Dickson K.W. Chiu Minhong Wang
Elvira Popescu Qing Li Rynson Lau (Eds.)

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New Horizons in Web Based Learning

ICWL 2011 International Workshops, KMEL, ELSM, and SPeL
Hong Kong, China, December 8–10, 2011
ICWL 2012 International Workshops, KMEL, SciLearn, and CCSTED
Sinaia, Romania, September 2–4, 2012
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Preface to ICWL 2011/2012 Workshops

The aim of the International Conference on Web-Based Learning (ICWL) series is to provide a leading annual international forum for researchers, professionals, and industrial practitioners to share their knowledge in this rapidly growing area. In 2011, the conference venue returned to Hong Kong, 10 years after its founding, and in 2012, it was held in Romania. This volume comprises papers from one collated symposium and four workshops from 2011 and 2012:

1. The First and Second International Symposium on Knowledge Management and E-Learning (KMEL 2011/2012)
2. The First International Workshop on Enhancing Learning with Social (ELSM 2011)
3. The 4th International Workshop on Social and Personal Computing for Web-Supported Learning (SPeL 2011)
4. International Workshop on Learning Within and from Smart Cities (SciLearn 2012)
5. International Workshop on Creative Collaboration Through Supportive Technologies in Education (CCSTED 2012)

These events were selected from a public call-for-proposals process. The event organizers put tremendous effort into soliciting and selecting research papers with a balance of high quality, novel ideas, and emerging applications. They also followed our recommended vigorous review process. A total of 40 papers from a wide range of countries were accepted.

We are grateful to the ICWL organizers for their generous support. We appreciate the hard work of all event organizers and Program Committee members in putting together the program. We also thank all the authors for their contributions.

Last but not the least, we thank Dr. Jeff Tang for helping us compile this book.

December 2012

Dickson K.W. Chiu
Maggie M.H. Wang
Demetrios Sampson
Costin Badica

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The First and Second International Symposium on Knowledge Management and E-Learning (KMEL 2011/2012) Chairs' Message

Fierce competition, globalization, and dynamic economy have forced organizations to search for new ways to improve competitive advantage. In pursuance of this, knowledge is seen as the core resource and learning is viewed as the important process. It is crucial for organizations to enhance the capabilities for effective learning and knowledge management (KM), especially via using information and communication technologies in the digital economy.

The creation, operation, and evolution of such research and practice raise concerns that vary from high-level requirements and policy modeling through to the deployment of specific implementation technologies and paradigms, and involve a wide and ever-growing range of methods, tools, and technologies. They also cover a broad spectrum of vertical domains, industry segments, and even government sectors. We intentionally seeks educators, researchers, scientists, engineers, industry people, policy makers, decision makers, and others who have insight, vision, and understanding of the big challenges in knowledge management and e-learning (KM&EL). After review, we selected ten and eight quality papers in KMEL 2011 and 2012, respectively, for presentation covering various aspects of KM&EL.

We appreciate the interest and support of all attendees. In particular, we thank the ICWL organizers, the *International Journal of Systems and Service-Oriented Engineering* (IJSSOE), and the *Knowledge Management & E-Learning: An International Journal* (KM&EL) for their generous support. The great success of the symposium is indebted to the hard work of all Program Committee members. We also thank all the authors for their contributions.

December 2012

Dickson K.W. Chiu
Federick Li
Maggie M.H. Wang

First International Workshop on Enhancing Learning with Social Media (ELSM 2011) Chairs' Message

The Organizing Committees of the First International Workshop on Enhancing Learning with Social Media (ELSM 2011) welcome you to the proceedings of the workshop. This workshop aims to discuss new contributions as well as practical experiences using emerging information technologies. In particular, it looks at the differences of using and not using social technologies for distance learning technology.

With the popularity of social media (e.g., Facebook, Twitter, Yahoo Answer, etc.), some sort of on-the-fly experience is gained by daily users. This type of experience can, in addition, be recognized as a particular way of cultivating domain knowledge, which can be used for various purposes. This phenomenon, use of social computing and multimedia networking infrastructure, has changed human behavior. The most popular and typical instance is education. The impact of distance learning on traditional universities, in particular, allows educational professionals to rethink how to efficiently and effectively apply up-to-date computing paradigm and technologies to improve instruction as well as to encourage students to learn. The use of social media has recently become an emerging issue to be adopted in distance learning, and various considerations should be carefully identified from both pedagogical and technological perspectives to ensure the successful incorporation of these technologies in distance learning.

The Program Committee accepted five submissions based on the paper quality and the relevancy. These papers are from Japan, China, and Taiwan. Each paper was reviewed by at least three Program Committee members and discussed by the Program Committee co-chairs before acceptance.

We would like to thank the ICWL 2011 Workshop chairs, Dickson Chiu from Dickson Computer Systems and Maggie Wang from The University of Hong Kong, for their support and coordination. We thank all authors for submitting their works to the workshop. We appreciate the Program Committee members for their efforts in reviewing the papers. Finally, we also appreciate the participants' involvement in the discussions during the workshop.

December 2012

Qun Jin
Timothy K. Shih
Hiroaki Ogata
Chengjiu Yin
Xinyou Zhao
Neil Y. Yen

4th International Workshop on Social and Personal Computing for Web-Supported Learning Communities (SPeL 2011) Chairs' Message

This workshop followed the previous SPeL 2008, SPeL 2009, and SPeL 2010 workshops, held in conjunction with SAINT 2008 (The 2008 International Symposium on Applications and the Internet), WI/IAT 2009 (The 2009 IEEE/WIC/ACM International Joint Conferences on Web Intelligence and Intelligent Agent Technology), and DEXA 2010 (21st International Conference on Database and Expert Systems Applications). The general topic of the SPeL workshop series is social and personal computing for web-supported learning communities.

Web-based learning is moving from centralized, institution-based systems to a decentralized and informal creation and sharing of knowledge. Social software (e.g., blogs, wikis, podcasts, media-sharing services) is increasingly being used for e-learning purposes, helping to create novel learning experiences and knowledge. In the world of pervasive Internet, learners are also evolving: the so-called digital natives want to be in constant communication with their peers, they expect individualized instruction and a personalized learning environment, which automatically adapts to their individual needs.

The 2011 installment of the workshop dealt with current research on collaboration and personalization issues in Web-supported learning communities, leading to the creation of a truly social and adaptive learning environment. Its aim was to provide a forum for discussing new trends and initiatives in this area, including research about the planning, development, application, and evaluation of intelligent e-learning systems, where people can learn together in a personalized way through social interaction with other learners.

In more detail, SPeL 2011 had as a special theme the provision of intelligent, adaptive support for collaborative learning. In this context, we solicited contributions that converge on this topic, either from the perspective of collaborative learning theory and practice (highlighting opportunities for the introduction of intelligent support in the process), or from the perspective of adaptive learning methods and techniques (traditionally more individual learner-oriented). This was aimed at complementing the workshop's general themes, and focusing on an emergent research area that is expected to have major impact in the field of e-learning in the coming years.

The workshop was targeted at academic researchers, developers, educationists, and practitioners alike. The proposed field is interdisciplinary and very dynamic, taking into account the recent advent of Web 2.0 and ubiquitous personalization, and it attracted a large audience. Furthermore, this installment's special theme drew the attention of researchers active in the area of collaborative e-learning who seek to provide input into, and thus shape the next generation of intelligent and adaptive technologies to support socially-grounded online learning.

After a thorough review process (each paper being reviewed by at least three Program Committee members), four high-quality papers were selected for presentation, covering aspects related to: computer-supported collaborative learning; intelligent agent technology in Web-based education; personalized and adaptive learning; cognitive, motivational, and affective aspects; pervasive e-learning applications.

We would like to take this opportunity to thank all authors who contributed to this workshop, the Program Committee members for their valuable and timely reviews, as well as the ICWL 2011 Workshop Chairs and Organizing Committee for their support and cooperation.

December 2012

Qun Jin
Timothy K. Shih
Hiroaki Ogata
Chengjiu Yin
Xinyou Zhao
Neil Y. Yen

Workshop on Learning Within and from Smart Cities (SciLearn 2012) Chairs' Message

From the Far East, to the Americas, and to Europe, cities and their surroundings are evolving toward a new dimension in which the information infrastructure becomes an indispensable asset of our life and contributes to the development of info-ecosystems embracing "smart mobility and last-mile logistics," "smart health," "smart government," "smart culture and tourism," the sustainability of natural resources and green economy. This integrated effort of info-urbanism is expected to produce social innovation and, inevitably, leads one to wonder what forms smart education can take, underlined by all the pieces that make up the mosaic of info-ecosystems. The virtual infrastructure – Web and mobile – will be integrated more closely with the physical landscape – Internet of things and sensible physical places – incorporating the latter into a complex ecosystem that will bring forward opportunities to learn from everyday life.

Technologies, increasingly embedded into everyday spaces and artifacts, will make the places not only more sensitive but also responsive and, potentially, coevolutionary (TEP, technology-enhanced places) and will give rise to new landscapes in which one can experiment, seamlessly, with the integration of physicality and virtuality.

The person, considered in all her/his complexity, will be placed at the center of educational contexts and scenarios that are increasingly ubiquitous, complex, and organic. The perimeter of the physical space in which the educational experiences develop will become increasingly undefined, liquid, and will host more and more nomadic and informal practices characterized by a high density of social interactions. In these scenarios, the mediating role of technology will widen over time to: foster relationships with the natural environments, filter content needed to support meaningful experiences at a glocal level, disclose feedback necessary to learn how to manage "in action" the complexity of static and dynamic, of learning contexts and processes.

This workshop, the first of its kind, proposed itself as a think tank to foster reflections on how the way we learn may be influenced and change because of the development of "smart cities," but also "smart villages" and "smart territories." The selected papers together offer an overview of the issues raised by learning in future smart cities.

The first contribution starts with theoretical considerations intended to foster a reflection of smart city education that should no longer be seen as "infrastructure & service" but rather as a founding process, through which the relationships between persons and the inhabited territories are continuously reshaped; the paper continues, with the description of a strategic and methodological approach that focuses on "museal field" and narrative as key elements of future "learning from smart cities" and, of course, of advanced integrated technological environments designed to support it.

The second contribution discusses the role played by context in promoting engagement and exploration in situated learning experiences during field trips. In particular, the authors consider field trips where children engage with the physical and social environment in order to learn about cultural and social aspects of the city they live in. By drawing on empirical data collected by means of qualitative methods, they show how learning unfolds along trajectories of experience toward predefined and emerging learning objectives. A reflection on the role played by technology in supporting learning experiences outside the classroom concludes the essay.

The third contribution presents a case history: a virtual museum introducing the interactive VR and MEMS applications related to the learning of chaos and complexity theory. The authors suggest that such a museum can be used in the city in order to create new ways of experiencing science, turning physical activities into virtual ones. In conclusion, a possible road toward pervasive museum for smart cities.

Finally, the fourth contribution offers a completely different perspective and focuses on just-in-time and efficient support to learning for professionals working in the "smart city." The authors present the principle and structure of a contextual mobile learning system, which uses a search engine to find appropriate learning units in relation with working activities and worker's profile.

Of course this workshop should be considered only as the first step in a long journey that will develop during the next few decades and that will hopefully lead us to the answers to questions like the following, which are extremely relevant to avoid the transformation of "smart cities" into "automated systems."

Through which educational path will people become participatory aware citizens of the future SimCities? How will we learn from the open books that are represented by the cities of art? How will data flowing from sensorized areas be elaborated to support awareness and learning? How will our behavior be influenced by knowledge of the co-evolution mechanisms and limits of the ecosystems? Will the educational infrastructure be smart enough to readjust, even autopoietically, to satisfy the needs that everyone could develop life long, in different contexts?

December 2012

Carlo Giovannella
Alke Martens

International Workshop on Creative Collaboration Through Supportive Technologies in Education (CCSTED 2012) Chairs' Message

In the beginning of September 2012, the wonderful Romanian resort of Sinaia hosted the First International Workshop on Creative Collaboration Through Supportive Technologies in Education (CCSTED 2012), organized in the frame of the 11th International Conference on Web-Based Learning (ICWL 2012), a remarkable annual conference that has reached various locations in three continents (Asia, Australia, and Europe).

Nowadays, creative collaboration represents a multidisciplinary process where different problems are explored by taking into account new perspectives, based on the idea of developing and evaluating technology-supported collaborative spaces for different age learners. Collaborative space can be a combination of real and virtual environments that enable group work. Generally, the process of designing a collaborative space involves: scripting collaborative learning (modeling how learners of different ages collaborate in those spaces) and developing technology-enhanced spaces to support creative collaboration.

In this respect, the general topic of the workshop was oriented on how to support creative collaboration through various technologies, at different levels of education: pre-primary, primary, secondary, university, and adult education. The workshop concentrated on current research in computer-supported collaborative learning topics leading toward the realization of a learning environment that can support creative collaboration processes.

Ten papers were selected and presented at the workshop, most of them emphasizing the experience and results obtained in project no. 511733-LLP-1-2010-1-FI-KA3-KA3MP:

CoCreat – Enabling Creative Collaboration Through Supportive Technologies – was co-financed by the European Commission, Education and Training, under LLP Transversal Programme KA3-ICT. The main paper subjects were the illustration and evaluation of collaborative spaces, focusing on the main roles and valences that creative collaboration proposes to various groups of learners. At the end of the workshop, a panel related to "Technology in Support of Collaborative Learning – Challenges and Perspectives" was held, as a conclusion to the discussions held during the presentations.

The number of participants was also impressive: over 50 researchers, specialists, and university teaching staff from 20 countries attended the workshop.

As main organizers of this workshop, the CoCreat team from Valahia University Targoviste would like to thank the participants, the Steering Committee of the CoCreat project, and the ICWL 2012 Conference organizers for their support. It should also be mentioned that the participants expressed their willingness to organize the second edition of the workshop, in 2013.

December 2012 Gabriel Gorghiu

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2012 International Workshop on Creative Collaboration through Supportive Technologies in Education

A Quality Assurance Support System for Learning-Object Development

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Abstract. Use of e-Learning has been expanding rapidly in recent years with the development of ICT and e-Learning tools. The trend shows that it will continue to grow as technology is becoming cheaper and more accessible. Despite the trend, e-Learning suffers from low quality learning objects (LOs) due to the lack of supporting tools for proper electronic LO development. This paper proposes a quality assurance support system for LO development that aims to raise quality awareness throughout the development process. The system's underlying data model makes use of RDF to model and implement a workflow for LO development following the ISO/IEC 19796-1 standard. The system also integrates Quality Function Deployment (QFD) and achievement standards from Achievement Standard Network (ASN) to support the proposed workflow. Preliminary evaluation of the system shows that the system can satisfactorily assure the quality of resulting LOs.

Keywords: QFD, ISO/IEC 19796-1, quality assurance, learning object development, RDF workflow, learning achievement standards, e-learning.

1 Introduction

E-Learning has become very popular in the present day and its usage has been continuously growing [1] because of its easy accessibility, cost effectiveness, and affordability of computers and internet. With the popularity of e-Learning, the number of e-learning resources or learning objects (LOs) is also increasing. However, Massy, who conducted an online survey asking citizens of the EU (European Union) about quality of e-Learning of their own countries, found that 61% of participants of the survey were not satisfied with the quality of e-Learning [2]. He stated that most of the e-Learning systems failed in pedagogical design and learning content were not appropriate to learner types and needs which resulted in the failure of learners to achieve target learning objectives. Although there exist methodologies developed to address the problems such as the widely used ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model [3], they are not standardized, and, as a result, deliver LOs with varying qualities. In addition, when there is no reference to guide work or processes such as achievement standards and learning objectives, the development LOs would be ambiguous. Even with the defined

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objectives and achievement standards, there is still no systematic process to assure that the development of LOs will conform to those objectives and standards. Lastly, finding references for learning content is a distressing task [4].

Therefore, a quality assurance support system for learning object development is proposed to alleviate the above mentioned problems.

2 System Design Principles

Stracke has stated that quality development covers every kind of the strategy, analysis, design, realization, evaluation, and continuous improvement of the quality within given systems [6]. As a result of such a demanding definition, the promotion and improvement of the implementation quality development requires standards and tools to help provide guidelines and support. The quality assurance support system for e-Learning proposed in this paper employs official as well as widely-accepted standards on learning, education and training quality (ISO/IEC 19796-1), achievement standards (ASN), quality function specifications (QFD) and information representation and exchange (RDF). It provides facilities and tools to deal with the problems of LO development with the following components:

2.1 RDF Workflow from ISO/IEC 19796-1

The ISO/IEC 19796-1 standard, published by the International Standardization Organization (ISO) in 2005, is the first quality standard for learning, education, and training [5]. The standard provides the reference process model "Reference Framework for the Description of Quality Approaches" (RFDQ) to guide stakeholders in learning, education, and training to document their quality processes [6]. RDFQ has been adopted in the proposed LO development workflow as the base process model for learning object development and is described using Resource Description Framework (RDF) [7]. The RDFQ/RDF includes several resource nodes which describe processes in the model. Because the model is a lifecycle of e-learning, the nodes are linked in a form of workflow structure which represents the development steps of learning object. With the advantages of RDF, the description and suggestion to complete a process can be obtained from Linked Open Data (LOD) [8]. The user will benefit from the workflow by having well-defined development directions and guidelines. In addition, it also raises quality awareness which leads to sustainable quality improvement.

2.2 Achievement Standards as Learning Objectives

Development directions can be ambiguous if the target goal is not clear. Achievement Standard Network (ASN) [9] provides educational expectation statements derived from various national academic curriculums and are accessible online. The statements are listed in a form of "parent-child" relationship (e.g. Fig. 1) which describes prerequisite expectations for achieving higher ones. In addition, this hierarchical structure has the advantage in suggesting a suitable learning path for a learner. These statements can be used as references for the development goal. Moreover, ASN published achievement standards in RDF format which makes it a simple task to link them to the proposed RDF workflow.

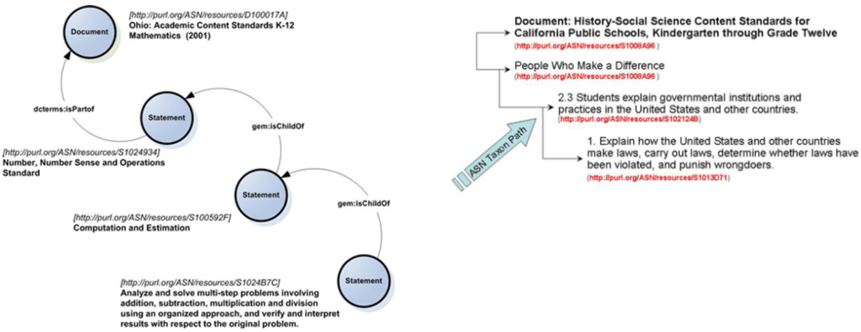


Fig. 1. Educational expectation statements provided by ASN

2.3 Systematic Quality Specification Using Quality Function Deployment (QFD)

Quality function deployment (QFD) is a technique to translate customer requirements into product or service characteristics [10]. This could be useful for identifying correlation between the customer requirements and characteristics to be implemented in the services or products. Because the main concept is very general, it has also been adopted in academic field for course construction [11]. Likewise, this same concept can be applied to learning object development as well. Although the goals and other requirements for the learning object have been set, the lack of systematic requirement transformation process could make it difficult to determine the type of content to include. QFD will assist in choosing the appropriate content that will satisfy all requirements and goals.

