordingly, one of the roles of technology in meaningful learning should be to function as a mind-tool applied, for example, for: 1) representing and simulating meaningful real-world situations, problems, or contexts; 2) representing the beliefs, perspectives, and stories of others; and 3) supporting discourse among pupils. (Jonassen 1995, 61-62; 2000, 8-9; see also Ruokamo 2000; Ruokamo et al. 2002, 2003; Vahtivuori-Hänninen et al. 2004).

The potential of video for providing the context, or a starting point, for learning has been promoted by many educators and researchers (e.g. Silander 2003, 70-71). The CTGV (1991, 1993) has stressed the meaning of video materials for generative learning environments, i.e. environments that include an emphasis on in-context learning organized around authentic tasks often involving group discussions. The theoretical framework behind the work of CTGV emphasizes the importance of anchoring or situating instruction in meaningful problem-solving contexts. These anchors illustrate problem-solving situations for pupils and therefore function as important tools for learning problem solving.

Especially in the field of complex and ill-structured domains, such as business, law, and medicine, case-based hypermedia products, including video, have been considered a well-suited tool for teaching and learning (Koehler 1997, 1638; Naidu et al. 1999). Similar case-based approaches taking advantage of video clips have also been reported in conjunction to training physicians (e.g. Wiecha et. al 2003) and teachers (e.g. Horvath 1998; So & Pun 2002).

4 Actor networks needed to design and produce the cases

The traditional roles of teachers and other staff are changing, with new roles emerging and boundaries being redefined. Few individuals are likely to have the full combination of skills required in online teaching. This means that collaboration and teamwork become essential elements in any development. (Higgison 2002). As Inglis, Ling, and Joosten (2002, 108-109) point out, the zones of expertise overlap and each specialist requires the contribution of the others: “Technicians need a feel for pedagogical principles, teachers need a feel of the possibilities and limitations of technologies” (see Figure 1.).

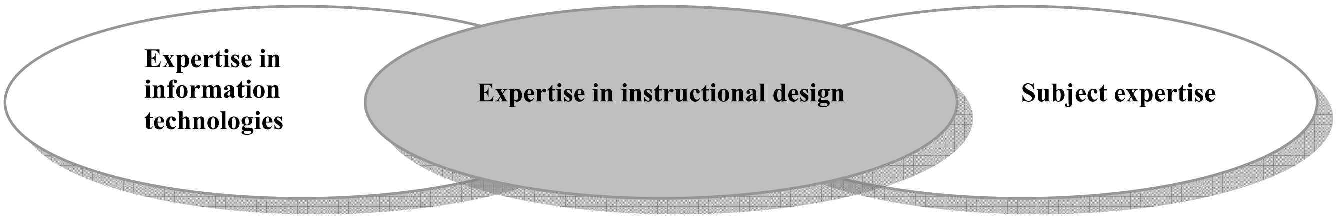

Figure 1. Overlapping zones of expertise in online teaching following Inglis, Ling & Joosten (2002)

When designing an online course, it is very helpful if the teacher has at least some familiarity with the possibilities and limitations of the technologies used and is able to communicate her/his ideas and goals concerning the course to the rest of the team. This requires a willingness to engage in teamwork. Some teachers may welcome the opportunity, while others may need a little time to get used to planning and producing learning materials as members of a team. Ideally, one might have a course team supporting and helping teachers in developing an online course (see also Ryan & al. 2001; Higgison 2002). This team could include a multimedia design expert, a technical expert and an educational technologist who provide support, for example, in planning the course and choosing the media and the online learning environment.

The teacher of the Network Management course took advantage of a large network of actors and support services throughout the project in order to develop the traditional lecture-based course into a case-based digital video-supported course. The development process and the network needed to accomplish the project are presented in Figure 2.

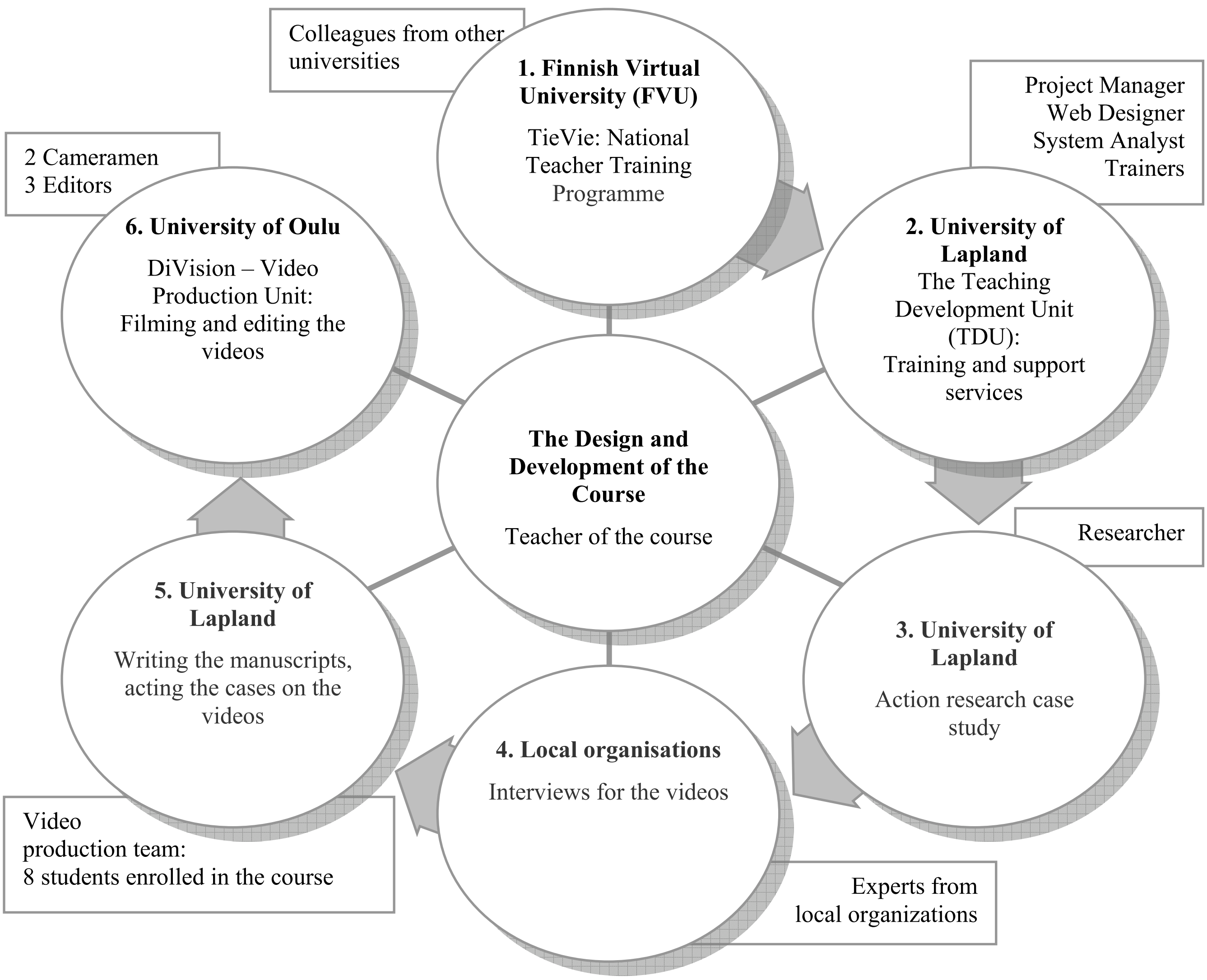

Figure 2. The development process and the network needed to accomplish the project

The development process started as the teacher participated in a teacher training programme, during and after which she designed and implemented the project with the help of an extensive network of actors, including e.g. technical and pedagogical support staff, teacher trainers, action researcher, students, and video production personnel. All in all, a network of approximately 30 actors contributed to the development of the course. In the following, the process and the actor network are discussed in more detail.

4.1 Teacher training

The need to innovate her teaching methods was identified by the teacher during 2003 when she participated in TieVie - National Teacher Training Programme [http://tievie.oulu.fi]. TieVie is a support service project of the Finnish Virtual University (FVU) [http://www.virtuaaliyliopisto.fi] providing training in the educational use of ICT. The aim of the training is to promote the pedagogically beneficial use of ICT in university teaching. The training provided by a network of five Finnish universities is free of charge, and it is intended for all teachers and other staff members in all Finnish universities. Examples of the multiple benefits that the participants gain from TieVie training include hands-on experience of learning in an online environment; the opportunity to design and implement an ICT based course development project, and gain support in carrying through the project. In addition, the training offers practical opportunities for networking with colleagues from all over the country. (FVU Newsletter 9-10/2004).

In addition to participating in the TieVie programme, the teacher participated in short-term training organized by the Teaching Development Unit (TDU) of the University of Lapland. TDU is for the most part funded by the Finnish Virtual University. TDU organizes short-term training and support services for university personnel to meet the needs of pedagogy, technology, and content production. With respect to online learning environments, teachers are offered the Discendum Optima [http://www.discendum.com], the Future Learning Environment 3 [http://fle3.uiah.fi], and the BSCW - Basic Support for Cooperative Work [http://bscw.gmd.de] platforms. The courses offered to teachers are planned around the idea of the project and they support the teacher through to its realization, i.e. designing, implementation and evaluation of online teaching. Instruction takes the form of "how to" sessions that last from two to twelve hours and are free of charge for university personnel. Teachers can select courses according to their own needs from a variety of courses offered.