2.4 Learning Resource References

Oftentimes, when creating a learning object, it is the best practice for the author to include references for any facts or claims. This helps learners to find additional information and also serves as evidences for the claims. Finding references can be a difficult and time consuming task [4]. There are various sources for references including the World Wide Web (WWW) which, although considered weak in terms of references, is gaining more acceptance as the reference source. There are many websites dedicated for searching and browsing web resources but it could still be inconvenient and inefficient to switch through several websites to find the specific types of resources. Therefore, wide reference search would be a good extension to the learning object development tool. This enables the author to seek for learning resources to be used as references in several media types easily and more efficient.

2.5 RDF Quality Assurance Model for LO Development

RDF is one of the World Wide Web Consortium (W3C) recommendations. It is a semantic web language which represents and describes any information. To enable sharing and accessing of learning object development information and linking with external resources such as LODs and ASN, RDF was chosen as the information representation for describing the workflow and QFD data of the developed learning object.

An LO will have its own RDF graph that describes its development workflow and QFD data. Initially, when the development starts, a resource node will be created to describe the general information of the learning object including title (dc:title), creator (dc:creator), QFD data (qfd:qfd), and workflow data (wf:workflow).

Figure 2 is an example of an initial RDF graph of a learning object ID ‘S1016EF5’. Each learning object will be assigned a unique ID for learning object identification.

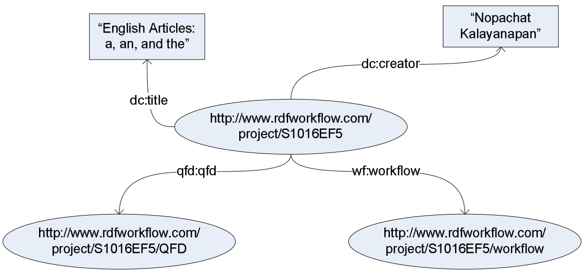


Fig. 2. An initial RDF graph of a learning object

Because there is no such a standard metadata set to describe QFD and workflow, therefore two sets of metadata were defined at wf and qfd namespaces as presented in Table 1.

Table 1. List of used namespace

dc	http://purl.org/dc/terms/
wf	http:// rdfworkflow.com/terms#
qfd	http://qfd.com/terms#

The wf:workflow predicate holds the workflow data of the ISO standard (Fig. 3). Although unique for each learning object, the workflow structure will be identical following the predefined workflow template. Each resource holds several predicates or properties that describe a process of the standard including process id (wf:id), description (wf:description), process name (wf:processName), method (wf:method), and example (wf:example). These predicates correspond to the attributes of the process as described in the standard document (Fig. 4).

In order to represent the flow of process, the predicate wf:nextprocess was introduced. The value of this predicate will be another resource representing the next process. For example, process ID NA.3.1 is the next process following process ID NA.1.1. This also implies that the process ID NA.1.1 has to be completed first in order for process ID NA.3.1 to be executed.

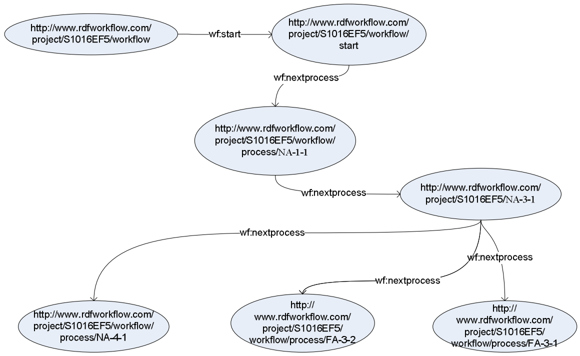


Fig. 3. Connected RFD resources representing the workflow of ISO/IEC 19796-1 standard

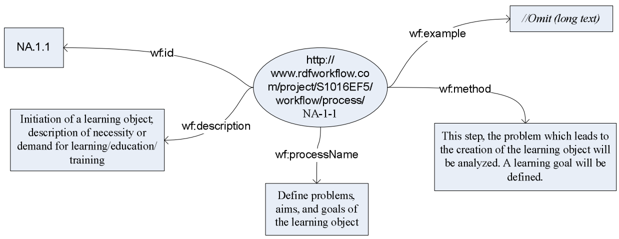


Fig. 4. A workflow process described in RDF format

In contrast to the workflow part, each RDF resource under the QFD sub-graph will be created after each respective workflow process has been completed. For example, in Fig. 5, two requirement nodes in the QFD sub-graph were created after the workflow process ID NA.3.1 has been completed.

Data representation of QFD is quite straightforward. The “What” and “How” parts are represented as individual RDF resources. The predicates for the “What” resource consist of the requirements for the learning object with their associated weights which could be determined by the results from the questionnaires given to the stakeholders. Similarly, the predicates for the “How” resources consist of the characteristics of the learning object. Each correlation value between the requirements and the characteristics are presented using either one of the predicates: qfd:weak, qfd:medium, or qfd:strong depending on the level of correlation presented in Fig. 6.

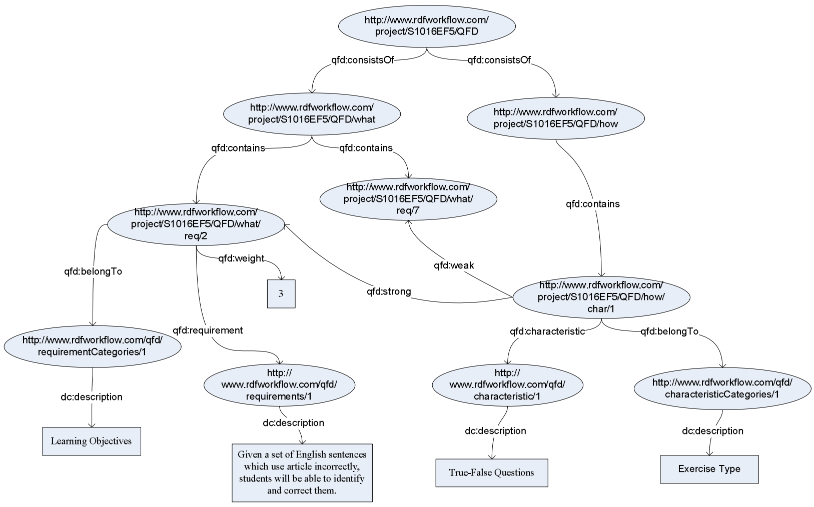


Fig. 5. QFD data described in RDF format

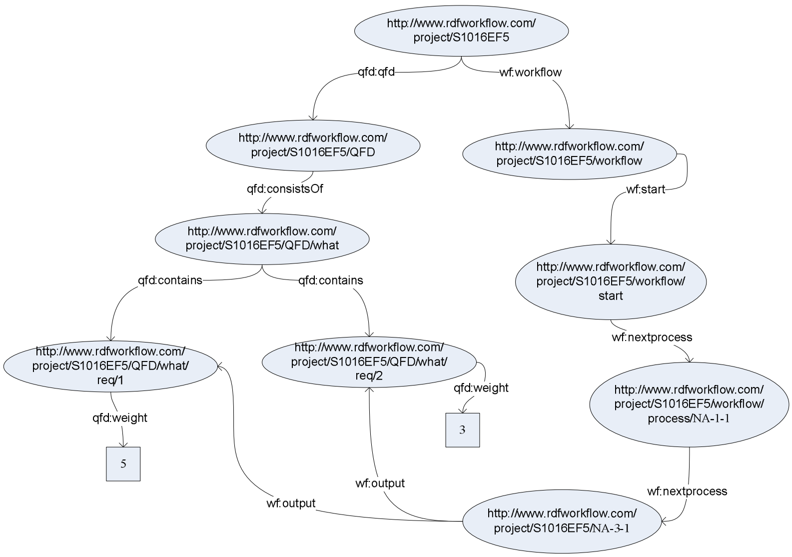


Fig. 6. Links between a workflow node and QFD nodes

3 System Implementation

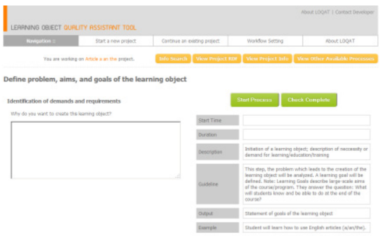
From the stated design principles and proposed idea, a system for learning object quality assurance has been developed. The front end of the system is the web interface that directs the process steps the learning object author. Any input from the author will be transformed to the corresponding RDF resources by the workflow engine in the backend. With the guided processes following the ISO standard and the suggested referenced curriculum from ASN, the system raises quality awareness throughout the development process.

In summary, the developed system comprises four major modules (Fig. 7) as described below:

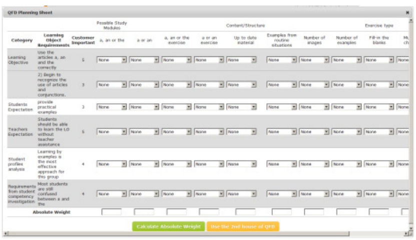
Workflow Engine serves as the backend that manages all RDF-related operations. The collection of RDF-described processes is kept in an RDF store. The module reads the current state of the user in the workflow and displays next steps needed to be performed. The module also handles storing RDF data whenever the author's action to document the development information in certain workflow steps is made.

QFD Constructor constructs a QFD table when the author reaches the design phase of the workflow. The module calculates the absolute weight from the requirement data input by the user and suggests the type of content to be included in the learning object.

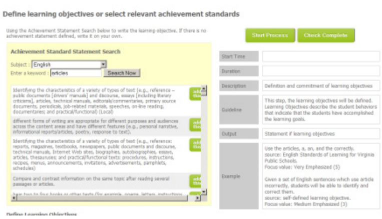
Achievement Standard Search enables the author to search for relevant achievement standards to be used as learning objectives. Because the achievement standards from ASN are retrievable in RDF format, it is possible for the module to link them to the RDF graph representing the learning object.



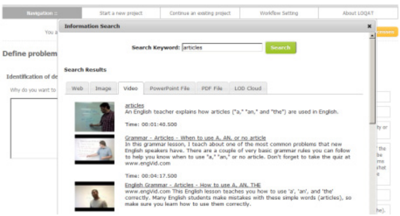
(a)



(b)



(c)



(d)

Fig. 7. System Modules: (a) Workflow Process with Guidelines, (b) QFD Constructor, (c) Achievement Standard Search, and (d) Wide Reference Search

Wide Reference Search makes use of both semantic and non-semantic search engines to enable authors to search for web references in several media types such as webpages, images, videos, etc. including data from the LOD cloud. However, the authors still need to evaluate the reliability of the retrieved resources by themselves. Normally, the higher ranked resources imply greater reliability as they have more frequent visits.

4 Evaluation

Quality is very subjective and difficult to measure. Thus, the paper used indirect measurement by adapting the assessment method from Individually Prioritized Problems Assessment (IPPA) [12]. IPPA was adapted to evaluate the effectiveness of the system. IPPA was developed by Work Package (WP) 03 of the EATS (Efficiency of Assistive Technology and Services) project and has been designed to evaluate the effectiveness of any kinds of assistive technology provision from a client-centered perspective by assessing changes before and after using the assistive technology. Firstly, the system was tested by ten computer teachers who had experiences in learning object development. They were assigned a task to develop a learning object of their preferred topics twice; first without the assistance of the proposed system and second with the system's assistance. A pre-defined set of problems partially taken from Güler's work [4] was given to the teachers. After the development, they were asked to rate the importance of each problem and the difficulty to solve it in the first round. In the second round, they were only asked to rate the difficulty since the importance was the same. Then the IPPA score of each problem was calculated. The set of problems are:

Problem 1. The amount of learning content is hard to organize.
Problem 2. The learning object does not conform to target learning objectives.
Problem 3. The learning object does not fulfill stakeholder expectations.
Problem 4. The learning content is not up to date or missing important information.

Figure 8 shows the results from the IPPA assessment.

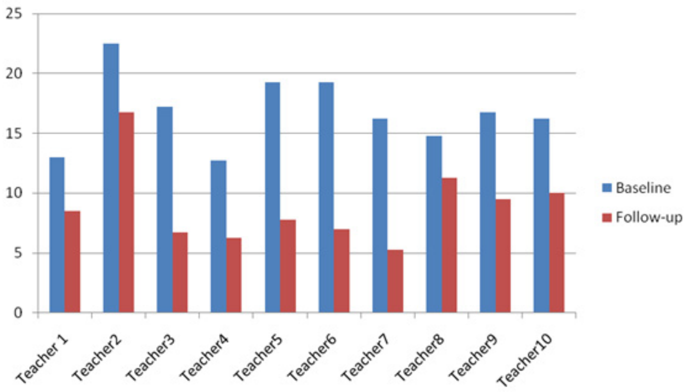


Fig. 8. The IPPA baseline score and IPPA follow-up score for every teacher

The score for reduction of difficulty (ROD) was calculated as

$$ROD = \frac{IPPA_{FU} - IPPA_{BL}}{IPPA_{BL}} \cdot 100$$

Where $IPPA_{BL}$ is the baseline IPPA score and $IPPA_{FU}$ is the follow-up IPPA score. The average ROD of all teachers is 46.85%.

The paper also presents the change in difficulty of each activity related to the problems. This analysis allows us to know which activity the proposed system could efficiently diminish its difficulty (Table 2).

Table 2. The average difficulty scores rated at baseline and follow-up

Problem	Reduced by	t-value	p
1	44.44%	4.523	0.0004
2	38.46%	4.427	0.0006
3	45%	6.107	1.52×10^{-5}
4	51.35%	4.396	0.0005

The preliminary evaluation results show that the system could reduce the difficulty to build a learning object from the pre-defined problems. Thus, the system is able to assure quality of the learning object to an extent. For further evaluation, the resulted learning objects should be tested for their effectiveness with learners.

5 Conclusion

The paper proposes a quality assurance support system for learning object development with the intention to support learning object authors in creating learning objects that conform to quality assurance processes which are adapted from ISO/IEC 19796-1 and raise quality awareness throughout the development process. The paper uses RDF to model and implement the standard. Moreover, achievement standards from ASN were used as references to academic curriculum and QFD technique was adopted as a requirement transformation instrument to design specifications of the learning-object. Lastly, the wide reference search enables the author to seek for useful references from available resources on the internet. The proposed system has been evaluated by means of difficulty reduction. The results show that the system reduced the difficulty of learning object development which has an indirect effect on quality. Conclusively, the system is able to solve identified problems and assure the quality of resulting learning objects to an extent.

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Timeliner: Supporting Collaborative Scientific Writing

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Abstract. This paper describes design, concepts, and initial implementation considerations of a timeline-based mash-up service, which addresses the needs of researchers involved in collaborative writing.

The process of collaborative writing was dramatically changed with appearance of new Web 2.0 tools and services. Being limited in time, researchers need tools for collaborative writing that can support their existing workflow in a non-destructive manner.

We start from short overview of existing studies on collaborative writing and then describe three design iterations including activity-centered design, user-centered design, and system-design. As a result of these design iterations, we introduce a concept of Timeliner — Web-based tool for supporting the process of collaborative writing.

Keywords: Timeliner, task management, data aggregation, collaborative writing, service design.

1 Introduction

Timeliner is a Web-based software prototype of a tool for supporting collaborative scientific writing. The need for Timeliner arose from daily routines related to collaborative writing faced by ourselves and later elaborated upon local and international research communities. By introducing Timeliner we address several issues of concurrent practices and collaborative writing workflows.

Collaborative writing is common and often unavoidable activity in such academic tasks as preparing articles, reports and presentations. Nowadays these artifacts mostly are produced collaboratively. Although several models of collaborative writing exist [1], in this paper we consider the collaborative writing as a process of two or more people working together to create a complex document, irrespectively of locus or synchronicity. As a research topic, collaborative writing has been approached in a number of contexts [2], [3], [4] and collaborative writing software has been the object of research since the 1970s [1], [5], [6].

In spite of the fact that many comprehensive collaborative writing systems have been developed in the 1990s, they newer were widely used [7]. The contemporary, mainly web-based approaches target to a large extent cooperative writing as an activity and not as a full-feature project-like process [8].

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The questions we aim to answer with Timeliner's project relate to boundaries, affordances and architecture of collaborative writing software, namely on how to provide unobtrusive support to scientific collaborative writing.

2 Knowledge Building through Collaborative Scientific Writing

Scientific writing is increasingly collaborative endeavor; multi-author research papers have become a mainstream. Greene [9] has illustrated this trend with the authorship data from Nature: *"Any issue of Nature today has nearly the same number of Articles and Letters as one from 1950, but about four times as many authors"*. The main driver behind increasing number of authors per paper is caused by the need to give credit to all those contributing to discovery. We argue that there are also other, not less important reasons for having multiple authors for one research paper. Collaborative scientific writing is a typical case of knowledge building in the sense of Bereiter's theory [10]. Bereiter distinguishes implicit learning from knowledge building, which happens in the form of creating or modifying public knowledge. The most fertile zone for knowledge building is on the boundary of different disciplines where collaboration between researcher's results in updated frontiers: cognitive artifacts, tools and discourses used by different researcher communities [11].

3 Designing Timeliner

We have based design of Timeliner on three complementary approaches:

- *Activity-centered design*: by identifying the activities that support scientific collaborative writing we at first outlined the conceptual boundaries of Timeliner;
- *User-centered design*: a second iteration with the twofold goal of validating and refining the results of the initial activity-centered design and focusing on the user's needs and goals to highlight Timeliner's expected affordances;
- *System-design*: a third iteration was focused on the software architecture of Timeliner and aimed seamless integration of the tool within the user's own digital ecosystem.

3.1 Identifying Boundaries for Collaborative Writing

Our initial conceptualization of Timeliner envisioned an unobtrusive tool embedded in the emergent Internet of Services [12] enabling both individuals and teams to plan, share, and track on their writing projects.

As taxonomies exist that address collaborative writing activities and are well established, providing relatively unambiguous vocabulary to reason about collaborative writing processes [5], [13], we use a set of activities introduced by Curtis & Lowry [13] to define and adjust boundaries for Timeliner.