The teacher and the students took part in the course on designing and producing digital videos, arranged by the TDU. The course was tailored particularly for this group. The course concentrated on the issues of manuscripting and filming the different scenes. Before this course, the teacher had taken part in a few courses, such as How to produce www-pages, Visual design of www-pages, Digital image editing, and courses on the online learning platforms.

4.2 Support services

In addition to participating in both local and inter-university training, it was evident that the teacher needed a network of educational technology experts to support the process, especially producing the digital video-cases. The teacher had no prior experience in manuscripting or producing digital educational videos. The first version of the Network Management course was designed into the Discendum Optima platform during the autumn 2004 when the cases for digital videos were written. The platform was used in updating the manuscript of the cases between meetings. Technical and web design assistance in planning and designing the online learning environment was given by the TDU.

The TDU also provides financial support for innovative projects that promote the use of ICT at the University of Lapland. For this project, financial support was applied and granted. Support was needed for filming and editing the cases, which was done by DiVision, a video production unit at the University of Oulu. The decision to resort to the experts at the University of Oulu instead of the University of Lapland was done because of the tight schedule which the local experts were not able to meet. In the future, the aim is to produce the videos with the help of local experts at the TDU and the Faculty of Art and Design at the University of Lapland. A promising option is that the videos are filmed and edited by the students of the Faculty of Art and Design as part of their studies.

4.3 Action research case study

Starting from spring 2004, an action research case study to develop and examine both versions of the Network Management course has been in progress. The action researcher has had a two-fold role in the process. On one hand, she has worked as the project manager at the TDU and on the other hand, as a researcher. The researcher's role has been to 1) discuss and help to develop the TSL methods of the course, 2) help the teacher to find the support services needed to produce the digital videos, and 3) discuss and decide on the methods of data collection and analysis.

The TSL processes are evaluated with respect to the characteristics of meaningful learning (Jonassen 1995, 2002; Ruokamo 2000; Ruokamo et al. 2002, 2003; see also Vahtivuori-Hänninen et al. 2004; Soini 1999) chosen for this study. The research focuses on the following questions: 1) Can designing, producing and solving digital video-supported cases with students a) contribute to their emotional involvement and motivation in the studying process?, b) support a meaningful studying and learning process of the students?, and 2) What kind of video-supported cases are best suitable for providing the context for case-based TSL process? The results of this research will be proposed for publication elsewhere (Hakkarainen & Saarelainen, proposal).

4.4 Students as producers of the video-cases

Recruiting the students to act on the video was not a straightforward decision, and the teacher and the researcher discussed even the possibility of recruiting actors from the Students' Theatre to act on the video. However, giving the students of the Network Management course the possibility to act in the videos was seen as a tool for learning. The pedagogical objective of this role-playing method (Cohen, Manion & Morrison 2003, 370-379) was to enhance the students' active role and emotional involvement in the studying and learning process (see also Asensio & Young, 2002, 17; Jonassen 2000, 228), and to develop a deeper understanding of the cases.

The digital videos were simulations of possible social situations related to the open-ended real-life cases. Their function was to illustrate the cases and act as the starting point and the context for studying and learning. The real-life cases were selected after reading theoretical articles on the topics of the course and some example cases obtainable in various contexts. The topics of the course were: (1) "wicked problems", which functioned as examples for problem-based learning, (2) networking competence, which introduced students to creating self-assessment criteria for organisations, and (3) innovation networks, which illustrated network management strategies. The teacher suggested some possible cases for presenting on the video as examples that would create the Finnish context in order to make the cases more familiar and interesting to students.

The first chosen case concerning "wicked problems" was chosen on the proposal of the student who had just read an article in a newspaper. The article dealt with a current and even heated debate on how to develop the local Ounasvaara ski and recreation area. The students put their souls into the case and did interviews with experts from local organizations representing the debate in real life. The video portrayed a meeting in which the local experts debated the issue. On the video, each student acted the role of a local expert who she/he had interviewed (Picture 1).

Picture 1. A screenshot of the first video-case manuscripted and acted by the students and the teacher.

The second case, measuring networking competence, was chosen because one student was writing his master's thesis on this topic. Finnish Sports Federation (FSF) was chosen as the organization whose networking competence was to be measured, and the video portrayed a meeting in which consultants, the representatives of FSF, and their partners, all acted by the students and the teacher, were discussing the issue.

The third case was chosen by the teacher and it based on research into innovation networks and network management strategies applied in these cases. Interviews for the research were done by the teacher, and the manuscript of the video was mainly based on these interviews, which are reported by Aho, Saarelainen and Suopajärvi in the publication edited by Aarsaether (2004, 169-218). The video portrayed the students and the teacher discussing a local municipality innovation and cooperation project.

The duration of the digital video including three cases was one hour. For designing and producing one filmed case students received 2 ECTS (European Credit Transfer System) credits. The course itself was 10 ECTS credits. In the ECTS one credit stands for approximately 25 to 30 working hours.

5 Conclusions

Designing and producing digital video-supported cases with students has clearly proven to be a worthwhile project which will also be implemented in the future realizations of the Network Management course. Therefore, some benefits of this TSL method need to be highlighted.

From the teacher's perspective, collaboration with the extensive actor network, including the students, has been of the utmost importance for succeeding in the development process. The collaboration contributed to the teacher's professional development, and with respect to students it turned her role into that of an active co-learner. The teacher was able to evaluate how the method helped her motivate and guide the students, improve communication with students, and reorganise study materials in an online learning environment.

The contextualness and activeness (e.g. Jonassen 1995; 2000) of the TSL process can be supported by the method. Producing digital videos is especially suitable for presenting local situations or even students' personal situations. Finding connections to the personal world of the students through touching on their interests can be considered an important characteristic of meaningful learning (Ruokamo et al. 2002). However, for a more in depth assessment of how the case-based digital video-supported TSL method supports meaningful learning, the student perspective is crucial. Therefore, the results of the ongoing research into the student perspective (Hakkarainen & Saarelainen, proposal) will help to decide on how to further develop the course.

Producing digital video-supported cases for online courses demands a broad actor network and is not therefore a realistic option to be implemented each year. Instead, producing one video-supported case each year or producing several video-supported cases e.g. in every two years seem more reasonable options. In the future, the aim is to establish collaboration with experts from different faculties, such as the Faculty of Art and Design, in a way that gives mutual benefit for all partners and perhaps without direct financial contribution.

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Narrativity in TSL processes

The Narrative of Problem-Solving Processes: Implementation as a TSL method in the Logic Programming Paradigm

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During the last decade a new computer science (CS) curriculum has been taught in Israeli high schools. The curriculum introduces CS concepts and problem-solving methods and combines both theoretical and practical issues. The Logic Programming (LP) elective module of the curriculum was designed to introduce a second programming paradigm to students. One main goal of the LP module was to teach students a declarative approach to problem solving and knowledge representation based on the use of abstract data types (ADTs).
In this paper we present an instructional approach based on students' gradual acquaintance with ADTs. This approach was designed to introduce an ADT-based problem-solving conceptual model to students.
We conducted a study aimed at assessing students' problem-solving processes when utilizing ADTs. The findings indicated that most students demonstrated autonomous problem-solving strategies when using ADT black boxes; however, their strategies were not always compatible with the ADT-based problem-solving conceptual model. Moreover, some of the students' strategies that diverge from the conceptual model might cause the students to develop incorrect programs. Specifically, the results of the study indicated that students have difficulties in establishing correct mapping between the problem and its abstract model - the corresponding ADT, and in establishing proper communication between distinct corresponding programming modules - concrete data, data predicates, problem predicates, and general ADT predicates. These difficulties are apparently associated with difficulties that a novice encounters in learning to program in Prolog, and with the cognitive load required to write a program, especially when dealing with high levels of abstractions.

Keywords: problem solving, abstract data types, black boxes, logic programming

1 Introduction

During the last decade a new computer science curriculum has been taught in Israeli high schools. The curriculum introduces CS concepts and problem-solving methods independently of specific computers and programming languages, along with the practical implementation of those concepts and methods encountered in actual programming languages (Gal-Ezer, Beeri, Harel, & Yehudai, 1995). One elective module of the curriculum, Logic Programming, was designed to introduce a (second) declarative programming paradigm.

We developed a two-stage "Logic Programming" course, implemented in the Prolog programming language, which was

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designed for high-school students. One main goal of the course was to expose students to different aspects of logic programming and to enhance their problem-solving and design skills in the context of the LP paradigm. The 90-hour

basic module was designed, as part of the CS curriculum, for beginners and covers the following topics: introduction to propositional logic and predicate logic, including logic programming, data base programming, compound data structures, recursion, lists, introduction to abstract data types (ADTs), and basic methods of problem solving and knowledge representation. The 60-hour advanced module, designed for advanced students, introduces advanced methods of problem solving and knowledge representation, advanced generic abstract data types, and advanced logic programming techniques (Haberman, Shapiro, & Scherz, 2002).

Logic programming enables programmers to concentrate on the declarative and abstract aspects of problem solving, and usually liberates them from dealing with the procedural details of the computational process (Sterling & Shapiro, 1994). Abstract data types are considered as useful tools for CS problem solving and knowledge representation (Aho & Ullman, 1992). Since in logic programming the compound data structures are manipulated by hiding the procedural aspects and details of their implementation (Ben-Ari, 1995) it is convenient for implementing and utilizing abstract data types. Hence, it is a suitable programming environment for teaching the notions of ADTs (Haberman et al, 2002).

The abstract data type, which is discussed in both modules of the “Logic Programming” course as a recurrent CS concept, is introduced to students as a *mathematical model with a set of operations* (Aho & Ullman, 1992). S*pecification* of an ADT is achieved by formally and verbally defining its use as a model as well as its operations. *Implementation* of an ADT is achieved by means of the logic programming language by formulating rules to define general predicates for each of the specified ADT operations. The actual implementation of an ADT is achieved by creating a black box. The *use* of an ADT for problem solving is done by defining problem predicates using predefined general predicates.

We developed an instructional approach to gradually introduce ADTs as flexible problem-solving and programming tools using evolving programming boxes (Haberman & Scherz, 2005) (section 2.2). We employed our instructional approach to teach problem-solving strategies and knowledge representation methods based on our ADT-based problem-solving conceptual model (section 2.1). We conducted an ongoing study aimed at assessing various aspects of students' use of ADTs in the Prolog environment (Haberman et al., 2002; Haberman & Scherz, 2003, Scherz & Haberman, 2003). In this paper we concentrated on a particular facet of students' difficulties in utilizing ADTs, specifically related to communicating with ADT black boxes (section 3).

2 The instructional approach

2.1 The ADT-based problem-solving conceptual model

The use of abstract data types in problem solving and knowledge representation is a dominant component of our curriculum (Haberman et al., 2002). Our conceptual model of utilizing ADTs in problem-solving processes and in developing computer programs is compatible with the formal definition of ADT as a formal CS concept (Aho & Ullman, 1992) and includes the following stages:

(a) **Conceptualization:** Comprehending the given problem; identifying the main ideas, concepts, entities and the relations among them; defining the main goals to be solved and queries to be answered.
(b) **Generalization:** Distinguishing between the general definition of a problem and its concrete specific cases. Choosing problem-predicates that describe the general relations within the problem and the data-predicates that specify concrete cases of the problem.
(c) **Abstraction:** Expressing the concepts and relations in terms of abstract data types; deciding on a suitable ADT that characterizes of the general problem by choosing: (1) an appropriate formal model to describe the collection of objects defined by the problem, and (2) general ADT-predicates that represent operations defined in the formal model that are suitable to represent the relations between the objects, as defined in the problem. In this stage, the content of the general problem is ignored, and its abstract form is being related to.
(d) **Formalization:** Representing the concepts and the relations that were identified in the problem as a Prolog program; describing the general problem in terms of formal terminology by using ADT black boxes that were chosen to describe the problem. At this stage problem-predicates are defined in the main program by transparently invoking general ADT-predicates (predefined in ADT black boxes).
(e) **Concretization:** Representing the concrete data (input) in terms of data-predicates. This can be done in the main program or in a distinct file. The concrete case of the problem is described by defining the problem-predicates in terms of data-predicates.

(f) **Testing:** Executing and debugging the developed program; assessing the program according to the specified requirements.

The ADT-based problem-solving process involves treating the problem at different levels of abstraction. The first three stages: conceptualization, generalization, and abstraction relate to the comprehension and analysis of the problem; the three next stages: formalization, concretization, and testing relate to the implementation of the results of the analysis, is

aimed at achieving a correct working program that provides a suitable solution for the given problem. The ADT-based problem-solving conceptual model - the problem's analysis, and the actual treatment employed during various stages of the problem solving process are shown in Figure 1. Initially, we relate to the given problem at its concrete level; next, we relate to the general problem, which is a generalization of the given problem, distinguishing between the specific data related to the given problem and its general characteristics. Next, we map from the general problem to a completely context-free abstract model (ADT) that captures the logical interrelationships among the problem's entities. This stage involves the highest level of abstraction in the problem-solving process. From that point we return to deal with the lower levels of abstraction related to the problem: first to the general problem to formalize the general features of the problem in terms of Prolog statements, and then to the concrete problem by linking up the general features with the concrete specific data.

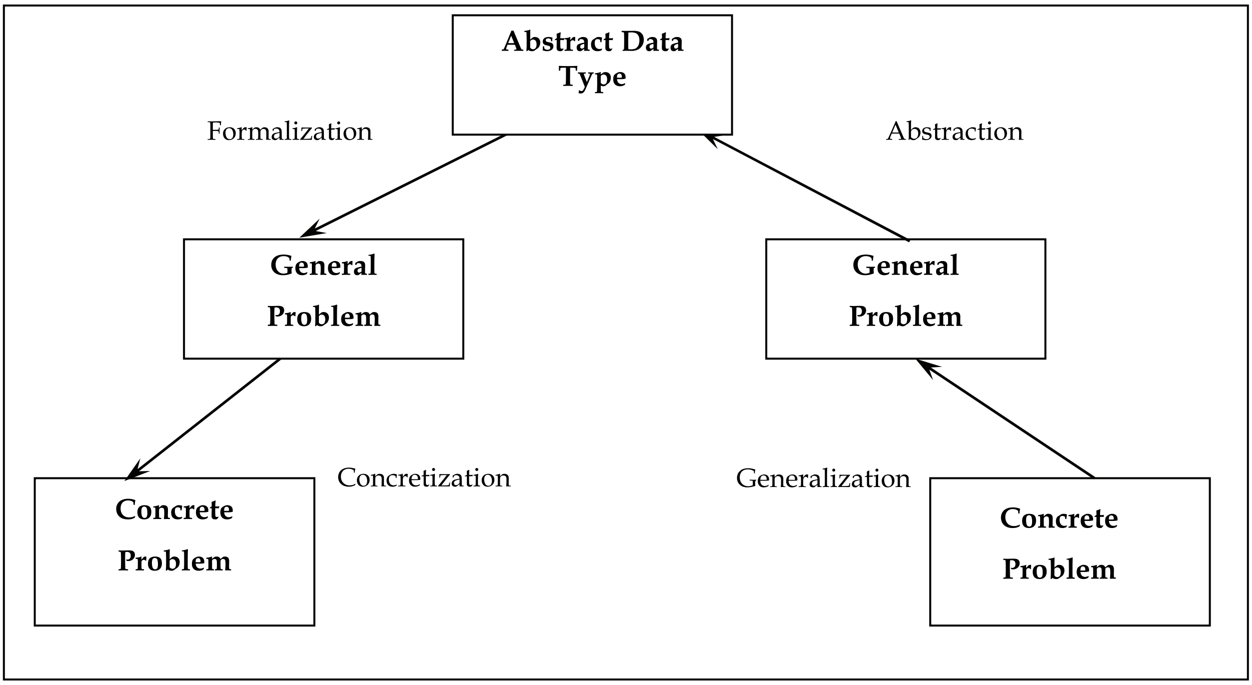

Figure 1. The ADT-based problem-solving conceptual model

2.2 Communicating with ADT black boxes

In this section we concentrate on a particular facet of utilizing ADTs in problem solving and developing programs – how the developed program communicates with ADT black boxes. In this section we demonstrate communication methods that are compatible with the ADT-based problem-solving conceptual model. In section 3 we present students' strategies that diverge from the conceptual model and might cause the development of incorrect programs.

Communication between the main program and an ADT black box is performed by establishing proper links in the following channels: (a) between specific data and data-predicates, (b) between problem-predicates and data predicates, and (c) between problem predicates and the corresponding ADT-predicates. The communication should be accomplished through the interfaces of the relevant modules/programs/ADT boxes.

Linking by casting into a pattern: The traditional way of formalizing the ADT formal model (i.e. the entities and the associated basic relationships among them) in a black box can be used to present the specific concrete data (the input) of a given problem. Students used to describe this method as "casting into a pattern" – a terminology that we adopted.