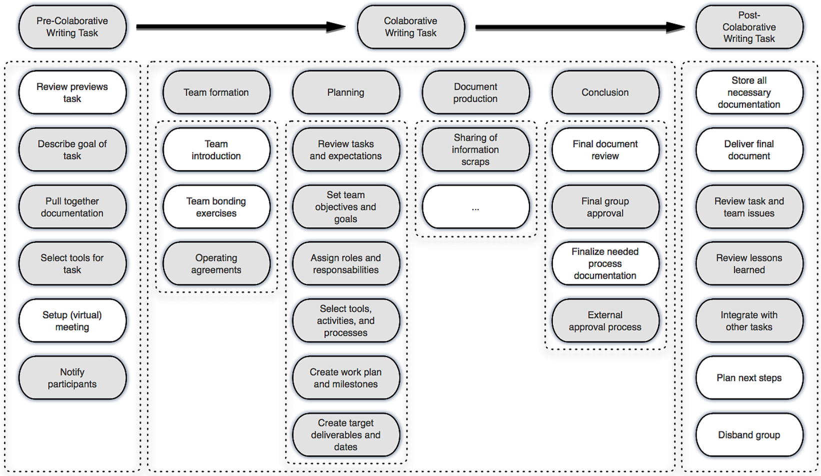

Fig. 1. Task and Activities of Collaborative Writing, adapted from Curtis & Lowry (2004)

According to Fig. 1, apart from building upon the digital ecosystem that both individuals and teams use to pursue their writing tasks, collaborative writing tasks can be facilitated by the following activities: *pre-collaborative writing activities* such as describing the goal of the writing task; pulling together the necessary documentation; selecting the tools for the task and participants notification; *collaborative writing activities* such as team formation; writing task planning; document production and conclusion actions like getting the final group approval and sharing the result of the external approval process; and *post-collaborative writing activities* such as reflecting on the accomplished writing task and possible integration with other tasks.

Taken out of the collaborative writing context, the highlighted in Fig.1 activities easily fit in either the personal information management [14] or the project management [15] categories.

Personal Information Management

Within the context of personal information management we include all related bits and pieces of information that can be relevant for managing papers intended for journals or conferences. A variety of relevant concepts may be ranged from *Call for Papers* to notifications of acceptance, including personal and shared notes, checklists, references and auxiliary files. Conceptually, these are information scraps [16], highly valuable if kept in their context, but difficult to structure due to their apparently random nature.

In this case, role of Timeliner is to provide locus and context thus preventing the project fragmentation problem in personal information management. Such fragmentation identified by Bergman, Beyth-Marom, & Nachmias [17] occurs when someone who is working on a single project stores and retrieves information items relating to that project from separate sources.

In this context, Timeliner aims to support information scraps related to the following activities (according to Fig. 1): select tools for task; pull together documentation;

sharing information scraps; review tasks and team issues; and review lessons learned. Timeliner does not, however, provide any personal information management services but rather an aggregation and indexing-like approach.

Project Management

As for project management, the activities targeted by Timeliner (see Fig. 1) are: describe a goal of a task; notify participants; operating agreements; planning (review tasks and expectations; set team objectives and goals; assign roles and responsibilities; select tools, activities, and processes; create work plan and milestones; create target deliverables and dates); final group approval; external group approval; and integrate with other tasks.

3.2 Affordances

Having established the initial Timeliner boundaries by using an activity-centered approach in our initial design iteration, we moved then on to a user-centered approach for our second design iteration, with the dual goal of: validating the results of the initial activity-centered design and refining and focusing on the user's goals and needs to identify expected affordances[1] of Timeliner. This was accomplished by conducted a survey among 20 active researchers from two universities in Europe and North America. Additionally we interviewed several researchers in our local research team.

Activity Centered Design Validation

Answers from the surveys and interviews identified tools that researchers use for their collaborative writing tasks. The users mentioned in their answers e-mail, Google docs, Moodle, Doodle, Skype, Evernote, Dropbox, blogs, Facebook groups, workflow tools, Gantt diagrams, Google sites, iCal, Mindmeister, Yammer, Apache Subversion, eGroupware and wikis, which supports our assumption that providing unobtrusive support to scientific collaborative writing without disrupting current work practices and workflow is a complex and multifaceted challenge.

Further, answers to the survey also show that the approach to collaborative writing adopted by most participants was actually falls within the collaborative writing processes framework established by Baecker et al. [5] and also by Lowry, Curtis & Lowry [13]. Responses included remarks such as:

"*Initially, set personal and team goals to achieve general/specific project aims. Then, meet punctually to discuss and reevaluate those goals*";

"*By setting goals and dates and then by sharing documents by e-mail, Google Docs or, sometimes, by using some more complex system such as Moodle (we use it on an European project as a group repository)*"; and

[1] Term used in this text referring to a tool's perceived affordances. In other words, to what users perceive as possible actions. An interpretation definitely closer to Donald Norman's use of the word on his 1998 book on *The Psychology of Everyday Things*, rather than to the concept originally introduced in 1977 by Gibson with *The Theory of Affordances*.

"*In many times we put meeting on-line or in person and we devise a plan for what we should do in the future. If there is any issue, we discuss them and try to resolve them*".

Not running into major activity centered design flaws, we then moved to the refining and focusing on the user's needs and goals.

3.2.1 Understanding User's Needs and Goals

Analysis of survey responses allowed us to identify expectations of users regarding Internet based support to collaborative scientific writing. When asked about how they would prefer to organize their collaboration with their colleagues, the users answered:

"*I feel the need for a dashboard to help me get an overview of all the different ideas and projects I participate in and the different tools and channels I use to collaborate with people*";

"*More clear definition of team work progress and individual tasks*"; and

"*With a specific web space (collaborative tool)*".

Respondents mentioned several additional features that would be welcomed by them in specific tool to support collaborative scientific writing:

"*More clear ways for (group) info sharing and visualization. Clear visualization of (general/specific) rules and goals on team work*";

"*Share and reuse docs; represent and disseminate knowledge, experiences, and competencies; managing best practices, and lessons learned; different forms of information visualization*"; and

"*Collecting and organizing information and knowledge, announcing meetings, and posting and sharing within group. Also, the ability to tracking, logging, and following up*".

Based on this analysis and on additional information gathering carried out over a number of unstructured interviews, two scenarios related to usage of Timeliner were created: using Timeliner for personal and for the collaborative work.

Scenario One: Using Timeliner Personally. A university researcher Michael uses different web-based services for academic writing, but he is unhappy because all his data is logically separated. Michael uses Timeliner to interconnect data from different sources by organizing it into integrated data flows. Each research projects contains a separate collection of interconnected resources. Switching from one paper to another leads to changing of entire working environment: cited papers, notes, emails, and project related tasks. They can be sorted, annotated, and accessed directly in one visual space.

Michael needs to know the best time to start work with specific paper, to complete the paper on time before a submission deadline. Michael imports into Timeliner deadlines from a Call for Papers. Now the deadlines are represented as a series of milestones on the timeline. Michael has full overview of each separate writing project and is able to allocate his time accordingly.

Scenario Two: Collaborative Work. Anna, Sergio and Jennifer are planning to write a joint paper for a conference. Anna creates a new timeline and shares it with Sergio and Jennifer. Now they have an opportunity to share resources, assign tasks to each other and organize synchronous (chat) and asynchronous (notes and annotations) discussions around project — all in one shared environment. Researchers have common access to all sources and to current version of paper they write. However each researcher can decide regardless of others, which specific resources she or he wants to share with others.

3.3 Creation of the System Architecture

A final iteration in our design process was creating the system architecture for Timeliner. As it was mentioned above, Timeliner had to have a possibility to aggregate different sources used in process of writing. Nowadays such sources typically are files stored in external cloud services. Several Web services already have implemented aggregation of content by supporting variety of APIs, one good example can be Hojoki collaborative mash-up tool[2].

The first challenge we faced was a choice of specific external services that Timeliner could support. In the survey we tried to explore the most popular content providing services that the survey respondents typically use in the process of scientific writing. A result of the survey was a compiled list of 12 popular Web services. In the initial design implementation of Timeliner we considered to use a limited subset of data types identified in the user survey. To simplify the initial development of Timeliner we selected a basic set of services to support: Google Drive as a storage for office documents and Evernote as a storage for collected notes, images, and other resources. However, the mash-up nature of Timeliner's architecture assumes that almost any data that uses API can be adapted in future. By combining APIs from different services Timeliner can be flexibly tailored for specific needs.

Several participants of survey mentioned also communication tools like Skype, whiteboard, and screen sharing tools. However integration of such tools seems to be a difficult task. To support communication processes we decided to implement in Timeliner the internal service for message exchange.

Supporting Collaboration

As it is illustrated in the second scenario, an opportunity to build communities of practice is an important feature of Timeliner. Support of group collaboration is implemented today in many web services, though the ways of implementations are different. In contrast to well-developed communication facilities embedded into social networks like LinkedIn and Facebook, the content-oriented services like Dropbox or Evernote usually propose only sharing of resources functionalities for the group work. Some services e.g. Mendeley and Slideshare offer limited features for community building. Sometimes such features are not very efficient; for example in Slideshare many groups are flooded by messages from spam robots. At the same time Slideshare proposes an alternative way for building micro-communities around content. These micro-communities usually are implemented by way of following a user or subscribing to comments for specific presentation.

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[2] `https://classic.hojoki.com/`

Another example of integrating an external data can be using Evernote service for storing annotations. The user can accompany the personal timeline with text notes, which can be shared with other users.

Integration of different services into an environment for collaborative writing with aim to build a community is a complex task. We propose the specific ways for solving this issue.

Instead of organizing users into groups we propose to share resources in associated with the users personal timelines. For example, if two or more users are ready to begin collaboration, they can start sharing their personal timelines with each other. By marking own resources as open and private the users can precisely define what resources they want to share. Process of sharing of timelines between two users is illustrated on Fig. 2. Resources planned to be shared are marked as gray lines; private resources are painted in black color.

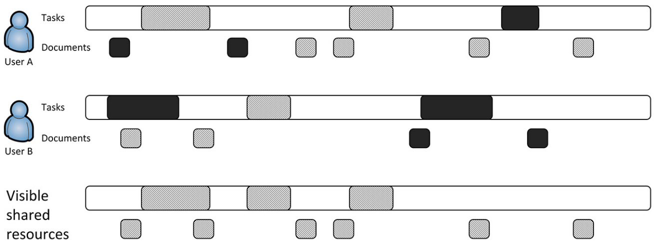

Fig. 2. Associated timelines and visible shared resources

Another way to support the process of communications implemented is aggregating comments and discussions from relevant external sources. For example the user can associate specific RSS feeds with her personal timeline. As a result, the user can receive a stream of messages related to specific Slideshare presentation, Wiki article, Flickr photos etc.

4 Initial Implementation Considerations

Timeliner is designed as mash-up tool for collecting external data provided by third-party services. It means that Timeliner has almost no concern about storing the data (except built in messaging engine), but it collects and processes metadata related to external data. By combining different types of metadata, Timeliner can link various resources into a new writing ecosystem.

To explain the design of general Timeliner architecture let's examine Fig. 3. All functionalities of Timeliner are distributed on four layers — data, metadata, visualization, and user.

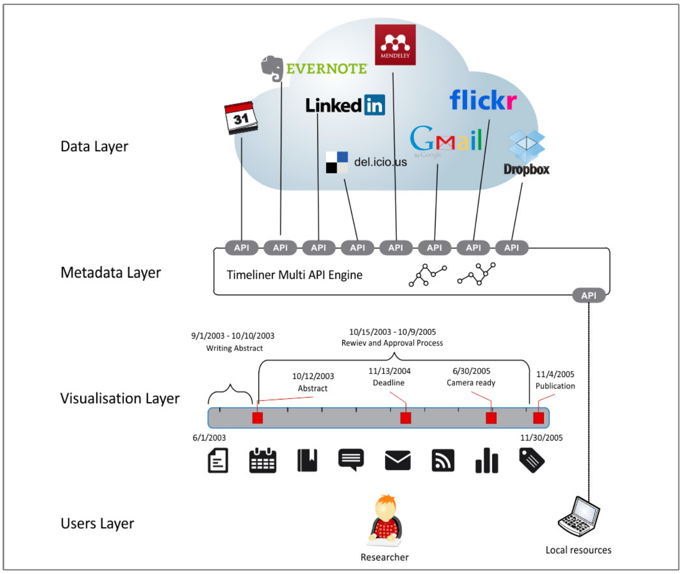

Fig. 3. Layered Timeliner architecture

The functionalities related to the data layer are implemented in existing third-party web services; these services have a responsibility for storing all user data. The cloud presented on the picture consists of several popular web-services, which can be used in Timeliner through their APIs, but in reality the effective list of used services may be varied according to user preferences. This approach allows using Timeliner as an incrementally extensible system.

The user interaction with the client software occurs on the visualization layer. This part of Timeliner represents a dashboard for accessing and manipulating resources used in the process of scientific writing and it can be adapted for different client platforms.

The visualization layer is connected to the metadata layer, which is deployed on dedicated server. Timeliner obtains access to the external resources using appropriate APIs and associate them to specific timelines. Such association is possible using the predefined metadata. Thereby Timeliner is responsible for storing user account data, metadata, and rules for associating data.

An important goal is to align Timeliner with existing users' workflows. Described approach allows us to ensure the incremental design and adjustable efficiency. Therefore we assume a high level of user customization: each instance of Timeliner should include only user-defined services.

5 The First Implementation

The first prototype of the Timeliner software is limited in ways of connecting to the external services. However it has most of functionalities described above for pre-collaborative, collaborative and post-collaborative writing tasks. A user interface is implemented in HTML and JavaScript and allows time zooming, drag and drop operations for tasks, users and resources.

Targeted document has a visual version tracking that shows the history of the document. We have also implemented internal chat board that has combined view with a system-generated activity stream.

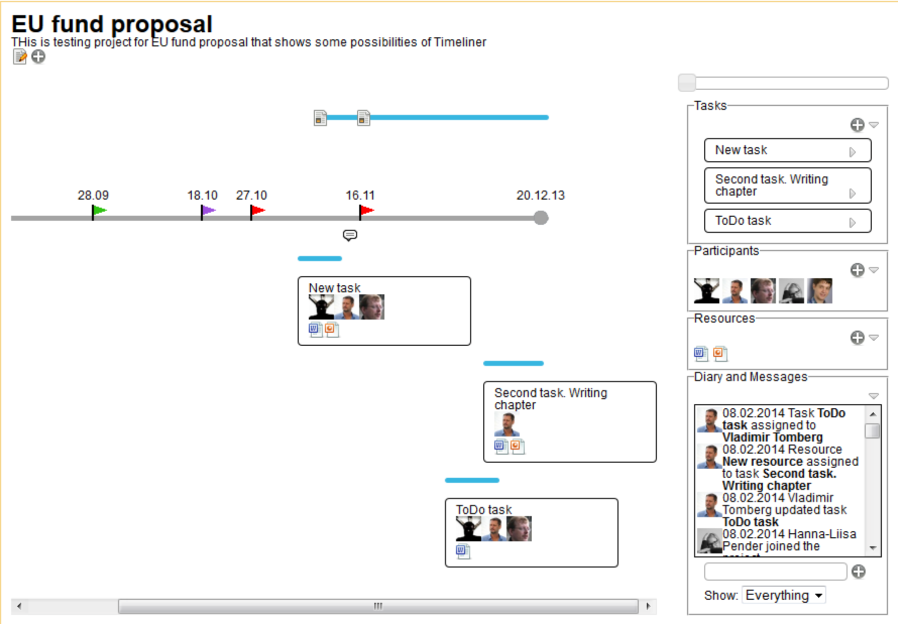

Fig. 4. User interface of the first prototype of Timeliner

6 Conclusion

In the previous sections we provided a description of Timeliner as an unobtrusive Internet-based tool support to scientific collaborative writing. This tool's preliminary proposal was depicted as the result of an initial design process carried out with the purpose of outlining its conceptual framework, which came to be of a tool supporting project and personal information management in the context of scientific collaborative writing. This was achieved in three steps: through activity-centered design we tried to identify activities supporting scientific collaborative writing; in user-centered design phase we tried to refine the results focusing on the user's needs; finally in system-design phase we tried to integrate external services into unified ecosystem of user.

Now, after establishing Timeliner's frame of reference, we should go back to the field and further check our assumptions with the users' actual work patterns, flow, and practices in all issues related with scientific collaborative writing. As such, the next steps include experiential contextual inquiry, observing the user in real context while taking the apprentice's role; and exploration tests for evaluating the user's perception of Timeliner's user interface design.

The main challenge is actually scaffolding scientific collaborative writing without altering current work patterns, flows, and practices.

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Optimization of Industrial Neural Network Simulators for GPGPUs

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Abstract. This paper introduces the porting of an industrial neural network simulator onto GPUs used in a tool-chain to sort massive amounts of E-mails and other textual data. Compared to other previous work, all steps are being executed on the GPU, achieving overall up to 33× speedup without using any cuBLAS functionality. All the time-consuming routines have been ported onto the GPU, i. e. the training-, the simulation- and the verification-phases, the training being the most time-consuming. It is planned to include these GPU-kernels into the product for special costumer's demands.

1 Introduction

Every large organization has to manage large amounts of data in an efficient manner. The company HMI-Tec GmbH offers solutions to sort textual data, such as email traffic, e. g. for large-scale trouble ticket systems and call-centers. The product is based on text recognition using neural networks. HMI-Tec has started collaborating with the High Performance Computing Center Stuttgart (HLRS) of the University of Stuttgart to research the possibilities of HPC and new hardware architectures, and outsource some of the largest optimization tasks.

This paper introduces the application requirements of the application `ANN` and the optimization and porting to GPGPUs done at HLRS. The novel contributions being the porting of all stages the neural network, combined with the correctness requirements of industrial applications.

The rest of the paper is structured as follows: Section 2 provides background information on the methodologies and the computer hardware employed, Sec. 3 describes the various implementation steps , while Sec. 4 shows the suitability of the optimization on the use-cases. Related work is presented in Sec. 5, finally Sec. 6 gives a conclusion and an outlook.

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2 Technical Background

2.1 Neural Networks

The application `ANN` is at the center of the tool-chain, responsible for sorting and enqueuing large amounts of textual data. It is based on a multi-layer fully-connected, feed-forward perceptron neural network, with a backward propagation learning algorithm with adaptations to the activation function. The layout of the network (number of layers and number of neurons per layer) are optimized once in an iterative process using genetic algorithms.