Linking to the List ADT: The linking is done by writing the specific data into a list Prolog data structure. For example, a list of students' names in a class will be presented in the following way:

```
% students_in_class ( Class, List_of_students)
  students_in_class ( class_A, ['Abraham', 'Dan', 'Roy', 'Lily', ' Tamar', 'Ben'] ).
```

Linking to the Tree/Graph ADT: The linking is done by presenting the data in terms of general predicates that describe the nodes and the vertices of a tree/graph. The specific data is added to the corresponding predicates' arguments. For example, data about animals' classification will be presented in the following way:

```
% vertice ( From, To)
 vertice ( animal,mamal ).      vertice ( mamal, cat).       vertice (mamal, lion ).
 vertice ( cat,  wild_cat ).    vertice ( cat, domestic_cat ).

% node (Node)
node(animal).   node(mamal).   node(lion).   node(cat).   node(wild_cat).   node(domestic_cat).
```

Linking by conversion: This method is based on presenting the specific data in the main program in terms of the data-predicates that are associated with the given problem. These predicates are syntactically different from the ADT general-predicates. The linkage is performed by defining a suitable rule that converts the problem-associated data presentation to an abstract ADT-based presentation, as illustrated in the following examples:

Linking to the List ADT: Here we demonstrate the following two methods of list conversion:

(a) **Linking by converting a presentation of a single-element to a presentation of a list-of-elements.** This can be done by using the *findall/3* general predicate, which adds to a list the values of a specific variable (entity) that satisfy a given goal. For example, given facts related to each of the students in a class: *% student(Class, Student_in_class)*, we create a list of all the students that belong to that class:

```
% students_in_class ( Class, List_of_students)
students_in_class(Class, List_of_students):-
                class(Class),
                findall(Student, student(Class, Student), List_of_students).
```

(b) **Linking by converting a presentation of successor-pairs to a presentation of a list-of-elements.** This can be done by a recursive path-based accumulation of the list's elements. For example, given facts about children born in a familly *% born_after(Familly, Child, Next_Born_Child)*, we create an ordered-by-birth list of children in the familly, starting with a specific child:

```
% children_in_family (Familly,Child, List_of_children)
children_in_family (Familly,Child, [Child, Next_Born_Child]):-
                        born_after(Familly, Child, Next_Born_Child).
children_in_family(Familly,Child, [Child|Rest]):-
                        born_after(Familly, Child, Next_Born_Child),
                        children_in_family(Familly, Next_Born_Child, Rest).
```

Linking to the tree/graph ADT: The linking is obtained by defining conversion rules aimed at formalizing the general-predicates *node/1* and *vertice/2* in terms of the corresponding data-predicates. For example, suppose that the data about the animals' classification will be presented by the data-predicate *% includes (Group1, Group1)*, meaning that Group1 includes the items of Group2:

```
% includes ( Group1, Group1)
 includes ( animal,mamal).   includes ( mamal, cat).   includes(mamal, lion ).
includes ( cat,  wild_cat ).   includes ( cat, domestic_cat ).
% animal_type(Animal_Type)
animal_type(animal).   animal_type(mamal).   animal_type(lion).   animal_type(cat).
animal_type(wild_cat).   animal_type(domestic_cat).
```

The converting rules will be defined as follows:

```
vertice (Group1, Group2)  :- includes(Group1, Group2).
node (Node ):- animal_type(Node).
```

2.3 A TSL method - Gradual presentation of ADTs as problem-solving tools

The problem-solving model described above may be used by the students both for solving small-scale problems during the course and for developing projects. The TSL process should be designed to gradually educate the students toward attaining proficiency as "problem solvers" through the use of integrated knowledge and autonomous problem-solving strategies. In this section we briefly describe an instructional approach that we developed for that purpose that gradually introduce ADTs as flexible problem-solving and programming tools using evolving programming boxes (detailed discussion of the instructional approach and its implications appears in (Haberman & Scherz, 2005)).

We recommend that the ADT concept be gradually presented in the following consecutive stages:

Stage 1 - Acquaintance with given specifications of ADTs: Initially students become acquainted with the specification of abstract data types (e.g., lists, sets, trees, and graphs). Suitable examples of concrete problems should be used to illustrate the presented ADTs.

Stage 2 - Use of ADTs to solve a given problem: Next, students should practice how to choose ADTs to solve a given problem. For example, students should be able to determine that the *tree*- ADT is the most suitable one to present the family parenthood relationship between the females (or males), whereas the *graph*-ADT should be used to present that relationship between all the family members (without referring to a specific gender).

Stage 3 - Use of ADT black boxes in programming: At this stage students should practice using predefined ADT black boxes to write computer programs that solve given problems. Specifically, students are taught to define problem predicates by transparently invoking predefined general ADT-predicates. We emphasize the following aspects: (a) the use of a black box is independent of its implementation and therefore does not require becoming acquainted with the implementation details; (b) the use of a black box binds to its interface.

Stage 4 - Specification of new ADTs: At this stage the student plays the role of a consumer who specifies and orders a new ADT black box from his teacher. The teacher implements the required ADT according to the student's specifications in terms of a black box, which is then used by the student to write his program.

Stage 5 - Acquaintance with the implementation of predefined ADT boxes: After students became familiar with the specifications and the use of ADTs, we suggest that they gradually learn how to implement an ADT according to its specifications. Initially, students become acquainted with the implementation of familiar ADTs. At this point the black boxes that have been transparently used in the previous stage become unfolded, i.e. the code within the black box is no longer hidden. Actually, at this point the black box becomes visible yet *only read*, and the students perform operations such as reading the code, running the code and following up its execution in order to understand "how it works".

Stage 6 - Manipulation of predefined ADT boxes: At this stage the *read only* boxes becomes "more" accessible in the sense that their code can also be modified. Here students learn advanced programming techniques and efficiency aspects, and practice code debugging, code modification, and writing new code from scratch.

Stage 7 - Implementation of new ADTs: After becoming acquainted with the implementation of predefined ADT boxes, the students experience how to implement new ADT boxes according to a defined specification. At this stage they eventually become independent of the teacher in terms of supplying built-in programming tools.

Stage 8 - Knowledge integration and autonomous problem solving: At this stage students make a significant step toward attaining proficiency, and they practice solving advanced and complex problems. The students employ ADTs to solve a given problem in the following process: They try to determine familiar ADTs suited for the given problem and use the relevant predefined ADT black boxes. When the predefined ADTs do not suit their needs, they specify new ADTs from scratch or modify the specification of other ADTs, implement them in terms of black boxes, and then use them to develop their programs. Moreover, the students start acting like autonomous developers, reusing their own tools, and on the other hand, they experience sharing tools with peers and reuse others' tools.

2.4 An example – The biblical genealogy

The following example shows an ADT-based problem-solving process that is compatible with the previously described conceptual model.

The problem: Given the biblical genealogy, we are interested in retrieving all the male ancestors of a specific person (e.g. Jacob).

The problem-solving process: Here we demonstrate the analysis, reasoning, and decisions that are employed in each stage of the problem-solving process. The final product – a Prolog program is presented in Figure 2.

(a) *Conceptualization*: The entities identified in the problem are persons. There are *father_of*/2 and *mother_of*/2 basic relationships between persons. We are supposed to retrieve the list of all the ancestors of a given person, starting with the first ancestor (the dominating father).

(b) *Generalization:* The following basic relationships: *person(X)* (X is a name of a person who belongs to the family), and *father_of(X,Y)* and *mother_of(X,Y)* (X is a parent of Y) are used to present concrete data, and explicitly distinguish between the biblical family and other families; hence, they are classified as data-predicates. In contrast, the definition of *ancestors(X,Y)* (Y is a list of the male ancestors of X) is general and is suitable for any family, independent of specific data; hence, ancestor should be classified as a general problem-predicate. The identified predicates should be declared in the interface of the intended program.

(c) *Abstraction:* the graph ADT is an appropriate formal model used to describe the collection of objects (i.e. persons) defined by the problem, and the *path(R,X,Y)* and *root(R)* graph-predicates are suitable to define the *ancestors(X,Y)* problem-predicate in the following manner: Y is the list of male ancestors of X, if R is a root of the genealogy, and Y is the list of nodes starting from R and ending in X.

(d) *Formalization*: The problem-predicate *ancestors(X,Y)* is defined in terms of the *path(X,Y,Z)* and *root(X)* graph-predicates that are predefined in the graph black box. The general ADT-predicates should be transparently invoked:

ancestors(X,Y):- root(R) , path(R,X,Y).

(e) *Concretization*: In this stage we present the concrete data in terms of data-predicates *person(X)*, *father_of(X,Y)* and *mother_of(X,Y)* as facts in a Prolog program. The concrete case of the problem is described by defining the problem-predicates in terms of data-predicates. In this example this is done implicitly by linking between the main program and the black box. Here the linkage is done between the *person(X)* and *father_of(X,Y)* data-predicates and the corresponding general graph-predicates *node (Node)* and *vertice (From_Node, To_Node)* based on the following assertions: X is a node if it is a person; there is a vertice from X to Y if X is the father of Y.

node(Node):- person(Node).
vertice (From_Node, To_Node):- father_of(From_Node, To_Node).

3 Student difficulties - diversity from the conceptual model

During the last few years, we conducted an ongoing study aimed at assessing various aspects of students' use of ADTs in the Prolog environment (Haberman et al.., 2002; Haberman & Scherz, 2003, Scherz & Haberman, 2003). We found that students adapted various strategies for using ADTs, some of which were compatible with the ADT-based problem-solving conceptual model. Other students improvised alternative strategies, which indicated that their conception of ADT did not match the formal CS definition. Nevertheless, the use of ADTs for problem solving and knowledge representation helped many students develop correct programs regardless of the strategies they used (Haberman et al.., 2002). Here we discuss students' difficulties related to incorrect linking between the product's components, in various stages of the problem-solving process, which might cause the development of incorrect/non-working programs.

In section 2.2 we described two types of linking. Our study revealed that most novices prefer *linking by casting to a pattern*, and few students manage to successfully perform *linking by conversion*.