When in production, the network is continuously trained anew with known historical and new, corrected input data sets, i. e. the most expensive part of any neural network is happening quite frequently and should be executed within a bounded time. The usual production input cases include classification based on a few thousand words and word-pairs into up to a dozen bins. The system is capable of classifying of several thousand emails per day with a success rate of over 90%. It is not retrained with new corrected input data sets to eliminate over-training.

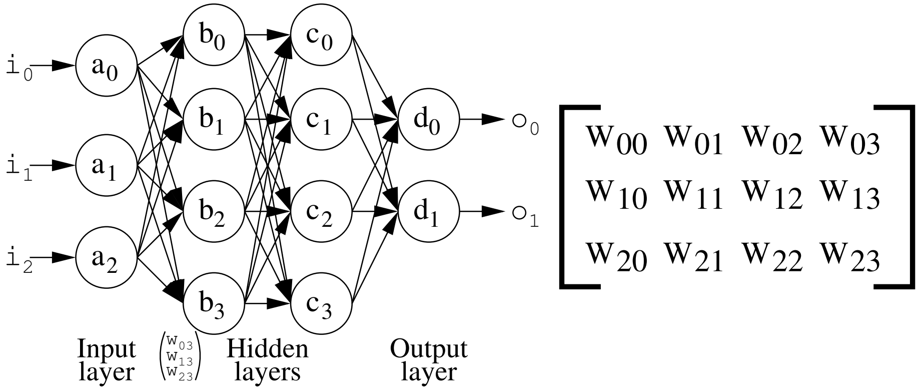

Fig. 1. Fully-connected Multi Layer Perceptron (left) and the weight matrix between layer a and layer b (right)

A general structure may be seen in Fig. 1, with i_i being the input values, w_i being the weighting values and o_i being the output values of each neuron. Here i_i being a numerical representation of words and word-pairs, e. g. "contract" and "hereby cancel", and o_i being the likelihood of the input data set ending up in a specific bin, i. e. in the aforementioned case being the mail-folder for contract cancellation. In the forward pass the input values i_i of each neuron are multiplied with the weighting values w_i, summed up and then passed to the activation function f, here being the sigmoid:

$$f(x) = \frac{2}{1 + e^{-2x}} - 1 \tag{1}$$

The back-propagation computes for each layer backwards the delta to minimize the error of desired output and actual output. The sequential back propagation is shown in Alg. 1. Please note, that all *italic* variables denote vectors of matrices, while `truetype` variables denote constant values.

Algorithm 1. Sequential Back propagation Algorithm for CPU

Initialize *sumweightDelta*, *oldweight*, *sumbiasDelta* and *oldbias* to zero
for all $Input\_pattern \in Epoch$ **do**
  $input[0] = Input\_pattern$
  for $i = 0 \ldots N$ **do**
    $input[i+1] = sig(input[i] * weight[i] + bias[i])$
  end for
  $change = Output\_pattern - input[N]$
  $sumbiasDelta[N] \mathrel{+}= (biasDelta[N] = (\texttt{flatSpot} + \partial\, sig(input[N])) * change)$
  $sumweightDelta[N] \mathrel{+}= (weightDelta[N] = input[N] \times biasDelta[N])$
  for $i = N-1 \ldots 0$ **do**
    $change = weightDelta[i+1] * biasDelta[i+1]$
    $sumbiasDelta[i] \mathrel{+}= (biasDelta[i] = (\texttt{flatSpot} + \partial\, sig(input[i+1])) * change)$
    $sumweightDelta[i] \mathrel{+}= (weightDelta[i] = input[i] \times biasDelta[i])$
  end for
end for
for $i = 0 \ldots N$ **do**
  $oldbias[i] \mathrel{+}= sumbiasDelta[i] * (\texttt{momentum} * \texttt{learnRate} / \texttt{patterns})$
  $oldweight[i] \mathrel{+}= sumweightDelta[i] * (\texttt{momentum} * \texttt{learnRate} / \texttt{patterns})$
  $bias[i] \mathrel{+}= oldbias[i]$
  $weight[i] \mathrel{+}= oldweight[i]$
end for

2.2 GPU Architecture

While a complete description of the current architecture is available in [7], we here want to give a short introduction into the concept of Graphic Processing Units (GPUs). Traditionally GPUs were designed to accelerate graphic computation like vertex calculation and texture shading. GPUs gain their processing power from the inherent parallelism of these calculations and the wide specially designed multi-channel memory buses, providing high bandwidth With the introduction of NVIDIA's CUDA the C-like programming paradigm reflects the multicore hardware topology, allowing numerical and scientific computing with up to 1.03 TFLops performance (with single-precision multiply-add). The CUDA programming model is based on so-called kernels, which is a function to be executed on the GPU (called device), started from the sequential code on the CPU (called host). These kernels are then started on the GPU, each with running multiple threads in parallel. Hundred of kernels can run thousands of threads. Equivalent to Flynn's taxonomy [3], this parallel computing paradigm is called Single Instruction, Multiple Threads (SIMT).

These threads are organized into one-, two- and three-dimensional blocks, which themselves are organized as one-, two- or three-dimensional grids. Figure 2 shows this numbering scheme. In order to start a kernel, the programmer may be started from within the host code using `<<<,>>>` notation. To map threads onto hardware, the notion of Warps is introduced, a Warp being a group of 32 threads.

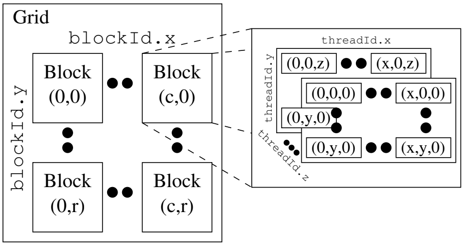

Fig. 2. CUDA Block and Thread organization

NVIDIA's Fermi GPU is the latest generation, consisting of 14 so-called Streaming Multiprocessors (SM). Each SM (of compute capability 2.0) contains 32 cores, which execute the same instruction on a Warp, accessing a shared register file of 32k x 32Bit register, 64 KB of local memory (configurable as 48KB of shared memory and 16KB of L1 cache or vice versa), 16 Load/Store Units (LD/ST) and four Special Function Units (SFUs) for complex mathematical functions, e. g. exponential. Each Fermi SM moreover contains two Warp schedulers, each assigning instructions to available halve Warps (16 cores) – if an instruction is to be executed on the full Warp it needs to be issued over two clock cycles. Double precision arithmetic instructions are additionally limited, so that only one Warp scheduler may issue a DP instruction at one time. Additionally, each Fermi GPU contains 768 KB of L2 cache. The programmer has multiple options to access device-local memory (so-called global memory), varying from declaring part of global memory as constant memory, i. e. read-only memory accessed through the `threadId`, setting up texture memory within global memory, i. e. read-only memory, offering filtering and caching benefits in case of two-dimensional mapping and standard global memory in normal fashion, i. e. read-write with no specific access pattern. Depending on access pattern (size, alignment and possibly overlapping from multiple threads), the halve-warps can access memory through a single memory transaction – or introduce bank conflicts and stalls. Needless to say, programming in CUDA offers many choices to improve (or hinder) performance.

3 Implementation

Since all neuron in the networks are connected to each other, they can be represented be a fully connected graph, see figure 1. Neuron networks can be Feed-Forward Multi-Layer Perceptron (MLP) like in figure 1 in which the output of each layer are fed to the input of the next layer. Recurrent network is another type of neural network with a feed back or bidirectional connections between the neurons. The model of the neuron network provided by HMI-Tec is a fully connected Feed-Forward MLP with supervised learning algorithm where the desired output is compared with the actual computed output and the error is fed back to a learning algorithm to change the network parameters to reduce the error. Neural network might be represented by matrices and vectors. In the Feed-Forward MLP each neuron output is connected to the input in the next layer, Fig. 1. To imagine how the weight matrix between to consecutive layers is constructed, see figure 1, notice that w_{00} is the weight between neuron a_0 and neuron b_0.

From that sense the back propagation algorithm is an iterative method on matrix and vector operations. As large as the neural network becomes, as large as matrices and vectors it has, and more difficult or impossible to execute the operations sequentially

3.1 CPU Implementation

In the original code `ANN` is programmed in C^{++} using the Boost [9] library and the Basic Linear Algebra Set (BLAS) [2] library.

The first task done by HLRS was to analyze the application, identifying the most critical parts and learn the data structures. It was obvious that the back propagation algorithm used for training was the most time-consuming part. Here, two buglets were discovered, that alone improved the serial code:

– While reading input data files, memory allocation was done basically using a `realloc` call, continuously increasing the allocated size. Since the size of the whole input data set could be computed before assembling the whole data, only one `malloc` call was used, speeding up this step by 7× for the big input pattern.
– The convention of smart pointers used in Boost library which keep track of how many pointers still pointing to a shared object. As long as there is no more pointers pointing to that object, the object is deleted.

Since the Boost plus BLAS implementation was not suitable for execution on GPU, the possibility of a CUBLAS [6] implementation was investigated. a standard C implementation was done, next. The next two sections discuss the implementations on CPU using the Boost and BLAS libraries, then without these libraries and the implementation on GPU.

BLAS Implementation. Basic Linear Algebra Subroutines library provides a lot of matrix and vector mathematical operations such as outer product, matrix-matrix multiplication, matrix-vector multiplications and others. Those operations make BLAS an attractive choice to try and replace the Boost library.

Standard C Implementation. In this part the back propagation algorithm has been rewritten by discarding all the libraries (Boost, BLAS,...) and re-implementing it using Standard C. The aim of this work is to make the code more GPU friendly and ease the task of porting it to CUDA.

3.2 GPU Implementation

While other papers have been using the cuBLAS library, in this work the library was avoided because it needs the matrix to be stored column-wise and the code provided and processed by other parts of HMI-Tec's application in row-wise format. To avoid the overhead in changing the storage format to column wise, cuBLAS was avoided in this work.

Multiple kernels have been written at different stages of the algorithm to implement the matrix and vector operations on the GPU. Constant memory is used to store some constant values needed by all threads. Using NVIDIA's profiler tools the number of used registers has been reduced to only 17.

4 Measurements

The measurements and result evaluation were done on the so-called Laki cluster, a NEC Nehalem cluster at the High Performance Computing Center Stuttgart (HLRS). The cluster consists of 700 computing nodes of type NEC HPC 144Rb-1, with each nodes containing dual-socket Intel Xeon E5560 2.8 GHz quad-core with 8 MB L3 cache and 12 to 24 GB of memory. Overall 32 of the 700 nodes are equipped with Tesla C1060 GPU cards and two nodes available with one dual and one triple Tesla C2050 based on Fermi architecture. We have considered five benchmark datasets, i. e. the sinus input and the mail patterns but due to page-constrains we are presenting only the mail pattern dataset to train neural network. The mail patterns correspond to real-life mail-traffic analysis patterns of 3765 words and word-combinations.

We have selected the following scenarios for our measurements:

- There are 3765 inputs and 16 outputs with total 1958 patterns.
- Using three hidden layers ranging from 1024–4096 neurons per hidden layers.
- The size of the input and output layer is same the input size of input and output pattern.

Figure 3 shows the comparison of all discussed implementations, the training time of the above case with a varying number of neurons in three hidden layers. The results show, that the Fermi GPU is about 10 times faster than the Boost-implementation (please note, that above-mentioned performance-bugs have been fixed).

As one may clearly see in Fig. 4, the training time highly depends on the number of threads scheduled onto the SMs, in order to optimize the register count. One may see, that for the 256 threads case, the execution time makes a large jump when moving from 2048 to 2304 neurons in each hidden layer (from 33.4s to 56.9s).

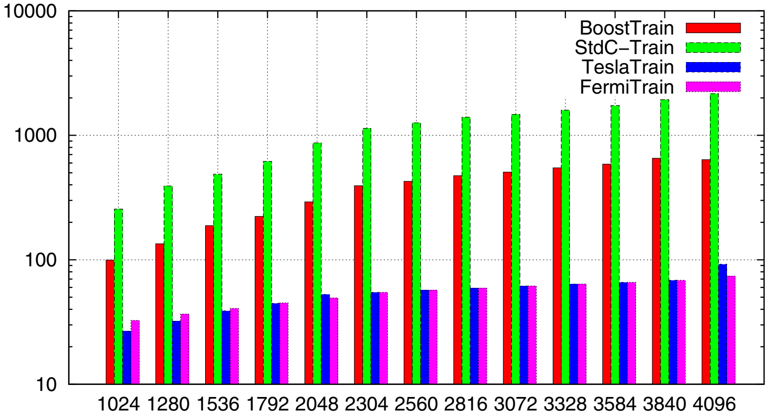

Fig. 3. Time [s] taken to train over different sizes of the hidden layer

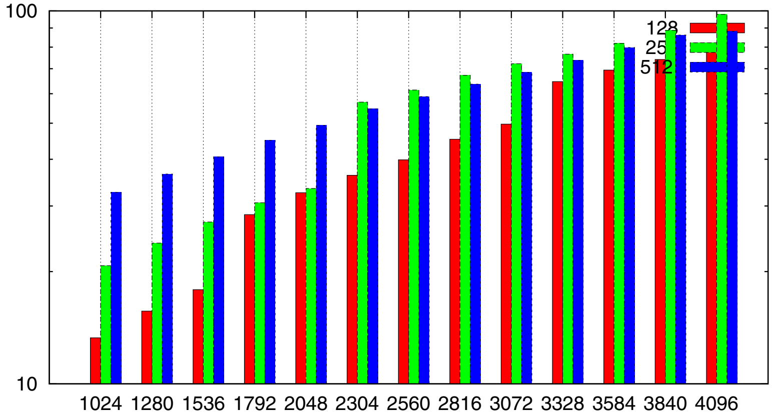

Fig. 4. Time [s] taken to train with different number of threads

5 Related Work

Due to variety of its applications, there is a lot of work and research done on different types neural network and its training with different types of algorithm. Scanzio et al [8] have implemented a parallel training of neural network for voice recognition. They used mixture of CUBLAS functions and CUDA kernels for GPU implementation compared with CPU implementation based on standard C language plus BLAS library without optimization and Intel Math Kernel Library (MKL) library with optimization. The neural network for experiment consists of one million neurons distributed into four layers. Due to hardware memory limitation, the input speech patterns are loaded into chunks. Their experimental result shows 19.1 time speedup compared to standard C and 5.2 faster than single thread MKL implementations.

Strigl et al [10] have presented a parallel training of neural network. They used Convolutional Neural Networks (CNNs) which is a variation of MLP neural network specifically for 2D patterns. Optical Character Recognition and Image recognition are the main applications of CNNs. They have implemented training on GPU using NVIDIA CUBLAS library and performed comparison with a threaded CPU implementation and the Intel MKL library to investigate scalability of neural network. The single precision benchmark dataset was used to evaluate performance comparison with different size and configuration of neural network. The experiment result revealed two to 24 time faster execution than CPU.

Takizawa et al [11] have implemented the back propagation algorithm on GPU. They used CUBLAS library with some CUDA kernels are also implemented to overcome the unavailable function in CUBLAS. The comparison done with different set of benchmark dataset shown 63 times faster computation than sequential single threaded CPU implementation.

6 Conclusion

In this paper we have introduced the optimization and porting of a commercially available software based on neural network for GPGPUs. The methodologies may be applied in other areas where neuronal networks are employed and, due to the input size or training requirements, are taking up computational time. There are many other efforts to port applications onto GPUs [4] and several focus on simulated annealing and AI methods [12,5] – a good overview and comparison of the requirements of data-intensive applications is given in [1]. The porting of the code in this paper proved very successful and has shown to deliver a speedup of 30x compared to the original software. The changes to the sequential code have already been incorporated into the product, the GPU version may be used as a future product. It therefore is the basis for future collaboration with HMI-Tec, one investigation to be continued is the parallelization of multiple concurrent kernels to accelerate small neural networks optimization, another investigation is with regard to the optimal configuration to be used for input datasets.

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Personal Learning Environment for Education: A Review and Future Directions

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Abstract. This paper examines and assesses the current research state of Personal Learning Environments (PLEs) in education and identifies the directions for meaningful future research. Instead of reviewing papers from computer science databases, we reviewed research papers from three main Academic databases which are Academic Search Premier, Education Research Complete and ERIC with open-ended search period until 30 June 2011. PLE is a new concept; therefore, we believed that in order to develop a better PLEs, developers or technical experts should work closely with education experts. Therefore, the main purpose of this paper is to review the research trend in education field. Results from the findings and several recommendations for future research in PLEs are discussed in the paper.

Keywords: Personal Learning Environment, PLEs, Trends, Future Directions.

1 Introduction

With the development of Web 2.0 which allows users to be active co-creators of knowledge and the changing ways of how people are using technologies to communicate and to learn nowadays, our learning environments have been shifted from a centralized institutional teaching approach to a more learner-centred decentralized learning approach [1]. Kang et al [2] also mentioned that Student Centered Learning (SCL) provides students or learning "choice" and "freedom" in their learning. To face this education paradigm shift, some scholars, researchers and higher education institutions have recently started to find the alternative to set up or to further enhance the traditional technology-enhanced learning environments which are Virtual Learning Environments (VLEs) or Learning Management Systems (LMS) to a more flexible, open, customizable learning environment which we called as Personal Learning Environments (PLEs).

With the increasing focus on individual, personal choices in everything including learning and development, PLEs could be an alternative approach for our future education system. However, since PLEs is still new in the field therefore to evaluate PLEs is kind of challenging and not many scholar studies or reviews are conducted to date. Thus, PLEs' evaluation for the use in education domain is not well established yet. In addition, initial studies on successful educational implementations

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and potential benefits for both teaching and learning using PLEs are positive but evidence is largely based on users' opinions or reactions only. Therefore, we felt that it was necessary to conduct a comprehensive review for the references of future studies for PLEs especially in education field. Therefore, the purpose of the paper was to examine and assess the current research state of Personal Learning Environments (PLEs) in education and identify the directions for meaningful future research for this new learning environment.

2 Personal Learning Environments

According to Pettenati [3], scholarly studies in the PLEs domain have started only recently but the interest around this concept is growing steadily as it is witnessed by two major events occurred in 2010 which was the first PLE conference (2010) held in Barcelona, and the PLE/PNE Massive Open Online Course (2010) jointly organized by the National Research Council of Canada, the Athabasca University and the University of Prince Edward Island. As for 2011, we notice an increase of PLEs interest in International Conferences such as International Conference on Web-based Learning (ICWL 2011, Hong Kong), European Conference on Technology Enhanced Learning (EC-TEL 2011, Italy), PLE Conference 2011(Southampton, UK) and few conference workshops specially organized for PLEs, for example, Evaluating Educative Experiences of Flexible and Personal Learning Environments (E3FPLE, Italy). In addition to that, ROLE Consortium which is supported by the European Commission, in the theme ICT-2007 Digital Libraries and technology-enhanced learning, as a Large-scale integrating project (IP), under the 7th Framework Program also actively involved in PLEs research and development.

With the interest from different parties mentioned above but still we could notice that the interpretation of PLE concept is quite miscellaneous, and discussions have raged as to the interpretation of the terms especially on the meaning of the "P" of the PLEs which most of the people used interchangeably between "Personalization" and "Personal". According to Wikipedia, "Personalization" involves using technology to accommodate the differences between individuals which is also similar to "Personalize" that is defined as "to design or produce (something) to meet someone's individual requirements" whereas "Personal" is defined as "done or made by a particular person; involving the actual presence or action of a particular individual" by Oxford online dictionary. The "Personal" Learning Environment (PLE) in this study is based on the latter definition which is "done or made by a particular person". PLEs definition in this study is defined based on the most used definition in the field which hinge around the following elements: "Personal learning environments (PLEs) refer to how people construct the environment for themselves: the tools they choose, the communities they start and join, the resources they assemble, and the things they write" [1]. Personal learning environments are "systems that help learners take control of and manage their own learning" [4]. According to EDUCASE [5], PLE may or may not intersect with an institutional LMS. Many scholars believed that with PLEs, learners are more motivated and engaged in the learning process [5, 1]. In addition to that, PLEs are frequently contrasted with LMS which LMS tends to be course-centric and the learning process in LMS is usually uniform and the learning path is designed and directed by the instructor.

3 Research Purpose

The purpose of the paper was to examine and assess the current research state of Personal Learning Environments (PLEs) and identify the directions for meaningful future research especially for education field. Therefore, instead of reviewing papers from computer science databases, we reviewed research papers from three main Academic databases which are Academic Search Premier, Education Research Complete and ERIC with open-ended search period until 30 June 2011. All articles were analyzed according to publication year, research topic categories, research methods and evaluation methods. Results for the most and least published research topics, research methods and evaluation methods can indicate the overall research trends and patterns in the field. Especially scholar studies in PLEs have been started only quite recently [13], so this analysis can help researchers who are interested in PLEs to not only identify the major trends, research topics interested by the scholars in the field but also to understand the influential works and individuals in their major subject domains [6]. Therefore, our study was guided by the following questions:

1. What research topics have been conducted so far and which are the most and least researched topics in the reviewed articles?
2. What types of research methods have been applied for PLEs studies in the articles?
3. What types of evaluation methods were used to investigate the effectiveness of PLEs in the reviewed articles?

4 Method

This study used papers published by three major databases: (1) Academic Search Premier, (2) Education Research Complete, and (3) ERIC with open-ended search period until 30 June 2011. These databases were chosen because these three databases cover more than 10430 journals [7] and Academic Search Premier is considered one of the most prominent databases in academic institutions [8]. As of June 30, 2011, our database searches using the keywords: “Personal Learning Environments” revealed 52 results. Articles with the exact keywords were extracted for full review. This strategy resulted in 15 articles. Abstract of the 15 articles were then further reviewed and article were reselected again based on PLEs defined by Wilson [1] and Downes [5]. This strategy resulted in 10 final articles for inclusion in this study. The discarded articles were either personal opinion in general learning or e-learning environments, use of PLEs as a platform without details description of the PLEs or only the title contained PLEs but contents were not related to the PLEs that defined by Wilson [1] and Downes [5]. Finally, more detail analysis was carried out for the final 10 articles as listed in Appendix. In order to answer our four research questions, we used the constant comparative method developed by Lincoln and Guba [9].

5 Results

5.1 Research Topic Analysis

The final analysis framework consisted of the following research topic categories and sub-categories as shown in Table 1:

1. Technology mainstream. Articles in this research topic explore the components (tools and applications) that could be integrated into PLEs. Some articles also discussed the technical issues and challenges encountered by using the new intervention in PLEs. In addition, user interface design, prototyping was also discussed in these articles. This category was further divided into sub-categories: Components, Challenges, and Prototypes.

2. Education mainstream. This category includes pedagogies used or suitable for PLEs. This category was further divided into Learning Models, Pedagogy, and Needs Assessment.

Table 1. Research topic's category and sub-category

Category	Sub-Category
Technology mainstream	Components Prototypes Challenges
Education mainstream	Needs Assessment Pedagogy Learning Model

5.2 Frequency Counts of Reseach Topics

In addition to the research topic analysis, the frequency counts of for each sub categories were examined. It should be noted that many articles addressed more than one of the topic categories which means one article might be coded into two or more categories or sub categories in this part of analysis. Table 2 shows the final frequency counts for each sub-category. Results showed that most published topic was "Learning models" in education mainstream category and less published topic was "Prototypes" in technology mainstream category. These results are quite reasonable because all the articles were from social science databases and not computer science databases. However we could see that there is a balance of frequency counts between others sub categories. This showed that the research area in the field is composed of research on technology and their integration into education which we name as Educational Technology. Besides, this also implied that both technology and education fields are important for developing PLEs. This result provided us some useful insights especially it showed us that researchers from both technology and education fields should work together in the future to further develop a better and more effective PLEs.

Table 2. Frequencies of category and sub-category

Category	Sub-Category	Frequency Count
Technology mainstream	Components	4
	Prototypes	2
	Challenges	4
Education mainstream	Needs Assessment	4
	Pedagogy	4
	Learning Model	5

5.3 Types of Research Methods

In this paper, we summarized the research methods employed in the articles that we reviewed. In addition, we also summarized the research settings and data collection methods of each article. Two major types of research methods were found among the articles:

(a) *Descriptive Research*, which typically used to describe the basic features of the data in a study.
(b) *Developmental research*, which systematically studied the design, development, and evaluation process of certain educational interventions [10]. The development of new PLEs model is also categorized in this type.

Table 3. Summary of review PLEs' papers

Research Design/Type	Frequencies
Descriptive	4
Developmental	9

As revealed in Table 3, the majority of studies are classified as developmental research (9 out of 10 articles). Richey, Klein and Nelson[11] redefined developmental research as a research methodology to facilitate the study of new models, tools, and procedures so that researchers can reliably anticipate their effectiveness and efficiency and, at the same time address the pressing problems of the field. Therefore, this result revealed that PLEs research is still new in the field and most of the scholars are just starting to explore and develop new PLEs' models for the use in education domain.

5.4 Evaluation Methods of PLEs' Effectiveness

The most often asked question by the people who use PLEs for teaching and learning would be whether PLEs are effective in helping to improve and to enhance students' learning. Therefore, in order to design and develop good PLEs, technical experts and developers should always ask themselves "How to develop an effective PLEs" during the design and development process. In this study, we found only one study that covered this research topic by Drexler [12]. Drexler [12] suggested four types of assessment components to measure the learning outcome of the networked student model: (1) Ongoing performance assessment in the form of weekly assignments, (2) rubric-based assessment of the PLE at the end of the project, (3) reflective essay and (4) multimedia synthesis of topic contents.

However, we found out that instead of measuring learning outcomes using assessment, three of the articles measured the users' experience (Usability test) and one analyzed the users' requirements (Needs Assessment) for PLEs as shown in Table 4. As mentioned before, this might be PLEs is still a new research area in this field and most of the scholars would like to know what the users think about PLEs instead of how effective the PLEs is. However, we should always be reminded that a usable PLE is necessary but it is not sufficient for positive learning outcomes which are one important criterion in technology enhance learning environment as mentioned by Kang et al. [2].

Table 4. Evaluation methods of reviewed papers

Category	Study(author, year, journal, page information)	Evaluation Methods
Education	Drexler (2010). Paper presented at the Annual Meeting of the American Educational Research Association [13]	Usability test
Education	Väljataga & Laanpere (2010). *Interactive Learning Environments*, *18(3)*, 277-291 [14]	Usability test
Education	Drexler (2010). *Australasian Journal of Educational Technology, 26(3)*, 369-385 [12]	Usability test , Assessments (learners' Achievement)
Education, Technology	Ivanova &Chatti (2011). *Journal of Educational Technology Systems*, *39(4)*, 419-439 [15]	Needs Assessment

6 Conclusion and Future Work

In this paper, we analyzed and categorized articles related to Personal Learning Environments (PLEs) in three databases with open-ended search period until June 30, 2011 in order to summarize the current research state of PLEs and identify the directions for meaningful future research. The findings of this study provide insights for researchers especially in (1) The kinds of research topics conducted in PLEs and the most and least researched topics in the field, (2) The types of research methods employed by previous articles and (3) The types of evaluation methods used to investigate the effectiveness of PLEs in the reviewed articles.

Overall, we found that previous articles of PLEs mainly focus in designing, developing, using and evaluation PLEs for teaching and learning. In addition to that, we could easily divided the previous research into two research categories which are (1) Technology mainstream which studied on components (tools and applications) that could be integrated into PLE and technical issues encountered by the new intervention and (2) Education mainstream which studied on the pedagogies for PLEs. Whereas, for the frequency counts of research topics, we could see that there is a balance of frequency counts between the two main categories. This could imply that even though this study only reviewed articles from education domain but PLEs is a research field that needs to be catered in both technology and education domains. This might be cause by that PLEs is an environment that is highly associated with social web or Web 2.0 tools [1]. This result also showed us that researchers from both technology and education fields should work together in the future to overcome the limitations both in technical and pedagogies in PLEs. Besides that, from our study, we also found out that most of the papers were only conceptual papers that proposed framework or tools and widgets for the use of PLEs.

In this study, we also found that the most used research method is developmental research. This confirmed Pettenati [3] and our statements that PLEs are just started recently. Therefore there is still a lot of space to grow and to further research in near future. However, from the publication date, we could also see that there is a steady increased of research quantities even though slow, and this might be cause by PLEs is a new approach and need longer time to evolve and to be validated.

Lastly, from the study, we could notice that starting from the year 2010, scholars in the field started to conduct studies regarding needs assessment, usability test and learning outcome measurement in PLEs. This could be a direction for future researches. In addition, future research should also be carried out to explore the improvements to previous studies especially on the detailed description and validation of the models.

Finally, since this study is valid only for the articles from databases in academic institutions, the result of this research study cannot be generalized. Future research should be conducted to examine articles from Science Citation Index (SCI) journals. However, the findings of this study are valuable in showing us meaningful directions for future research in the field either technically or pedagogically.

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Appendix

Table 5. Reviewed articles in the stuy

Study(author, year, journal, page information)
1.Drexler (2010). Paper presented at the Annual Meeting of the American Educational Research Association
2.Väljataga & Laanpere (2010). Interactive Learning Environments, 18(3), 277-291
3.Drexler (2010). Australasian Journal of Educational Technology, 26(3), 369-385
4.Ivanova &Chatti (2011). Journal of Educational Technology Systems, 39(4), 419-439
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6.Charles; Hardin & Whyte (2008). Interactive Learning Environments, 16(10),p47-62
7.Wilson (2008). Interactive Learning Environments, 16(1), p17-34
8.Taraghi, Ebner, Till, &Mühlburger (2010). International Journal of Emerging Technologies in Learning,1, 25-30
9.Žubrinić, Kalpić (2008). International Journal of Emerging Technologies in Learning, 3(2), 54-58
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Didactical Competence Modeller: Dynamic Story Creation for Serious Games

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Abstract. Traditionally, a driving goal of digital storytelling is the generation of dramatic stories with human significance, but for learning purposes, the need for drama is complemented by the requirement of achieving particular learning outcomes. This paper presents an interactive storytelling conceptual framework that supports the dynamic creation of stories based on predefined pedagogical goals. The approach is based on a hierarchical structure of plot pieces, denominated Narrative Building Blocks which, represent the elements that convey the story context as well as the roles and behaviours of each actor. In addition a case study is described where the concepts presented throughout the paper are applied and exemplified.

Keywords: Digital Storytelling, Emergent Narratives, Competences.

1 Introduction

Serious games are strong contenders supporting competency development since they offer tailored experiences, in which participants learn through a grammar of doing and being [19]. The advantage of such games over passive learning is that experimentation, risk-taking and tolerance to risks itself is encouraged within a safe environment [6]. Additionally serious games increase motivation, provide ego gratification, encourage creativity, socialization and above all are fun [11].

The use of technology, and in this case, the use of game-based learning, as a way to enhance knowledge transfer can also bring several advantages in curriculum design [14]. Content can be easily adapted to the needs of a particular user, taking into account pedagogical rules defined by experts. This personalization is rarely possible in most teaching mediums such as books, tests or written exercises. Games have a great advantage of being adaptive, allowing the personalization of content based on individual player needs. The same game can provide several different user experiences avoiding mimicry learning, thereby making students "learn how to learn" as Turkle argue in [21].

This adaptation of content can be done through several approaches such as: applying transformations on virtual environments, changing the behaviour of autonomous agents or applying structural plot adaptations using Interactive Storytelling. This approach is beneficial as in some cases, the acquisition of competences is related with a particular situated context. Therefore, by structuring

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a plot, it is possible to provide the user with a set of different situated contexts where , through experience, s/he can learn competences related to those contexts. However it is important how Interactive Storytelling systems structure the plot and relate to situated contexts in order to create meaningful and coherent user experiences based on pedagogical goals.

The work presented in this paper describes an interactive storytelling conceptual framework that supports the dynamic creation of stories based on predefined pedagogical goals. The representation of the story consists of a hierarchical structure of plot pieces, denominated Narrative Building Blocks, that represent static or dynamic story elements. The creation is accomplished through the association of plot pieces with those particular pedagogical goals, thereby creating meaningful and interesting stories. Using this approach it is possible to generate educational and personalized stories that can be inserted into a specific learning plan complementing other learning mediums. The conceptual framework guarantees the creation of coherent stories based on pedagogical rules defined by experts as well as provides a means to automatically assess player performance (although these topics are beyond the scope of this paper).

The paper begins with a review of literature relating to Interactive Storytelling, Emergent Narratives and Authoring and highlights some of the challenges one may encounter while using serious games for training. This is followed by a description of a model and building blocks required to put all elements of a story coherently together. This leads to a description of a suggested approach for creating individualized game scenarios customized to the pedagogic needs of each user. Finally a case study and a conclusion is presented.

2 Related Work

In this section an overview of the current state of the involved research areas is presented. Developing games have a strong link to the representation and guidance of narratives. Stories is what make games meaningful experiences. Interactive Storytelling (IS) is therefore a central area when addressing Serious Games. One of the main challenges addressed by IS is related to the creation of stories that emerge from the human player behaviour, denominated emergent narratives, as opposed to following a pre-defined plot. In terms of learning and therefore training, this is very important as it has major impacts in the player experience through out the game. As a concept, emergent narratives are very intuitive but is by far trivial to find a representation for such unpredictable sub-plot sequences and also the best balance between guidance and freedom of choice within a game run. Emergent Narratives and Authoring are therefore central concepts in the work presented in this paper being the focus of the related work.

2.1 Interactive Storytelling, Emergent Narratives and Authoring

Interactive Storytelling find potential application as digital entertainment and art, as well as support for training and education through the use of serious games. Many research prototypes aimed at the development of training and education applications using Interactive Storytelling, these are referred in the literature as narrative-centred learning (NLEs) environments [12,15,4].

NLEs systems also support the experiential learning cycle of Kolb which portrays two dialectically related modes of grasping experience - Concrete experience (CE) and Abstract Conceptualization (AC) - and two dialectically related modes or transforming experience - Reflective Observation (RO) and Active Experimentation (AE) [7]. For the modes concerning CO and AE to be effective and efficient, IS underlying a serious game needs to possess Agency, Transformation and Immersion properties as described by [13]. Therefore is crucial that the representation of the story has the necessary mechanisms and expressiveness to support a good balance between user freedom and well-structured stories. Emergent Narrative approaches appeared as a potential solution for this problem referred by the IS community as Narrative Paradox [2].

Emergent Narratives (EN) emerge according to local character behaviours, this leads to the question of how can a player experience Agency[13] with such systems. In this context Aylett in [1], introduces the notion of Social Presence , where she states that it is expected that the player behaves "in-character" according to his social role in the environment. Therefore the system is not expected to generate a good story if the player acts in a way that is inappropriate for the character that he controls. In addition to social presence, the environment can raise player's desire to understand the event sequence and thus may be used as a motivation factor for him to make meaningful actions.

Authoring in the context of emergent narratives is still a big challenge since the stories develop through a player input instead of following a linear narrative path [3]. The integration of interactivity into the game narrative requires a fundamental rethinking of the design process [9]. In this context Spierling et al in [18], introduced the notion of implicit creation. Opposed to explicit creation where the authors explicitly write every detail of a plot, implicit creation sees authoring as the specification of a dynamic model that underlies states, actions, and other elements that emerge at run-time. After having realized the importance of defining the narrative roles, it is also important to evaluate the authoring process from a process-based perspective. The story shaping process is made by the user choices in the context of a action spectrum proposed by a particular EN scenario. Although the player has a definite range of options, the narrative is not pre-defined, those choices make gradually shape and re-shape the spectrum of available actions through interaction. This process can be illustrated by the "flying wedge" metaphor proposed by Laurel in [8], in this metaphor is showed how the narrative development constrains future interactions as it is illustrated in Figure 1.

At the beginning of an EN scenario the player is free to chose any action but through successive choices, the options will significantly narrow. By making decision as the story unfolds, the player determines the range of possible future interactions, therefore, as a result, certain actions would fall outside the scope of the player probable actions range and would not be used. Based on this model

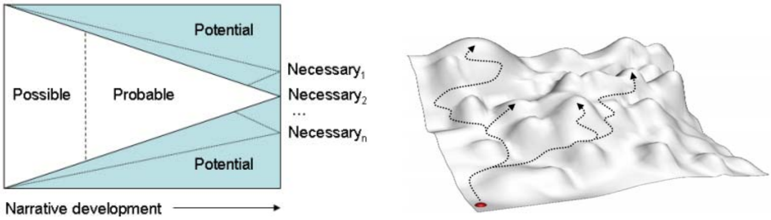

Fig. 1. Laurel's ”‘flying wedge”’ (left) / Louchart's Story Landscape (right)

Louchart et al proposed in [10] a conceptual metaphor called Story Landscape used to visually represent an EN as it is illustrated in Figure 1. Points on the landscape represents possible EN states and climbing hills represents moving towards a more and more dramatic situation. In a ”valley” there are many potential mountains to climb and many paths to follow.