Often, even though students correctly identify the appropriate ADT for a given problem, they fail to use correctly the corresponding ADT- black box; more specifically, because they fail to establish proper links between various components at the abstract level (the space problem and the corresponding ADT operations), or at the programming level (e.g., specific data, data-predicates, problem-predicates, and the corresponding ADT-predicates). Specifically, we identified the following students' difficulties:

(a) **Incomplete abstraction** This refers to missing mapping between problem predicates and the corresponding ADT-predicates. For example, in the problem presented in section 2.2, it might be the case of ignoring the need to use the *root(R)* predicate, thus causing incorrect formalization of the *ancestors/2* predicate in terms of the general-predicate *path/3* (because of missing the instantiation of the starting node R): *ancestors(X,Y):- path(R,X,Y).*

```
Quries (goals)
?- ancestors('Jacob', List_of_Ancestors).

A program that describes the problem
The Interface
Data Predicates
 % person(Person)
% father_of(Father, Child)
% mother_of(Mother, Child)
General Problem  Predicates
%  ancestors(X,Y)
________________________________________
Formalization
Data Predicates
 % person(Person)
person('Abraham' ).   person('Sarah' ).  person('Issac' ).   person('Jacob' ).
% father_of(Father, Child)
father_of('Abraham', 'Issac').
% mother_of(Mother, Child)
mother_of('Sarah', 'Issac').
General Problem  Predicates
%  ancestors(X,Y)
  ancestors(X,Y):- root(R) , path(R,X,Y).

Communicating with the black box

node(Node):- person(Node).
vertice (From_Node, To_Node):- father_of(From_Node, To_Node).

A "graph - black box"
The Interface:
%  node(Node)   -  Node is a node in the graph
%  vertice(Node_1, Node_2)   -  There is a vertice  from Node_1 to Node_2
%  root(Root)
%  path(From, To, List_of_nodes)
________________________________________
The Implementation:        [Encapsulated and hidden]
%  root(Root)
root(Root):- node(Root), not vertice(_ , Root).

%  path(From, To, List_of_nodes)
path(X, X, [X]).
path(X, Target, [X | Rest]):- vertice(X, Succ), path(Succ, Target, Rest).
:                  :
```

Figure 2. The ADT-based school-solution for the Biblical Genealogy problem

(b) **Missing linkage to an ADT-black box**. We found that students use general-predicates that are defined in ADT-black boxes, but they do not perform any linkage between the data-predicate and the corresponding ADT-predicates. Interviews with students revealed that they might misleadingly assume that somehow the connection between the predicates automatically occurs owing to loading both files of the main program and the ADT-black box.

(c) **Linking to an incorrect ADT-black box.** Sometimes the students use general-predicates of specific ADT-black box, but they perform linking to another black box. For example, students use set-predicates, but perform linking to a list-black box.

(d) **Incorrect linking**. Sometimes, even though the students refer to the suitable ADT- black box and try to perform a link to that black box, they fail to do it correctly. Students often believe that the casting of specific data (input) into data-predicates guarantees of accessibility to the data when posing a query, and therefore they might skip linking to the black-box, or to the problem-predicates.

For example, in the following example, the student missed a link between the general problem-predicate *number_of_students_in_class (Class, Num_of_students)* and the data-predicate *students_in_class(Class,List_of_students)*. He assumed that when invoking the general list-predicate *num_of_items_in_a_list*/2, somehow the argument *List_of_students* will be instantiated due to the data casting to the *students_in_class (Class, List_of_students)* data-predicate:

```
% students_in_class (Class, List_of_students)
students_in_class ( class_A, ['Abraham', 'Dan', 'Roy', 'Lily',' Tamar', 'Ben'] ).

% number_of_ students_in_class (Class, Num_of_students)
number_of_ students_in_class (Class, Num_of_students):-
        num_of_items_in_a_list(Num_of_students, List_of_students).
```

Another incorrect linking occurs when students perform seemingly (but incorrect) casting directly to the invoked ADT-predicate using a functional-based syntax:

```
% number_of_ students_in_class (Class, Num_of_students)
number_of_students_in_class (Class, Num_of_students):-
        num_of_items_in_a_list(Num_of_students, students_in_class (Class, List_of_students)).
```

The correct formalization should of course include the invoking of the corresponding data-predicate:

```
% number_of_ students_in_class (Class, Num_of_students)
number_of_students_in_class (Class, Num_of_students):-
        students_in_class (Class, List_of_students),
        num_of_items_in_a_list(Num_of_students, List_of_students).
```

(e) **Difficulties due to dealing simultaneously with several levels of abstraction.** Sometimes students avoid mapping from the problem directly to a generic ADT, and they define a mediator-problem-based ADT aimed at describing the general problem. For example, a correct formalization of the problem-predicate *number_of_ students_in_class/2* according to this approach will consist of a three-level linking:

```
%% Linking by casting into a pattern - to the List ADT
% students_in_class (Class, List_of_students)
students_in_class ( class_A, ['Abraham', 'Dan', 'Roy', 'Lily',' Tamar', 'Ben'] ).
%% Linking between a problem-predicate, a data-predicate, and a mediator-problem-based ADT-predicate
% number_of_ students_in_class (Class, Num_of_students)
number_of_students_in_class (Class, Num_of_students):-
        students_in_class (Class, List_of_students),
        num_of_students_in_a_list(Num_of_students, List_of_students).
%% Linking between a mediator-problem-based ADT-predicate and a generic ADT-predicate
% num_of_ students_in_a_list (Num_of_students, List_of_students)
num_of_students_in_class (Num_of_students, List_of_students):-
        num_of_items_in_a_list(Num_of_students, List_of_students).
```

For some students this might cause problems in linking between the specific data and the problem-predicates. For example, students correctly perform the linkage only when posing queries to the program, and avoid performing links in the program, thus resulting in a program in which the generality of the problem's solution is usually reduced.

The results described above indicate that students have difficulties in establishing correct mapping between the problem and its abstract (context-free) model– the corresponding ADT, and in establishing proper communication between specific corresponding programming modules. These difficulties are apparently associated with difficulties of a novice in learning to program in Prolog (Scherz, Goldberg, and Fund, 1990; Pain and Bundy, 1985,), and with the cognitive load required to write a program (Newell and Simon, 1972) especially when dealing with high levels of abstractions (Haberman, 2004).

4 Concluding remarks

In this paper we demonstrated how evolving ADT boxes can be employed to teach an ADT-based problem-solving approach in the logic programming paradigm. We believe that the suggested TSL instructional model can be adopted to enhance problem-solving techniques in any programming paradigm, and can also be used to guide the students toward achieving proficiency in programming based on abstraction and reuse of code.

We recommend that this instructional approach be employed while the students are provided with an appropriate learning environment that promotes learning processes. Examples that provide scaffolding should be used to present the activities associated with each stage of the model. Moreover, appropriate exercises as well as activities that support the approach should be developed to motivate students to use black boxes transparently, reuse code provided by others,

modify code, and use appropriate ADTs to solve given problems. Teachers should be aware of students' difficulties in each stage of the TSL process, and should identify the "weak links" and the "missing links" in the students' problem-solving strategies, like the ones presented here. In addition, they should organize learning and instructional activities in such a manner as to minimize the cognitive load imposed upon the students when they are required to develop a program. One way that this can be achieved is to coach the students to organize their programs hierarchically and modularly (Scherz, et al., 1990). Moreover, in order to foster integrative knowledge, we recommend that students should continue, at each stage of learning, to practice and meaningfully utilize the tools and the methods that they have previously acquired.

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A Narrative View on Children's Creative and Collaborative Activity

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The aim of this paper is to examine children's ideating processes of creating playground of their dreams from the viewpoint of narrativity and narrative thinking. The children aged 6-7 were asked to express their ideal outdoor playing environments and a large number of narratives emerged. This study concerns how these narratives were constructed through creative processes and what affect narrative thinking has on the process. The research process consists of 15 playful ideating sessions, during which the children (N = 49), through play, expressed their thoughts by drawing and telling stories. Our starting point is the pivotal nature of narrative thinking in creative and collaborative activities, we also aim at a closer theoretical examination of this phenomenon. Through narratives the children structured their experiences and the products of their imagination into larger entities. The children were enchanted by exceptional ideas and their imagination was stimulated by integrating fact and fiction. We realized that in situations where the children were emotionally committed to building a story and functioned in a reciprocal manner, refining and elaborating ideas together, there was collective thinking, which in this context can be regarded equal to shared narrative thinking. Based on the interaction between data and theories we present our theoretical model of narrativity and consider possible applications of this model into the context of school. The results will be utilized in the design of learning environments consisting of playgrounds with information and communication technologies, as well as based on play and games.

Keywords: narrativity, narrative thinking, collaborativity, creativity, frame play, Information and Communication Technologies (*ICT's*)

1 Introduction

What type of activity should tomorrow's learning environment encourage and what kind of stimuli should it provide for a developing individual? We assume that the challenges of a future's society are particularly linked to supporting creativity and collaboration in activities. If we think of a global society of the future as based on interactive creativity, what becomes relevant is not new technology but the new ways of acting (see Himanen 2004). Also into the *Finnish National Core Curriculum for Basic Education* (2004) is written a goal to renew thinking and ways of action. It can be based on a creative collaboration, which is best characterised as a trust on others, playfulness and support for taking risks (Uusikylä 2003). It is therefore reasonable to pay attention to socially shared activity (cf. distributed cognition, Oatley 1990), for which creativity is essential.

Within this article we examine the roles of narrativity and narrative thinking within the collaborative process, as well as the challenges of the learning environment from this angle. The focus of the analysis was children's ideating processes of their dream playing environments. During these sessions, which were similar to *frame play* (Broström 1996; 1999), the children ideated playing environments based on e.g. humour, fear, taking care, summer fantasy and adventure (e.g.