3 Creating Pedagogical Stories for Serious Games

Military and health training always happens in real world situations or in near reality simulated environments [17]. This is a crucial difference when comparing with for example sports, singing or other kind of training of more recreation activities. For military, health and also equally important corporate training there's a necessity of representing contexts and environments as well as social actors and their interactions. Moreover, all this elements will play a part in the unfold of the story (game run), therefore a holistic vision/framing of all this environment is also very important. Having this into account, it's clear that a story should be supported by a model that coherently puts all this elements together. Swartjes has developed such a model denominated Fabula Model [20] [16] with the purpose of annotating an emergent textual story. This model formalizes the relationship between several elements that usually exist in a story, as characters, environment and so on. It also defines different kind of relationships between each element of the model, like psychological, casual, etc. Although it has only been used to annotate textual stories this model presents the potential to express situated contexts. With this goal and the purpose of facilitating the creation of stories for serious game, we have extended this model in order to fit 3D environments and also both static and dynamical aspects of an emergent story. We have denominated, both static and dynamic, as Narrative Building Blocks which are described in more detailed in the following subsections and exemplified in section 4.

3.1 Narrative Building Blocks (NBBs)

NBBs as described in the previous section are plot pieces that assign static or dynamic content to a particular emergent story scenario. From a conceptual point of view, NBBs can be seen as the elements that convey the story context to an audience, defining the role and behaviour of each actor. This means that NBBs have a direct relationship with one or more competence, therefore they bridge the gap between competence descriptions and game mechanics [5].

Having a definition of a story based on NBBs makes possible the dynamic creation of stories without the direct intervention of an author. Nevertheless is important to realize that the assembly process is delicate, the combination of NBBs can not be done blindly otherwise the framework could generate inconsistent stories. Thus this process must be supported by clear narrative and pedagogical rules that ensure the correct combination of elements, ensuring consistency and validity of the created story.

The NBBs can be of two types, namely structural block, representing static elements of a story or they can be narrative cases, representing situated contexts within a story, conveying a context where the player can experience a given situation. These situations correspond to peaks in the story landscape.

We consider Structural Blocks as the elements that create the initial context of a particular story. Base on this blocks, the story takes shape and unfolds. The Structural Blocks are XML files that can represent things like: the existence of particular characters, their characteristics, for example behaviour models and its instantiation, and also roles in the story. Also, they can represent the relationship between characters, the story execution environment, spaces and activities that can be performed by the characters and simulation configurations.

We consider Narrative Cases as situated contexts inside a story. These contexts are defined by an author and corresponds to situations that the author identifies as important in the context of a story unfold. These cases are defined using the Fabula Model and are used as a way of guiding the narrative execution.

3.2 Dynamic Story Creation

In order to create individualized game scenarios based on the pedagogical needs of each user, we developed a module called *Didactical Competence Modeller* (DCM), responsible for supporting the story assembly process based on the following elements: a competence gap; a set of pedagogical and narrative rules; and a graph where the nodes are NBBs are and the links are dependencies between NBBs.

The causality relationship between NBBs nodes implies that to assemble one particular Narrative Building Block, one must assemble also all their dependencies, that in fact are other NBBs. The relationships are unidirectional and are represented internally in the form of a graph. The use of this representation gives clear advantages, due to its expressive power and the possibility of processing the structure efficiently using graph algorithms. Another advantage of using this representation is the ability to assign weights to the adjacency relations, which can improve processing efficiency as well as increase the expressive power of the author.

Pedagogical and narrative rules can be associated to a given NBB. This is important to guarantee the validity of the NBB in a particular context.

For example, NBBs for communication related competences can have different NBBs because several cultures may have different ways to communicate. Although it is the same competence the situated contexts are different.

These rules are represented using logic statements that can be on of two types:

- **SingleRule** - Is a simple evaluation of two values based on a operator (for example: country == uk or projectBudget $\leq$ 1000).
- **Expression** - Is an aggregation of rules, that allow one to create more complex rules. It is represented by a two rules (SingleRule or Expression) and an operator (for example: (country == uk) && (1 < 2) $\leq$ 1000).

Both SingleRule and Expression supports different operators which are described below:

- **SingleRule** - == (equal) , != (not equal), < (less than), > (greater than), $\leq$ (less or equal than) and $\geq$ (greater or equal than).
- **Expression** - && (and), || (or).

Didactical Competence Modeller (DCM). The DCM is composed by three sub-modules, namely: The Story Builder responsible for the creation of the NBB dependency graph, the Rule Engine responsible for processing the graph and validating the rules associated with each NBB and the Database Connector responsible for managing database accesses.

As illustrated in Figure 2, the assembly process starts with a set of competences. Next, the Story Builder retrieves all the NBBs associated with the specified competences from the database. The NBBs are then converted by the Story Builder into a graph and the dependencies are also added to this graph.

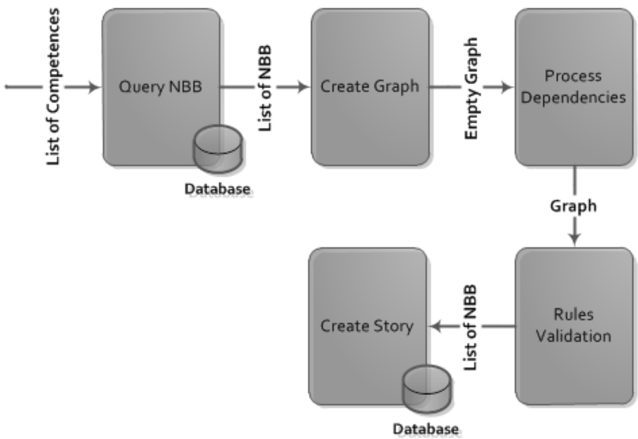

Fig. 2. Didactical Competence Modeller assembly process

The Story Builder processes the dependencies of each NBB in order to validate the consistency of the graph. This step consists of an inference process where the Rule Engine asserts the rules associated with every graph node. For that purpose a Depth-First Search (DFS) algorithm is applied marking all invalid nodes (nodes in which the evaluation result is false).

This process can be enriched by evaluating the connections weights, allowing the identification of stronger or weaker connections and therefore understand the impact of the removal of certain node in a particular context.

The result of the evaluation process is a valid story graph, containing a set of NBBs which form the content of the story design. Nevertheless, the quality and complexity of the created stories depends strongly on the quality and quantity of pre-authored content (NBBs).

4 Case Study

The case study presented in this section was done in the context of EC funded TARGET Project[1]. The Stakeholder Management case study focus on learning how to successfully manage stakeholders, involving decision making in complex and controversial situations and understanding the importance of external communication in projects exposed to public interest. The player assumes the role of a project manager that has the main goal of building a wind mill farm in Norway. For that purpose there are several tasks that progress based on the player decisions such as: choosing the supplier; choosing when to order turbines from the Danish company; and choosing road-alternative. For illustrative purposes we took decision making competence in order to provide concrete examples of how both the structural blocks and narrative cases can be instantiated to build a story.

Figure 3 illustrates an example of decision making Structural Blocks associated with the choosing the supplier, choosing when to order turbines from the Danish company and choosing road-alternative decisions. Each of this decision is translated into a particular GameComponent that is used in the project simulation configuration as a way of adding those decisions as project tasks. In this example the amount of decisions will be dependent on the player professional experience, therefore the more experience the more decision the player will need to do during the game execution.

The Narrative Cases are a direct translation between a specific plot context and the Fabula Model representation. The result will be a graph representing that specific plot context in a representation that can be used by a narrative system to guide the story unfold. In this particular case, is expressed a situation involving two agents were one is influenced to make a decision.

The story creation process is started by the DCM. The first step consists in retrieving from the database all the NBBs related to decision making. These NBBs are the used to create a NBB graph similar to the one illustrated in Figure 5.

[1] `http://www.reachyourtarget.org/`

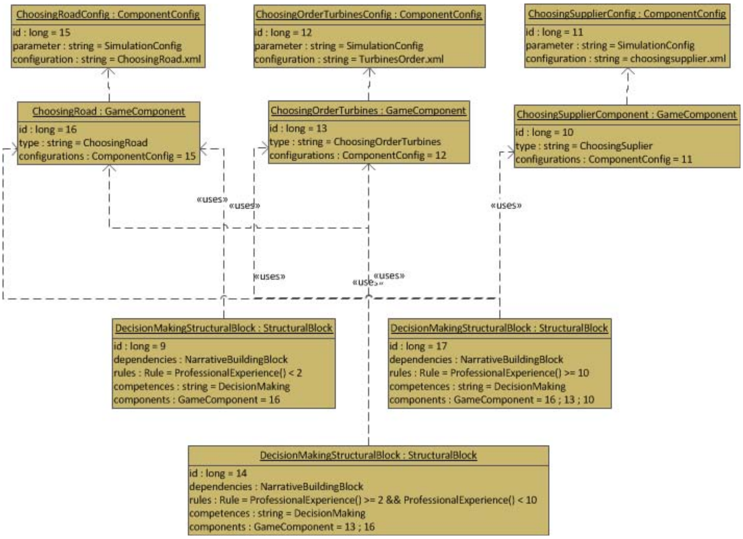

Fig. 3. Decision Making Structural Blocks

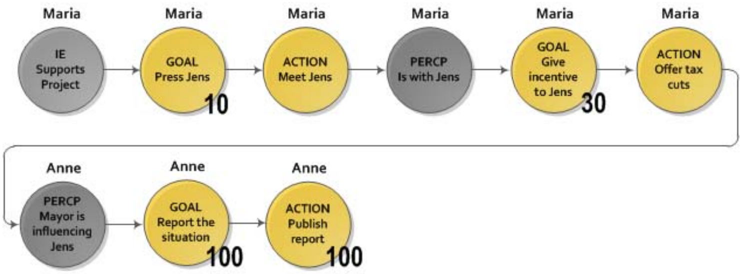

Fig. 4. Example 1 Narrative Case Representation

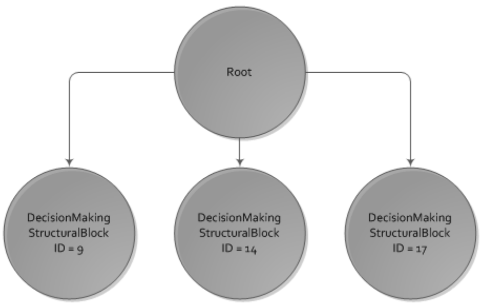

Fig. 5. Example 1 Narrative Building Block Graph

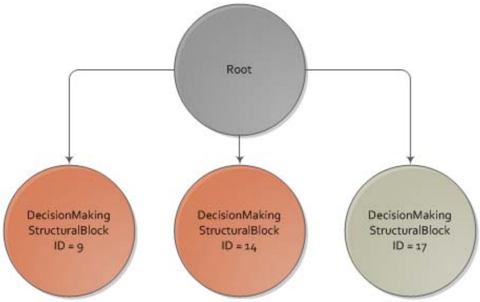

Fig. 6. Example 1 Narrative Building Blocks Evaluation

The next step is to add the dependencies to the graph. In this case none of the retrieved NBBs have any dependencies, therefore no NBB will be added to the graph. The graph is the processed in order to assert the rules associated with each NBB. In this example all the NBBs have rules related to the player professional experience. This information can be retrieve from the domain model. Since the player has more than 15 year of experiencing both Narrative Building Block 9 and 14 will be marked as invalid as illustrated in Figure 6.

5 Conclusions

From a game-based learning perspective the DCM offers support to knowledge transfer using serious games based on pedagogical goals. This is accomplished through the association between the narrative assets and pedagogical goals. Also, the ability to associate narrative and pedagogical rules to NBBs increases the expressiveness and allows the creation of more complex story content. Although it still requires an author with domain knowledge to create the necessary NBBs, the described properties of the DCM enables it to have the potential to generate educational and personalized stories that can be inserted into a specific learning plan complementing other learning mediums.

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ESITrace: A User Side Trace and Annotation Collection Tool

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Abstract. This article aims to present ESITrace, an e-learning-dedicated trace collector. ESITrace collects different kinds of traces produced by the learner while doing his learning activities, in the context of a Web based learning environment. This tool is a keylogger that collects two kinds of traces: involuntary ones, called simply "traces" and annotations which are added by the learner on his learning material to memorize his ideas. We follow a learner-side approach to track the entire learner's activities, even those made outside the e-learning system. These traces enable the teacher to be aware about the learner's activities and progression, and can be used by the learning management system to adapt the learning material to the learner behavior.

Keywords: Trace, annotation, learning activity.

1 Introduction

Observation of learners in Web based learning environments, or e-learning platforms in general, is essential for the teacher as it enables him/her to be aware about the learners' current situation. In the same time, this awareness can be used by the e-learning platform to adapt the learning material according to the learners' behaviors.

To collect information about learners' behaviors in a Web based learning environment, several methods can be used, such as "multiple choice questionnaire" or exercises results. It is also possible to get more information without asking learners through collecting the raw numeric traces left by the learner during her/his learning activities.

This observation allows us to obtain different kind of information about the user's learning behavior such as: the learning pace, the preferred means of learning (written, audio, video, interactive, games…), etc.

In this article, we present ESITrace, an e-learning-dedicated trace collector. This tool collects different kinds of traces produced by the learner whiles doing his learning activities, upon a Web based learning environment. It records the digital traces in log files, on the learner-side. This approach allows us to trace all the learner's activities, even those made outside the learning system. These interactions include navigation within the educational objects and between them, Web browsing, and any parallel activity done outside the learning material.

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ESITrace collects two kinds of traces: involuntary ones, called simply “traces” and annotations which are added by the learner on his learning material to memorize his ideas. ESITrace uses then different kinds of visualization to present this information to both the teacher and the learner.

This article is organized as follows. In the first section, we present the concept of traces and annotations, whereas traces are produced in an involuntary way, annotations are added by the learners in a voluntary way. Then, we present the process of trace collection and the different exiting tools. In the third section, we present our tool “ESI Trace” which enables to collect both the learner’s activity traces and the annotations. We describe also the technical details of ESITrace implementation.

2 Traces and Annotations

In educational hypermedia systems (EHS), the digital traces of the learner’ behavior can be collected automatically from the interaction of the learners with the e-learning environment, or in a "not automatic" manner based on the annotations created voluntary by the learner on the learning objects manipulated in the EHS. These learning objects can be: a handout, an exercise, a simulation, an MCQ...

It is essential to use the term *voluntary* to show that these traces are left deliberately by users who are aware of the importance of the provided information to help to improve their learning environment. In the following, we give detailed definitions of these two concepts “traces” and “annotations”.

2.1 Traces

Traces are information obtained from users’ interactions with the learning environment. There are currently several views on what could be the definition of the traces.

Pernin [11] defines a trace as "*an indication of the activity of actors in a learning situation, whether instrumented or not*." He supplements his definition by making it clear that it is "*a result achieved during or after an activity, an event or a set of events related to the progress of the learning situation* ".

In another sense, slightly different Champin [6] talks about a sequence of states and transitions representing the user activity: "*the temporal sequence of objects and operations mobilized by the user when it uses the system is called trace of use*".

In this paper, we consider the definition given in [12]: "*The trace is defined as a temporal sequence of observed elements recorded from a user’s interaction and navigation*".

We are interested in the digital information on users registered activities, typically in log files, when using a Web based learning environment such as e-learning platforms. We are talking about primary or low-level traces. The analysis of these "low-level" traces provides “high-level” information called indicators.

2.2 Annotations

Annotations are notes that users voluntarily register when they interact with the EHS. There are several definitions of the document annotations (digital or real) which are synthesized in [1]:

• According to psycholinguists and cogniticians, *the annotation is a trace of the mental state of the player and a record of his reactions towards the document* [13].

• According to the librarians, *the annotation is the reader's activity of putting textual or graphical marks on a paper document, and that according to several objectives* [9].

• According to experts of Human Machine Interface (HMI): *The annotation is a comment on an object such as the commentator wants it to be noticeably distinguishable from the object itself, and the reader interprets it as noticeably distinguishable from the object itself.* [2]

We can conclude that the annotation in an EHS is a deliberate and cognitive trace that the learner wants to transmit to the tutor or the administrator with the aim to express an opinion or a reaction towards a content s/he visited.

After defining the concept of "trace" and "annotation", we present in the following the trace collection part.

2.3 Trace Collection

Approximately 78% of Web-based learning environments include a tool for capturing digital traces [8]. These systems use different collection approaches depending on the source of observation: the server, the client, or specific mechanisms to the learning system.

The Web server logs do not give enough information about the learner's activity performed on his/her machine outside the server in question, while specific software record only the interactions conducted in a dedicated environment and in a proprietary format. Approaches based on log file analysis on the client-side can overcome these drawbacks. They allow the collection of traces in heterogeneous systems. These traces provide information not only on the activity of the learner within the course or the e-learning platform, but also outside of it, providing information on the moments of inactivity of the learner. That is why we choose this approach.

If, during an exercise, the student conducts a search on the Web, this interaction is not observed on the server. However, this interaction may be important to explain the learner's path. It is therefore interesting to instrument the client side to observe all the learner's interactions. This approach is not widely used. It is still a research area, due to the different technology choices and the degree of information finesse that one is seeking [3].

Among the works adopting this approach, we can mention WebIC [14], a system of link recommendation, focusing on information retrieval. Its purpose is to provide the users with links that seem best suited to their expectations, based on his/her research in search engines and links that s/he follows. The system - installed on the client side - identifies important words during the user navigation, and proposes pages that have content that may contain information corresponding to the collected words. In [4], the system traces the user's actions, and records the visited pages and the navigation mode. In addition, the system measures the thematic diversity of recently visited pages. The latter is calculated from a distance between texts. In the work of Beauvisage [3], the used data come from probes for collecting Internet traffic, installed on the user workstations at home. The obtained list of visited URLs by each user is the first material of the study. On this basis, Beauvisage [3] proposed a description of the users' path from page to page and site to site, focused on the session.

In the field of EHS, Loghin [10] proposes a keylogger agent able to record all the keyboard and mouse events produced by the learner, the executed processes and also the titles and the content of the dialog boxes displayed on the screen. However, very little work in EHS implements this approach. Usually, they trace only the learners' actions in the e-learning environment using the server logs or specific tools integrated in the tracked environment.

To capture the maximum of information about the learner's navigation during the learning session, we choose a client side approach to collect traces and annotations. In the next section, we present a comparison between the existing collection tools according to criteria that we set.

2.4 Tools for Collecting Traces

Before beginning the design of our own observation tool, we compared five collection tools, including two tools that are used in the Moodle platform (Gismo[1] and SBT-IM [7]). We conducted this comparison according to a list of criteria.

The first criterion is the collection type, it can be server-side, client-side or mixed (server and client). The second criterion is the tracking source, it is the type of data (visited Web sites, viewed documents, sound, video ...) used by the learner during the training. The third point is concerning the annotation, whether it is supported by the system or not. The fourth is the structuring of traces and annotations to be easily viewed by the analysts and the observers. The fifth and sixth criteria are the transformations of the traces and the calculation of indicators. These criteria are optional as the objective of the observation systems is to collect the learners' navigation traces that can be provided to other specialized tools in the calculation of indicators.