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Juujärvi & Hyvönen 2005; Hyvönen & Juujärvi, in print). Into these emotional surroundings of play, the children created stories, thus narrativity turn out to be an essential element of the creative and collaborative action.

Our starting point is the pivotal nature of narrative thinking in creative and collaborative activities. The study of narrative is multidisciplinary, it is divided within the focus of many disciplines such as literature or psychology. According to our experiences narrativity needs more *interdisciplinary* and *transdisciplinary* research (cf. Ruokamo & Tella, in print). Within this article we intertwine educational and philosophical aspects of narrativity and get closer to both a versatile theoretical examination of this phenomenon and a transdisciplinary research. We are not trying to define the borders of a story – such as what is considered as story and what is not – but rather accept it as a relative term.

For our theoretical background we present a few theoretical views of narrative thinking (e.g. Bruner 1986, 1990, 1996; Mateas & Sengers 2003), socio-cultural views (e.g. Vygotsky 1978; Wertch 1991; Wells 1999; Wells & Claxton 2002) on collaborative activity, concept of creativity (e.g. Amabile 1996; Cropley 2001; Uusikylä 1999) and philosophical aspects of possible worlds (e.g. Kripke 1980; Lewis 1986) and thought experiments (e.g. Gendler 2000; Bokulich 2001).

This article forms part of the Let's Play project studies. The aim of the project is to design, develop and build playful learning environments within the school grounds. Pilot environments are going to be built during the year 2005 utilizing information and communication technologies (ICT), but which will primarily begin with Identification Technologies. Playful and activity based learning environments will contain innovative and interactive applications for *play* and *games* (cf. *playfulness*; Hyvönen & Ruokamo, in print), which can be used in preschools and elementary school. Therefore we will consider how the use of technology in playful learning environments can, at its best, offer varied possibilities for the support of children's narrative thinking and creativity.

2 Aims and objectives

Focus of this paper is to clarify how children's narrative thinking appears in creative and collaborative activity, to glean what are the main points emerging from the interaction of theories and data. We will develop a theoretical model of narrative thinking and creativity and in future work we will develop a pedagogical model for the school context. Based on these models we will consider the prerequisites for play and game applications for playful learning environments. But first let us define the main concepts used in the article: narrative thinking, collaboration and creativity.

3 Main concepts

3.1 Narrative thinking from a multidisciplinary perspective

Narrative perspectives in analysing thought processes have become more popular in recent years (example Lyle 2000; Mateas & Sengers 2003.) Narrative thinking refers to a thought process of creating a story. With narrative thinking events and experiences are organised into plotted structures (Bruner 1990). With the help of plot characters, surroundings and activities are connected to each other (Bruner 1986). In this way story is functioning as a tool for constructing meanings about the surrounding world and thinking gains a narrative form, becomes explicit and easier to manage (Bruner 1996; Egan 1986). Thus, stories help us in deal with more complex meanings (Schwartz 1996).

Narrative thinking is natural and one of the earliest forms of thinking for the human mind (Bruner 1990; 1996). Narrative thinking is not only connected to lingual structures, because it is present in the pre-lingual stage in the child's development. This can be observed in children's play, when they mould the story verbally and with different creative actions like drawing or making gestures. Thus, in narrative thinking emotions, imagination, memory and thinking is combined (Bruner 1996; 2002).

Narrativity has a close relationship with possible worlds. When constructing a story one builds parts of another possible world. Understanding, that things could be differently needs elaborative thinking, constructing and active thinking wholes that can be thought of as "worlds". Thinking of other worlds involves thinking more complicated notions, such as relations between individuals. Complex notions such as this are, for example, causality and time. One may perceive that possible worlds are only stipulated entities (Kripke 1972), or that they are physical entities (Lewis 1986). In the latter, the limits of language are not limiting the very idea of possibility – imagining a possible world does not have to be only a verbal act.

Narrative thinking is not only something that is present in the early development of thinking processes, as in children, but also in story-like experiments within science and philosophy, termed thought experiments. It is believed that thought experiments play an essential part in testing a theory's consistency and explanatory power (Bokulich 2001). Making thought experiments is essentially a process of refining the theory (Gendler 2000), executing a thought experiment is an act of make believe. This process can also be collaborative (Bishop 1999). In this sense playing can be thought of as making a thought experiment where an imaginary setting puts certain views of the actual world to a test. With narrative thought process one can make sense of unusual (Bruner 1990) or new.

3.2 Collaborative activity

The nature of collaboration is dependent on whether the participants are sharing a common idea or task (Engeström 1992). In our case, this means children's commitment to the ideation of the *same* playing environment by connecting their own ideas or thoughts with the ideas of others. Narratives from the viewpoint of collaborative activity, is thus not only the sum of the narratives of individuals, but the active building of narratives collaboratively. In this case the focus is not to transform one's own structures of mind, but to contribute and refine shared narrative information (cf. Bereiter 2002).

Collaborative activity has been the focus of educational research and is well known both in the study of play and learning. An advantage of collaborative activity is based on Vygotsky's (1978) concept of the *Zone of Proximal Development* (*ZPD*) in which children are challenged with the graduated zones, which are slightly above their current individual level of functional competence. However, the present view of an educational reform is that the role of each of participant as learner and tutor in a collaborative activity is emphasised (e.g. Wells 1999), in which case the *ZPD* is at the same time a potential challenge for everyone despite of the level of development.

Neil Mercer (2000; 2002) highlights the intermental perspective in collaborative activity, which means that common pursuits are based on *Intermental Development Zone* (*IDZ*). The term describes social activity, where the meaning of the constructing of common view is highlighted. By emphasizing collaborative activity socio-emotional factors are also significant. Therefore *ZPD* also consists of action, thinking and emotions (Wells 1999). In successful collaboration emotional scaffolding concludes *the gift of confidence*, the sharing of risks in the presentation of new ideas. (Mahn & John-Steiner 2002).

3.3 Creativity

Creativity is essentially associated with the activity of producing something novel, imaginative and satisfying to oneself. (Cropley 2001; Uusikylä 1999). In addition the product of creative action should be appropriate to the given task. In the context of creativity it is usual to discuss divergent thinking (Cropley 2001; Russ 2003) that involves non-logical processes and novel situations in which there may be several relevant answers (see Eysenck 1994). Furthermore, the prerequisite for creativity is a heuristic process. The goal is not to reach a predetermined answer, but where solutions may develop through a number of paths (Amabile 1996). There appears to be a relationship between creativity and narrative thinking. When children play they often share their fantasy world and construct the stories of play through collective activity. Thus narratives are tools for thinking and creativity. From the point of view of frame play children from the age of 6 become more conscious of the situation of imaginary play and they reach an awareness of the purpose of play when adults can easily join in with imaginary situations (Broström 1996; 1999).

Creativity is supported if the situation is not stressful. Thus it is important to encourage children to play with ideas and to test solutions rather than pursue one correct goal. From the point of view of creative imagination children's thinking is usually suppressed. One obstacle in playing with ideas is a fear of mistakes and the use of existing models based on the thoughts of adults (Hakkarainen 2002). Within this research ideating sessions were constructed with an atmosphere that nurtured children's creativity and imagination. The ideating sessions of designing playing environments were organised in a playful way, because it allows more possibilities to create hypothesis and inventions. It is argued that in creative activity playfulness has had positive influences (Lieberman 1977; Christie & Johnson 1983).

4 Data collection and analysis methodology

The empirical data was collected during autumn 2003, from 15 ideating sessions, in which children (N=49) aged 6 to 7 years expressed the kind of playing environment of their dreams. A session involved a group of 2 to 5 children that consisted of either all boys, all girls or was mixed. The children ideated by drawing and discussing around a large drawing sheet spread on the floor (figure 1). Researchers also participated in the process and emphasized that the playing environments would be outside. Sessions lasted 30 to 45 minutes and were recorded on videotape. Videotapes were transcribed afterwards and all the drawings were photographed.

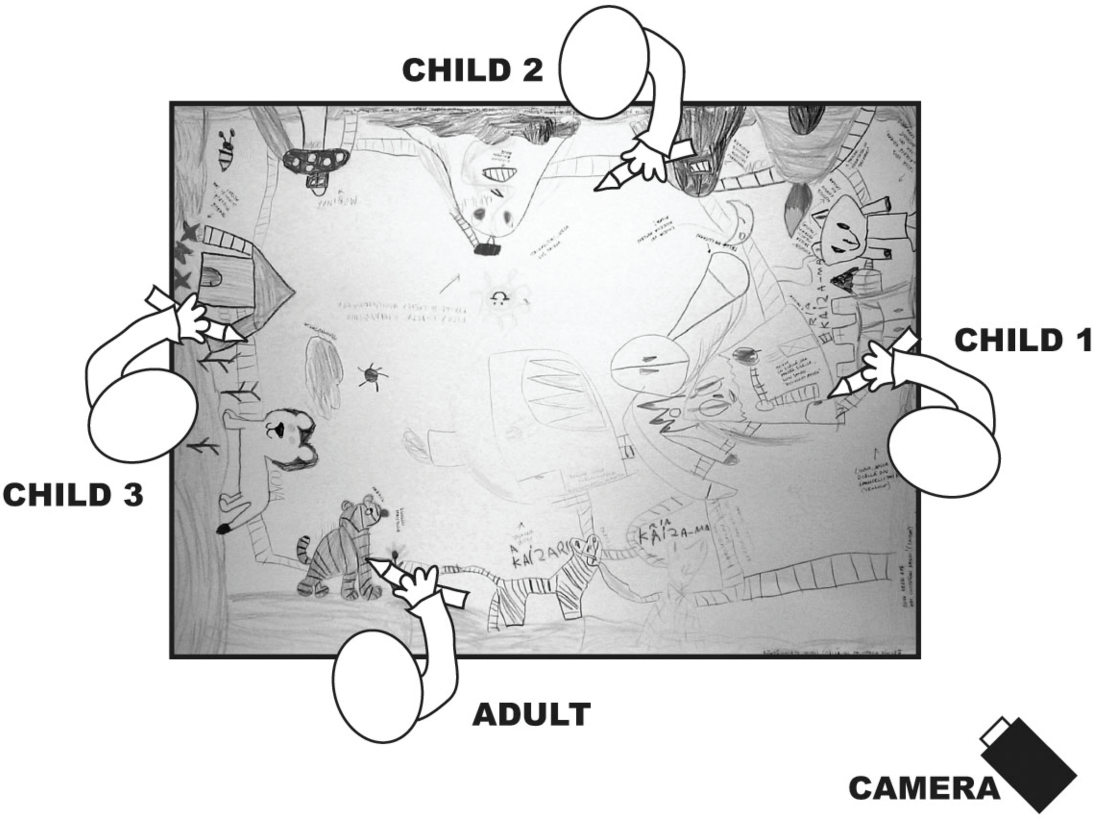

Figure 1. Example setting from an ideating session.

The playful nature of ideating sessions were similar to Stig Broström's (1996; 1999) description of *frame play*, in which an adult may also participate in the construction of the plot and imaginary situation. *Frame* refers to the participants' conscious and joint plan of the imaginary play situation. During the ideating sessions researchers participated by listening, discussing and drawing with the children. Researchers also asked about aspects of the playing environment and what the children would like to do there. In this sense data collection sessions were similar to participant observation. Adults joined in the storyline, but the children's ideas and initiatives held the main role around the drawing paper.

The study is based on *narrative analysis* (e.g. Polkinghorne 1995) and g*rounded theory*, according to which a phenomenon is approached through data-based information and the interaction of different theories (Strauss & Corbin 1994). In our case, the intention is not to create a theory of the individual thinking, but weight is put on the processes within group thinking. Since there were several children involved in the ideating sessions, analyzing the process by means of videotape or transcribed data is ambiguous. The fast pace of the children's activities and the difficulty of interpreting non-verbal communication make the interpretation of collaborative activity comparatively challenging.

Analysis of the data was based on the qualitative analyses of the ideating sessions. Through video and transcription of the children's dicussions, drawings and their activity during the sessions were evaluated. The constructed narratives of the children were set apart so that one narrative unit consists of one story with a clear plot or a connected whole. Thus, one narrative could be a short description of environment and activity or the whole environment ideated on the paper.

5 Results

The children were eager to ideate environments of their dreams: the 30 narratives were collected over 15 sessions, averaging two narratives per session. In these processes children often shared their narrative thinking and constructed narratives with a high level of collaboration. Narratives emerged in the levels of play, verbal action and emotions and these became more complex and more emotional during the collaboration. Below we will present the results starting with the playfulness in the sessions and finishing with the descriptions of shared narrative thinking and the theoretical model of narrativity.

5.1. Narrative thinking as playing

Frame play sessions inspired children to insert narratives into the playing environments. Narratives were represented as drawings, descriptions and discussions about the playground of their dreams and connected activities. Many stories were born of the creative and playful processes and can be thought of as an indication of children's narrative thinking and a way of organising new experiences into plot-like shape. Sometimes narratives were born so that children imagine activities in the environments and were the narrators of those situations. Sometimes children played in the roles of the narrative as in extract 1 below. Figure 2 shows the children's common narrative.

Extract 1. Aapo, Tomi and Juho are structuring the narrative "The ship fires a ship and the rocket fires a park" by playing

> Aapo*: What Im gonna do?... well there is no canon!*
> Tomi: *Yes, there is none.*
> (notices that he also has none and draws a canon on his ship)
> Aapo*: Theres going to be a bang!*
> *Tomi: Mine is shooting there, look, it shoots directly at pirate ship.*
> (indicates the pirate ship of Aapo) … *Big ammo… shoots kind of really far, doesnt it?*
> Aapo*: Mine too…*
> Tomi: *Little rocket!*
> Juho*: Oh geez! If that rocket… oh no!*
> Aapo*: Rocket goes, it brakes that in a minute and then all of those!*
> Tomi: *Yes it does! The ship shoots ship and rocket shoots park.*
> Aapo*: Look.*
> Juho: *My pirate ship gets revenge.*
> Tomi: *Yeah! But not this, this shoots u into outerspace. And that flies to space certainly*

Figure 2. The ship fires a ship and the rocket fires a park.

Extract 1 demonstrates that most of the narratives that arose from the ideating sessions were created through collaboration, showing that two or more children share an imaginary situation in a collective way. The most rich and complex narratives emerged in playful situations characterized as spontaneity, a manifestation of joy and a sense of humour, which interrelate with divergent thinking (see Lieberman 1977). Below we present the main features of children's narrative thinking and shared narrative thinking.

5.2 Children's narrative thinking in collaboration

From the data we distinguish four features in children's narrative thinking: entity, fascination with surprise and integration of fact and fiction, and emotions. In addition, we perceived five properties of children's shared narrative thinking (see table 1).

Table 1. The main features of narrative thinking and shared narrative thinking.

Narrative thinking		**Shared narrative thinking**	
Category	Implication	Category	Implication
Entity	*Tendency to form meaningful entities*	Imitative	*Construction of common imagination and common ground*
Surprise	*Meaning in the stimulation of thinking*	Associative	*Creating narrative through associations*
Integration of fact and fiction	*Tendency to generate imaginative situations*	Productive	*Creating narratives through collaborative ideating*
Emotional	*Essential role of emotion in the ideating sessions*	Transformative	*Refining and elaborating ideas through collaboration*
		Emotional	*Emotional commitment to shared idea*

Through narratives children structured and organised their experiences and products of imagination into **entities** through which the ideated environments acquired a meaning. In narrative thinking an element of **surprise**, that is, presenting surprising alternatives inspired the children's imagination and narrative thinking. For example in one session each of the children first drew a tiger, and when the researcher asked if the animals could speak, the children didn't react much to the question, but after that the animals became climbing frames in which you could slide down from the animal's tongue. So, we argue that, in this case, surprise – asking if tigers could speak – stimulated the children's imagination, but this only happened when children found the ideas proposed appealing. We noticed that surprise is closely connected to **integration of fact and fiction** in narrative thinking. Indeed, combining fact and fiction seemed to inspire children and tended to exclude the conventional in the narratives. Extract 2 below shows an example in which two boys ideate an environment by combining fact and fiction. Figure 3 shows the children's ideal playground corresponding to this narrative.

Extract 2: Paavo, Niko are structuring the narrative "Lava proof swimming trunks are needed" - fact and fiction

Paavo*: I'll make a volcano!*
Niko*: Yeah, I'll make volcanoes, too!* (giggle)
Paavo*: But these are not real ones. They're fake volcanoes!*
Niko*: I'll make a big one, at least! Lava is splattered there!*

Paavo*: Hmm, this is fun!*
Researcher*: Why is there lava?*
Paavo*: There could be coloured water, red water.*

Researcher*: Yeah, it could be fake water.*
Paavo: *Yeah, is it ok Niko?*
Niko: *Yes.*
Paavo*: Like red cloth you could jump into.*

Niko*: Hmm…you can swim there.*
Researcher*: In lava?*
Niko*: Yeah*
Paavo*: Then* swimming *trunks are needed!*
Niko*: Yes!*
Paavo*: And lava proof ones!*
Researcher*: Ooh. Super trunks.*
(boys laugh)
Researcher*: Exactly. So your clothes don't get wet and the lava doesn't burn.*
Paavo*: Then we could play volcano climbing!*

… What an unusual climbing place!