Considering these criteria, the result of our comparison of the five studied collection tools is represented in the following tables:

[1] `http://moodle.org/mod/data/view.php?d=13&rid=3949`

Table 1. Comparison between client side collection tools for traces and annotation

Collection Tool	Collection Type	Tracking source	Annotations	Structuration & Visualisation of traces	Trace Transformation	Indicator Calculation
The Observer[2]	Client	Video	Yes	Yes	Yes	No
GISMO	Server	Moodle database (log table)	No	Yes	No	No
SBT-IM	Server/Client	Moodle database + client side interaction	No	Yes	Yes	Yes
Minikey log[3]	Client	Client side interaction	No	Yes	No	No
Memo Note[1]	Client	-	Yes	Yes	-	-

Table 2. Detailed comparison according to functional criteria

Criteria	Observer	GISMO	SBT-IM	MiniKey	MemoNote
Keyboard data				•	
Mouse data				•	
Navigation data		•	•	•	
File data				•	
Clipboard data				•	
Server side data		•	•		
Storage and management of traces	•	•	•	•	
Collection of annotation					•
Management of annotations					•
Automatic start of the tool				•	
Configuration of the tracking tool			•	•	
Filtering and searching of traces				•	
Trace visualization	•	•	•	•	
Trace processing	•	•			
Trace analysis	•	•			
Indicator calculation		•			

2.5 Synthesis

Based on the comparison presented above, we think that our solution should cover the basic functionalities of a system to collect traces. We choose a client-side collection type to trace the majority of data sources (Websites, accessed files ...). In addition to traces, the tool should collect the volunteer annotations of learners and enable structuring and visualization of the collected traces and annotations. The transformation of traces and the indicator calculation would be an advantage.

3 ESITrace

According to the positioning described above, we describe in this section the design of our trace collection tool, called "ESI Trace".

[2] http://www.noldus.com/

[3] http://www.blue-series.de/products/mkl/mini_key_log_en.html

Regarding the collection process, we discussed the three existing collection approaches (user-centric, server-centric and those based on specific software). As we need to collect traces of learners' interactions outside the e-learning platform for the determination of some indicators, we opted for the user-centric (client side) approach through a program installed on the learner's machine.

Regarding the sources of traces and their granularity, some indicators need to record all the learner's actions. Thus, the traces, in our sense, are traces of interactions, which are enriched with each new interaction during the learner's activity. We first explain the trace model that we use, and then we present our collection tool.

3.1 Trace Model

To establish our trace model, it was necessary to identify the objects describing the system and the operations performed by the user.

We identified two types of actions: actions on the resource (open, close, browse: back, forward, etc.), and actions on the content of the resource (copy / paste, delete, etc.). This distinction allowed us to define the set of the observable objects. In our case, these are the various environment resources (button, menu, scroll, etc..) through the various interaction tools such as the keyboard and the mouse. In this way, the traces are structured as a temporal sequence of states that we consider as pages and transitions that are all actions performed on the pages.

These traces are recorded for each learner (user) between the times of the start and the end of the learning session (time_start, time_end). The structure of the traces is presented in the following figure.

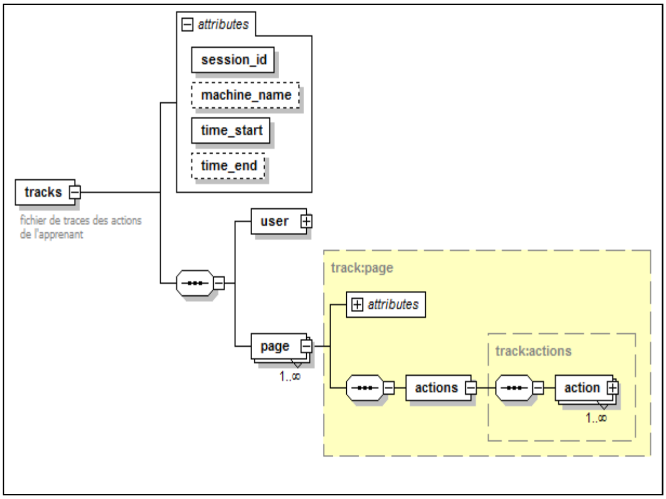


Fig. 1. The trace model [5]

The page is not restricted to a Web page, but can also refer to any file or program running locally or on the Internet. For this, we propose to record its URI (Uniform Resource Identifier), the title if available, the program on which it is executed, and its order of appearance (first access).

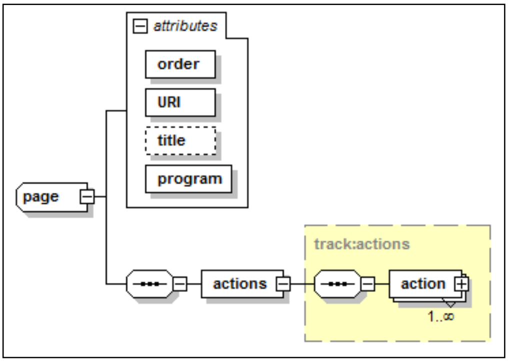


Fig. 2. Description of the trace model page

The learner's interactions with the page are stored in the item "actions". It contains a list of "action" components identified by: the order of appearance, date and time of execution, the type of the action (mouse actions: left button, right or middle; the keyboard keys: F1, F2, shortcut CTL + C, CTL + X, etc.), and the type of interaction (copy, paste, print, etc.). We choose to observe primary actions (keyboard and mouse actions) to replay the learner's path, and also because the majority of trace collection tools (keylogger) provide this granularity of information.

3.2 Description of the ESITrace Tool

To implement the ESITrace tool, we considered several modules including one for collecting navigation traces (visited URLs, mouse clicks, keystrokes...) and another for the collection of annotation. The latter uses an annotation tool called WebAnnot [1]. It is a Firefox's plugin to make annotations on the visited Web pages.

We implemented the ESITrace tool using the .Net Framework 4.0 and Microsoft C #. It runs on Windows platforms. The user interface is designed using the graphics library WPF (Windows Presentation Foundation).

The user has to authenticate online (to the remote server) to access the main window of the application. The following figures show ESITrace interfaces.

At the bottom of the main window, there is three buttons (Fig. 3). The button "Affichage" or "View" launches the interface to visualize the collection results (trace files). The "Démarrer" or "Start" button launches the collection of user's traces. The 'Configuration' button allows configuring the application.

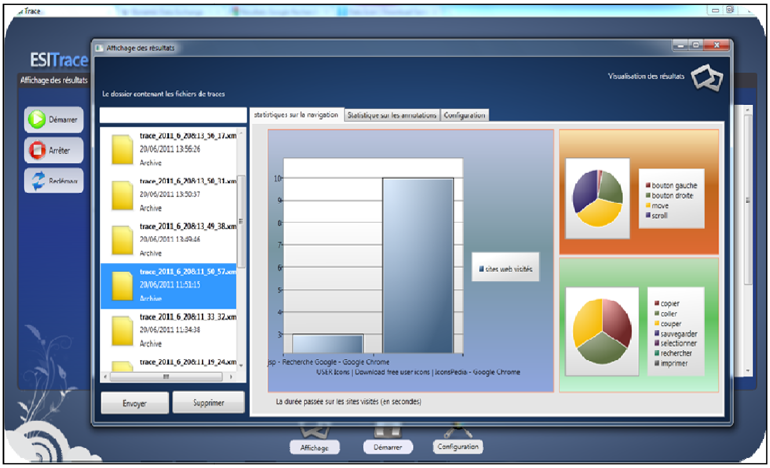


Fig. 3. A snapshot of the ESITrace tool

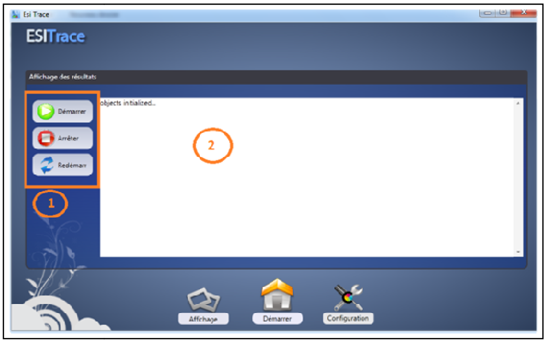
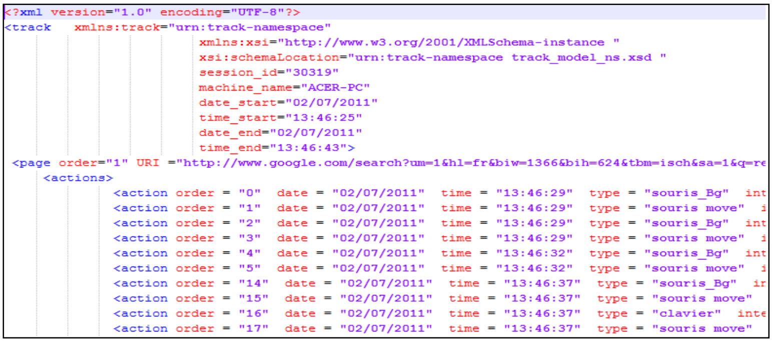


Fig. 4. Trace collection window

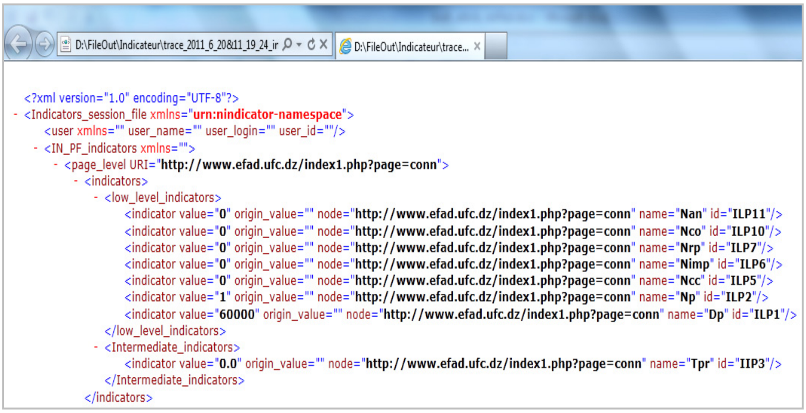
When the user clicks on the "Start" button another window appears (Fig. 4). The tool can be configured to launch the collection automatically when the user opens the starting Url (e.g. the login page of the e-learning platform), and to stop the collection if it encounters the ending Url (e.g. the disconnection page). The user can also start and stop the collection manually (number 1 in Fig. 4). S/he can see the actions collected in real time (number 2 in Fig. 4).

ESITrace allows to filter some Urls that will not be tracked, enable or not the tracking of all or part of the supported Web browsers (Chrome, IExplorer, FireFox, Opera), as well as activate or not the collection of annotations. At the end of the collection, an XML trace file is generated and can be automatically uploaded to the server. The following figures show an example of the collected traces (Fig. 5) and the calculated indicators (Fig. 6) using the IDLS system [5].



```
<?xml version="1.0" encoding="UTF-8"?>
<track   xmlns:track="urn:track-namespace"
              xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance "
              xsi:schemaLocation="urn:track-namespace track_model_ns.xsd "
              session_id="30319"
              machine_name="ACER-PC"
              date_start="02/07/2011"
              time_start="13:46:25"
              date_end="02/07/2011"
              time_end="13:46:43">
 <page order="1" URI ="http://www.google.com/search?um=1&hl=fr&biw=1366&bih=624&tbm=isch&sa=1&q=re
    <actions>
        <action order = "0"  date = "02/07/2011"  time = "13:46:29"  type = "souris_Bg"  int
        <action order = "1"  date = "02/07/2011"  time = "13:46:29"  type = "souris move"  i
        <action order = "2"  date = "02/07/2011"  time = "13:46:29"  type = "souris_Bg"  int
        <action order = "3"  date = "02/07/2011"  time = "13:46:29"  type = "souris move"  i
        <action order = "4"  date = "02/07/2011"  time = "13:46:32"  type = "souris_Bg"  int
        <action order = "5"  date = "02/07/2011"  time = "13:46:32"  type = "souris move"  i
        <action order = "14"  date = "02/07/2011"  time = "13:46:37"  type = "souris_Bg"  ir
        <action order = "15"  date = "02/07/2011"  time = "13:46:37"  type = "souris move"
        <action order = "16"  date = "02/07/2011"  time = "13:46:37"  type = "clavier"  inte
        <action order = "17"  date = "02/07/2011"  time = "13:46:37"  type = "souris move"
```


Fig. 5. Example of a trace file



```
D:\FileOut\Indicateur\trace_2011_6_20&11_19_24_ir    D:\FileOut\Indicateur\trace...

<?xml version="1.0" encoding="UTF-8"?>
- <Indicators_session_file xmlns="urn:nindicator-namespace">
    <user xmlns="" user_name="" user_login="" user_id=""/>
  - <IN_PF_indicators xmlns="">
    - <page_level URI="http://www.efad.ufc.dz/index1.php?page=conn">
      - <indicators>
        - <low_level_indicators>
            <indicator value="0" origin_value="" node="http://www.efad.ufc.dz/index1.php?page=conn" name="Nan" id="ILP11"/>
            <indicator value="0" origin_value="" node="http://www.efad.ufc.dz/index1.php?page=conn" name="Nco" id="ILP10"/>
            <indicator value="0" origin_value="" node="http://www.efad.ufc.dz/index1.php?page=conn" name="Nrp" id="ILP7"/>
            <indicator value="0" origin_value="" node="http://www.efad.ufc.dz/index1.php?page=conn" name="Nimp" id="ILP6"/>
            <indicator value="0" origin_value="" node="http://www.efad.ufc.dz/index1.php?page=conn" name="Ncc" id="ILP5"/>
            <indicator value="1" origin_value="" node="http://www.efad.ufc.dz/index1.php?page=conn" name="Np" id="ILP2"/>
            <indicator value="60000" origin_value="" node="http://www.efad.ufc.dz/index1.php?page=conn" name="Dp" id="ILP1"/>
          </low_level_indicators>
        - <Intermediate_indicators>
            <indicator value="0.0" origin_value="" node="http://www.efad.ufc.dz/index1.php?page=conn" name="Tpr" id="IIP3"/>
          </Intermediate_indicators>
      </indicators>
```


Fig. 6. Example of the calculated indicators

4 Conclusion

E-learning activities present many problems like learner's isolation and lack of awareness about his current activities and progression. One way to improve this awareness is to collect data and information about different aspects of his current activities using traces and annotations.

Whereas traces are information obtained from users' interactions with the learning environment, annotation is the reader's activity of putting textual or graphical marks on a document. To capture the maximum of the learner's traces and annotations about his/her learning activities, we implemented a client-side tool for trace and annotation collection called ESITrace.

To specify ESITrace functionalities, we have compared different trace collector's tools according to our requirements. We choose a client-side collection type to trace the majority of data sources (websites, accessed files ...). Trace collection is based on a specific Trace Model that specifies which kind of data will be collected. Upon this model, we developed the ESITrace tool. It collects both learner's traces and annotations. It also enable structuring and visualization of the collected traces and annotations.

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An Iterative Approach towards Interactive Digital Narrative – Early Results with the Advanced Stories Authoring and Presentation System

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Abstract. Narrative has always played an important role in knowledge transfer between human beings. The Advanced Stories Authoring and Presentation System (ASAPS) was developed as the practical side to a research effort Interactive Digital Narrative (IDN) that combines theory and practice in a tightly coupled relationship. The first implementation of ASAPS foregrounds a robust and flexible architecture based on an extensible markup language. The early ASAPS narratives described here are an indication for the potential of this approach, which will incorporate additional technologies in the future.

Keywords: Interactive Storytelling Tools, Authoring System, Interactive Narrative, Digital Knowledge Transfer, Story, Plot, Instantiation, Protostory, Narrative Design, Narrative Vectors.

1 Introduction

The role of narrative has always been the transfer of knowledge in the form of retelling human experiences. A contemporary form of narrative is Interactive Digital Narrative (IDN), an emerging practice that applies digital media and its procedural, participatory, spatial, and encyclopedic qualities to create new expressive forms, which are focused on moving beyond the restrictions imposed by more traditional media. An important aspect of IDN research is the creation and analysis of experimental artifacts. Toward this end, many researchers in this field have created specialized authoring tools, including Storyspace [1], Agent Stories [2], Art-E-Fact [3], the authoring part of the IS engine [4], DraMachina [5], Adventure Author [6], Scenejo [7], Bowman/Zócalo [8], Scribe [9], Inscape [10], FearNot! authoring tool [11], Rencontre [12], and Wide Ruled [13]. While these capable software packages certainly allow the creation of IDN artifacts, they are wedded to particular theoretical and pragmatic positions, which influence users in their choices and potentially limit the scope of works created with it. From this perspective, existing IDN authoring tools can be broadly described as belonging to three categories: tools incorporating particular traditions, tools incorporating specific approaches, and tools designed to be more general. Examples in the first group include Storyspace (Hyperfiction), Inform [14] (Interactive Fiction), Recontre [12] (Hyperfiction), and Korsakow system [15]

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(Interactive Cinema) The second group contains tools created for specific approaches in IDN research and include Agent Stories (Agent-based narrative with story clips), Art-E-Fact (directed graph based dialogue), IS engine (Character-based approach with hierarchical plans), Bowman/Zócalo (Domain Elaboration Framework with a planning system), Adventure Author (Branching dialogue trees), Scenejo (Story graphs in combination with dialogue patterns), Scribe (Front end for interactive drama in a training environment), FearNot! (Emergent narrative from the interaction of planned agent behavior), Wide Ruled (Text-based author-goal driven story planner), and DraMachina (Story Blueprints).

An example for the limitations of particular traditions or approaches is Storyspace, a tool designed around the assumptions of the Hyperfiction (HF) tradition in IDN [1], which incorporates a metaphor based on nodes and hyperlinks, but only limited procedurality in the form of conditional hyperlinks. While similar restrictions exist with all the tools in the first and second group, the emphasis here is not to point out flaws in any particular approach but to suggest that a combination of approaches will be beneficial and allow a wider range of IDN experiments.

The third group (represented here by Inscape) exemplifies a pragmatic approach. What is missing in the Inscape project is a general definition of IDN shared by the project partners, as evidenced by a mid-project review reflecting very different perspectives, from suggestions to apply narrative theory [16] to a proposal for making stories by recording interactive experiences [17]. Since Inscape is lacking a clear distinction of IDN vs. other forms of digital expression such as digital movies it becomes difficult to evaluate the resulting artifacts as IDN works.

From this perspective, authoring tools that only incorporate specific traditions or particular research approaches are limiting as a basis for bold IDN experiments, since practitioners should ideally have all available tools and methods at their disposal. At the same time, the an IDN authoring tool should be grounded in a broad definition of interactive narrative to provide a theoretical framework for the analysis of the resulting artifacts. Also, the new architecture should make provisions for future revisions and sustainable continuous development, in order to avoid adding to the long list of discontinued and no longer available IDN projects like Agent Stories [18], Inscape [10], and Placeholder [19]. Last, but not least, the tools should be easy to use and thus spur IDN creation to gain a greater body of works for analysis.