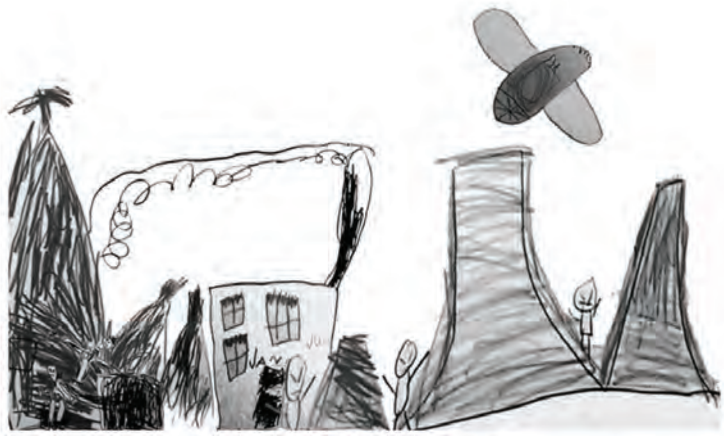

Figure 3. "Lava proof swimming trunks are needed"

In extract 2 children differentiated between reality and fiction but seem to be fascinated with the more fictitious surroundings. The more fantastic assumptions, like swimming in lava, stimulated a greater refining and elaboration of the narrative turning it into descriptions of other possible worlds. Integrating fact and fiction turns views of reality into a test of possible worlds by making thought experiments. As in frame play, an adult joined the imaginative situation but allowed the children to construct a common narrative for themselves. Thus, in one socially shared story, narrative thinking or some aspects of it created by many children were represented. We assume that high quality collaboration arose where constructing a story was based on the *Intermental Development Zone* (*IDZ*, Mercer 2000; 2002). Stories that were versatile and rich in content were mostly constructed collaboratively, and, especially in situations where children's narrative thinking was **socially shared**, their imagination, memory, thinking and emotions came together. In this case the representations of shared narrative thinking were not only verbal but included the movements, actions and drawings during the process. According to the data, *shared narrative thinking* can be categorized into imitative, associative, productive, transformative and emotional intermental phenomenon.

When children shared ideas for the narrative, refined it and developed it further, they were acting as guides and innovators, but also as targets for copying and learning from each other. In all sessions shared ideating was based on **imitation**, which appeared to be meaningful, especially in the shared reciprocal state, collective imagination and in constructing a common view. It is possible that for children at this age imitation is one of the ways in which they signal to their partner that they accept the stated idea (see Faulkner & Miell 2004) and in this way an *IDZ* is created. It was also typical that the stories were created **associatively**, for example, in one session a child drew a house upside down and the other elaborated on it turning it into an amusement park building associatively from her own experiences. In addition, shared narrative thinking can be said to have been **productive**. This is shown in the sessions as rich and imaginative output.

Due to the collaborative nature of *elaborating and refining ideas,* shared narrative thinking is **transformative**. During the collaborative process of constructing a narrative, the ideas of others were not taken per se but constructed and refined further. In this case transformative narrative thinking is connected to divergent thinking and to the creativity. Thus in the ideating sessions acquired *IDZ* was made possible, along with narrative thinking, *Intermental Creative Zone* (*ICZ*). The *reciprocal creativity* idea is refined so that none of the children can create it alone.

The data supports the assumption that emotions are closely linked to imagination (see Egan 2005) and narrative thinking (see Bruner 1996). During the sessions children welcomed the ideas that attracted them emotionally, like those associated with humour, fear or adventure. We agree with Egan (1992) in that children's imagination is best stimulated by stories with a content that affects them at the emotional level. Shared narrative thinking represents **emotional commitment** to the same idea. For example, if one of the children or adults came up with an exciting idea, others took part in the imaginary situation by eagerly making gestures and empathizing with the idea intensively. Common humour and excitement functioned as emotional stimulations to the collective imagination and play.

In the ideating sessions children ideated playing environments spontaneously sharing only *relevant thoughts*. This is enough for understanding because in social interaction a story can carry both meaning and context, i.e., surroundings for the meaning. The story itself is actually broader than is explicitly expressed. For example in the session where Niko and Paavo created the volcano environment, Niko's "*you can swim there*", is based on the assumption that then you'll need swimming trunks and swimming in lava is possible in play. Implicit assumptions are starting to broaden the story into a whole other possible world.

5.3 Towards a model of narrativity

Based on the perspectives that arise from the data and the theories of narrativity, we developed a three-dimensional model of narrativity (figure 4). This model includes the dimensions of meaning, activity and collaboration. The model introduces a flexible idea of narrativity, starting from separate entities and moving towards whole worlds, leaving narrativity somewhere in between. The 30 narratives found during the sessions were situated in this model.

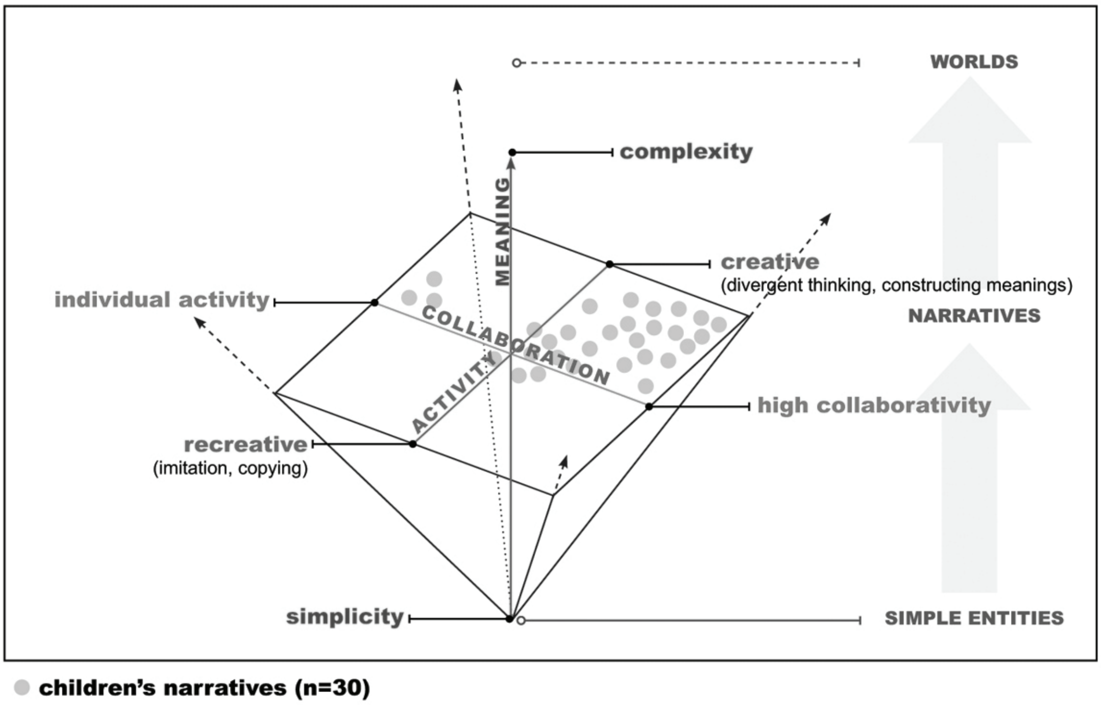

Figure 4. Model of narrativity

At the bottom of the model are the simplest meanings, such as characters and things. Moving up, the act of combining simple elements with different kind of relations, such as time, causality and so on, introduces a narrative. At the top, narrative expands into a whole possible world. As we approach the narrative level, which shouldn't be thought of as a definite level with real borders but as a continuum, the meaning of the axes of collaboration and creativity grows. The narratives were hard to fit into the figure because of the very complex nature of all three dimensions. It seems that most of the narratives are concentrated in the creation-collaboration corner, i.e., the corner of *shared narrative thinking*. In the creative sessions of this study, children were not told to collaborate, it happened naturally through stimulation by the *entities* contributed by others and through *association*, *surprise* or the *integration of fact and fiction*. The activities observed can be categorized as *imitative, productive* and *transformative*. Presumably, expansion into broader worlds occurred, but the more explanatory level, that is, the level of narrative, was our main focus.

6 Conclusions

This study showed that in creative and collaborative activity the children's narrative thinking was shared and it arose especially by playing and refining imaginative situations. Through shared narrative thinking children entered the *Intermental Creative Zone* (*ICZ*) and, in this way, crossed the borders of individual imagination. It is through *reciprocal creativity* that most of the children create the playing environments of their dreams and include in them meaningful narratives in the shape of actions. Therefore, it is important to develop playful environments that are based on *narrative activities*, the children's own activity and collaboration. Based on this, we are developing our *Model of Reciprocal Creativity*, which we will test in the pilot playing environments. We also have further plans to introduce new technological elements to them.

It is important that children refine possible worlds that are relevant to their current views of reality. When constructing possible worlds by means of narrative, children gain an understanding of more complex meanings and learn to create new meaningful wholes. Playing is fertile ground to develop children into flexible thinkers and actors of the future. Thus, play can be properly regarded as a relevant context for shared narrative thinking and divergent thinking.

The role of the adult in this process is to emotionally support creativity and stimulate divergent thinking, taking care to allow space for the children's own natural narrative activities. As our data showed, surprise and integration of fact and fiction was one of the most important factors in narrative thinking. Reacting to surprising stimuli, constructing a world, they became more elaborative. Interesting and exciting conflicts between fact and fiction produced more shared narrative thinking.

The surprise factor could also be supported by technology, by providing random inputs in time, challenging the children's narrative thinking. *Information and Communication Technologies* (*ICTs*) could support this kind of collaboration between remote places. Most of the content of the narratives should still come from the children. *ICT* would just provide a more dynamic environment – children as collaborative constructors of their own worlds and technology making it more alive and offering more possibilities. Thus *ICT* would serve to support and stimulate imagination.

Supporting children's narrative thinking thus creates many challenges for future learning environments and for the use of ICT. The learning environment of the future should be adaptive, flexible and customizable in order to create support for the children's own narrative activity and creativity. It should also provide possibilities to easily include learning processes into the play and narrative activity. The question of building a pedagogical model for narrative learning experiences therefore requires further study. The theoretical model of narrativity introduced here also requires more interdisciplinary and transdisciplinary research.

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