Consequently, the approach discussed here aims to incorporate and integrate multiple traditions and various practical approaches within IDN. At the same time, it places a focus on the creation of a solid basis for continued development and attempts to lower the threshold for IDN creation by providing a simply UI and thorough documentation.

2 Advanced Stories Authoring And Presentation System (ASAPS)

In 2006, the author started a long-term research project, which combines a broad theoretical perspective aimed at producing an integrative theory for IDN with a practical implementation for narrative experiments. The result on the practical side is the Advanced Stories Authoring and Presentation System (ASAPS), an open software platform for IDN experiments.

The architecture of ASAPS reflects the focus on extensibility and sustainability in its initial implementation. The systems architecture combines a modular approach with an extensible markup language and thus takes cues from the architecture of the World Wide Web. The current version of ASAPS combines a markup language (ASML), an authoring tool (ASB), and a playback engine (ASE). (Figure 1)

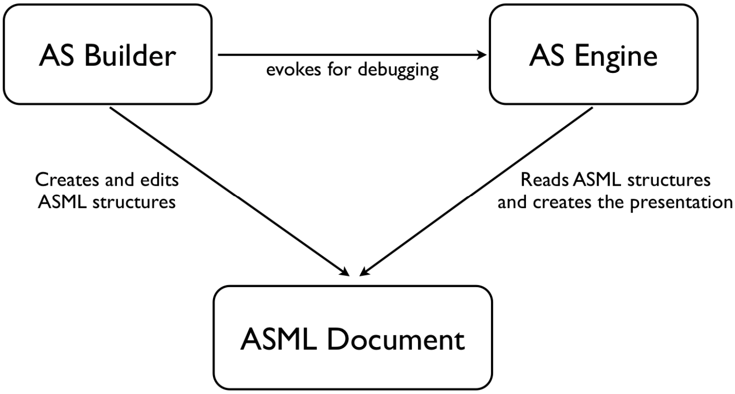

Fig. 1. ASAPS modular structure overview

ASAPS implements a flexible theoretical framework (for a full discussion see [20]), which posits IDN as distinct from more traditional narrative forms, and encompassing three different stages- System, Process, and Product. The IDN system is comprised of a space of potential narratives, termed protostory. Contained in a protostory are the four categories of settings, environment definitions, character definitions, and narrative design, a malleable structure, which supersedes the traditional notion of plot. The contents of the categories of environment and characters supply material for the narrative design. A concrete narrative design consists of assemblages of atomic narrative units, called beats, a metaphor taken from stage drama [21]. Combinations of beats constitute narrative vectors, or substructures of the overall narrative design.

The long-term goal for ASAPS is to integrate many of the theoretical strategies and pragmatic approaches embedded in the aforementioned tools and make them available to practitioners by either replicating them directly within the platform or by providing software "hooks" which enable ASAPS to communicate with other systems. In that way, the project aims to improve collaboration between different researchers and to provide practitioners with an extensive toolset that was so far unavailable, since the different approaches have not been available in combination. Ideally, ASAPS will in the future be able to produce a wide range of IDN works, spanning a range from Hypertext Fiction to the application of advanced AI strategies as exemplified in Mateas' and Stern's *Façade* [21]. At the same time, ASAPS is intended to serve as a test-bed for the continued refinement of an IDN-specific narrative theory.

2.1 Current Implementation and Early Results

The first implementation of ASAPS foregrounds an extensible, robust architecture and a user-friendly interface with full documentation over advanced computational functions. ASAPS is currently implemented in the form of an XML-based markup language, which describes complete IDN experiences in human-readable form. The current ASML (Advanced Stories Markup Language) specification consists of four top-level entities (Settings/Environment/Characters/Plot) and 14 beat functions (TitleScreen, DurScreen, IntroText, ConversationChoice, MovementChoice, PickProp, VideoBeat, SWFBeat, SetGlobal, ConditionCheck, RandomBeat, AddRemoveInventory, SetCounter and EndScreen). Media types supported by the current version of ASAPS include images, 2D animations, video and audio.

ASAPS has been in continuous development by the author since 2006. The ASML language has seen about 30 revisions, while the ASE playback engine has reached version 78, and the builder application ASB is at version 9.13. The software together with a 60-page user guide and several example narratives is currently available by request as part of a private beta distribution for MacOS X and Windows platforms from the project website [22] The following sections discuss the components and early results in more detail.

2.2 ASB (Advanced Stories Builder) and ASE (Advanced Stories Engine)

ASB provides a graphical interface for all current ASML functions. In ASB, a designer designates image files, animations, or videos as nodes, props, and character states. Then, she creates the narrative design by adding and editing beats. The structure of the narrative design is plotted out in The *Graph* view (Figure 2). In turn, the graphical contents of individual beats are edited in the *Graphics Editor* (Figure 3).

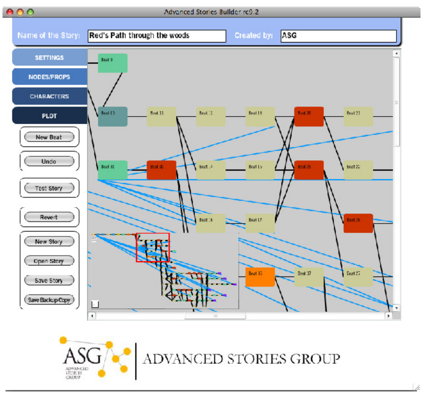

Fig. 2. Graph View

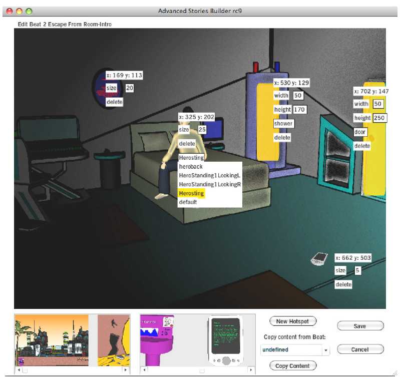

Fig. 3. The Graphics Editor

The ASE component reads ASML files and referenced media assets and generates the presentation for the user. Repeated play-through is fully supported in ASAPS, and the ASE engine automatically resets all parameters for each repetition. A user can also save the current state of an IDN and resume at a later date. ASE is tightly integrated with ASB and aids during development with a debug function. (Figure 4)

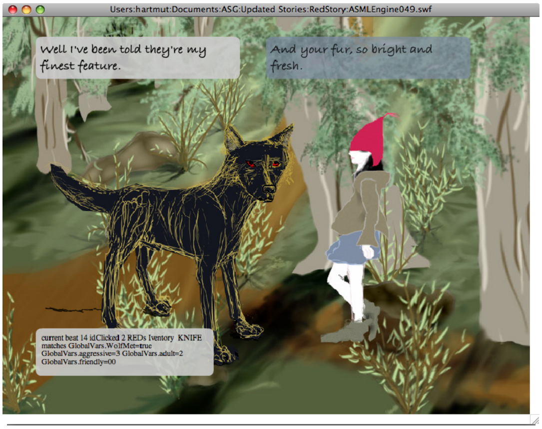

Fig. 4. ASE presentation with debug overlay visible

2.3 Early ASAPS Narratives

Given the focus on creating a solid architecture for the first completed iteration of ASAPS, early ASAPS narratives are not expected to push the boundaries for IDN artifacts in terms of computational sophistication; rather, they serve as test cases for the overall "meta approach" in that they embed narrative approaches so far available in different tools like Storyspace [1], the Korsakow system [15], or Adventure Author [6]. At the same time ASAPS exceeds these tools by enabling combinations of their respective narrative strategies.

Red's Path Through the Woods (2006) was the first ever ASAPS artifact, and is loosely based on the brothers Grimm's fairy tale *Little Red Riding Hood*. The main motive in this new version is character development as a result of an accumulation of decisions. The interactor is given a "blank" Red character and forms her persona by making choices. Oftentimes such actions do not yield immediate repercussions. Instead – and is as often the case in real life – the consequences of several actions are presented only at a later stage.

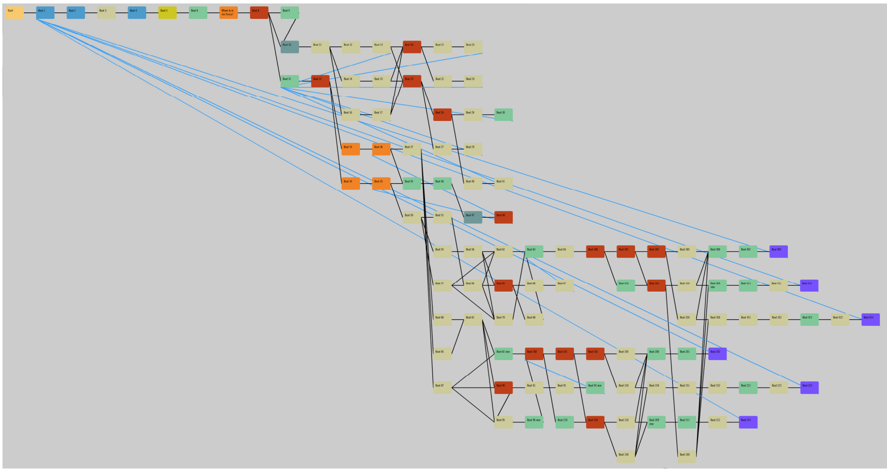

Fig. 5. Structure of *Red's Path Through the Woods* in ASB's Graph view

Red's Path is a branching narrative comprised of 112 interconnected beats with several return paths (Figure 5). The concept of delayed consequences is implemented by variables, which are used to track different character traits; *friendly* for the nice, shy, and a little naïve girl, *aggressive* for the determined, forceful girl, and *adult* for the flirtatious girl in the process of discovering her sexuality. Every decision in *Red's Path* influences the character trackers, while great care was taken to make choices non-obvious, yet causally related to the respective character trait. Condition checking beats are used to determine overall development and the options available to the interactor's character Red. For example, if Red's character has flirted frequently before and consequently has a high *adult* counter, she has the option of "talking her way out" when attacked by the wolf later on. *Red's Path* has six possible outcomes, but a much larger number of possible walkthroughs, as a consequence of a narrative design with return paths and accumulated counters. The structure of *Red's Path* represents a branching narrative strategy reminiscent of Hyperfiction Narratives created with Storyspace, but enhanced with graphics and procedural branching based on accumulated variables.

Tonguc Sezen's *Tears* (2009) is a work in the tradition of adventure games. In *Tears* the interactor assumes the role of a journalist who lives in a colony on planet Mars and wakes up to an emergency alert. The journalist receives an assignment to investigate the catastrophe that has struck the colony and must first escape from his own apartment, which proves to be difficult. *Tears* applies rendered nodes that give the appearance of a 3D game engine. The narrative design represented in the overview of the structure (Figure 6) reflects a spatial narrative strategy akin to work possible in Adventure Author based on different interconnected places, which are visible as clusters of beats in the structural overview.

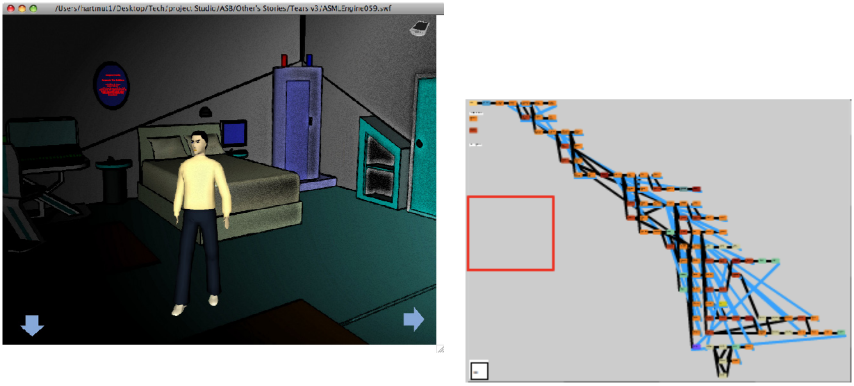

Fig. 6. Scene from Tears by Tonguc Sezen and structural overview

Hank Blumenthal's work *Reflections* (2009) puts the interactor in a New York apartment filled with the memories of a couple that lived there expressed in movie clips. By exploring the spaces and viewing movie clips placed there, slowly a story of love, betrayal, and finally, murder emerges from the discontinuous parts. Blumenthal uses ASAPS to create an interactive experience that is initially bewildering, but rewards the interactor with a rich and captivating narrative. The structure represents a spatial narrative design with tightly grouped representation of staggered beats based on the rooms of the apartment (Figure 7). This narrative design enhances narrative strategies available in the Korsakow system for movie clips with spatial placement.

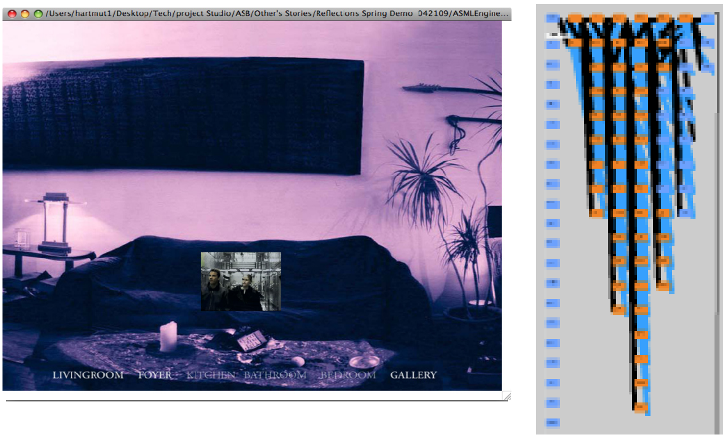

Fig. 7. Scene from *Reflections* and structural overview

3 Early Evaluation and Future Plans

The works discussed in the previous section show how ASAPS in its current form is able to accommodate different narrative strategies while maintaining the focus on IDN. Parallel to the development process, informal user studies have been conducted on a regular basis in order to evaluate and improve ASAPS. So far, about 30 works have been created with ASAPS and the feedback from the authors of these works has been used to enhance the current version by changes to the UI and additional features in the form of new beat types.

Informal criticism of ASAPS by the research community has mostly centered on the lack of more advanced computational functions, for example natural language processing. This was expected, since the focus for the first version was on designing and implementing a solid architecture as a robust foundation that facilitates future revisions and extensions. ASAPS authors have most prominently asked for the addition of a 3D environment, as ASAPS currently only supports 2D graphics.

Consequently the focus for the next major version of ASAPS is to integrate ASAPS with a 3D game engine like the open source version of quake [23] and to create “hooks” to other systems in the form of “networked Beats”, with the ability to send parameters to and receive beat content from remote servers or local applications via standard TCP/IP protocols. This will enable many additional functions in ASAPS without burdening the system itself. For example, in concert with a text input function, a conversation could be realized by sending text to an online chatterbot service like A.L.I.C.E [24] or cleverbot [25] and displaying the reply in a beat. In a similar way, a query could be sent to the knowledge-based commonsense reasoning engine OpenCyc [26] or similar projects and the reply processed by ASAPS, thus integrating AI functionality. Additionally, a function will be added to send the current state of an ASAPS narrative to a remote server and integrate the answer as “remote Beat” in the existing structure. In this way, beats could be created entirely by other systems, making ASAPS even more accessible for collaboration with third party software and other research projects. To support such developments, both the ASML language specifications and a Document Type Definition (DTD) for verification will be made available at the ASAPS website. This will only be a first step towards a more open process. In the long term, development of ASML and the related communication protocols is envisioned to progress in a similar fashion to how HTML revisions as handled by the W3C [27] organization. Towards that end, we are currently working on open licensing terms for ASML-related technologies.

Another area of focus for future revisions is improving the use of the platform for the analysis of user’s interaction with IDN artifacts. A future revision of the ASE playback engine will include anonymous tracking of user’s moves in order to provide quantitative data for the analysis of user behavior.

We are encouraged in our efforts towards continued development of ASAPS by the feedback we have received so far and by a similar effort towards an integrated software architecture for IDN by Szilas et al [28]. Their project OPARIS (OPen ARchitecture for Interactive Storytelling) defines distinct functions for different modules and a central director component tasked with translating and mediating between different modules. In comparison, the architecture of ASAPS is less defined, which provides more flexibility for diverse implementations.

4 Conclusion

The ASAPS architecture has so far lived up to the expectations of creating a usable platform, which can implement narrative strategies from different traditions and approaches within the field of IDN. Also, the platform was flexible enough to integrate user's requests for added functionality like additional beat types. To this extend the implementation of the concept of protostory in ASB has been successful in getting authors to experiment.

The plans for future revisions are designed to strengthen ASAPS as a platform for IDN experiments and critical analysis. The long-term goal is to establish ASAPS as a standard interchange format and middleware between diverse systems. Similar to the way the WWW enabled access to different media types and communication between different software systems, ASAPS could serve this function in the IDN space.

To implement the plans for future development, the author has applied for an NEH digital startup grant and drafted a plan that includes a more formal evaluation of ASAPS by a group of advisors. In the mean time, a comparative analysis of narrative experiments created by a class of 24 students is underway and work on an ASAPS playback engine for mobile devices continues, which will enhance the appeal and reach of the ASAPS platform.

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HCI Model for Culturally Useful Knowledge Sharing

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Abstract. Human Computer-Interaction is expanding its domain of application and in so doing can lose its focus. As well as a variety of methods developed for designing interfaces both for input and output interactions, there is growing concern over the Digital Divide, so accessibility is a key issue.

By combining related design model we present the relevant issues for Indigenous users. This covers how we might assist Indigenous people to participate in online knowledge learning communities, and what sort of guidance this provides for the design of such systems. First we look at previous research into encouraging participation, such as analyzing the goals and beliefs driving online behaviour, to which has been added user-competency with different media, and user beliefs, such as their value to the community.

Keywords: Human Computer Interaction Model, Searching Knowledge, Indigenous Knowledge.

1 Introduction

There is an increasing focus on accessibility as a goal for HCI research. This covers a broad scope of concerns, from providing ubiquitous and self-evident hardware interfaces to providing suitable online environments. This paper develops a generative theory of Human-Computer Interaction to support practitioners who wish to create or design new interfaces across cultures, for example for low literacy, high multimedia users. This project focused on knowledge sharing and search mechanisms as a priority for Indigenous users for knowledge sharing in the Web 2.0 environment, using Zhang and Norman's [1] view that "it is the interwoven processing of internal and external information that generates much of a person's intelligence" (p. 87).

The design we developed was for a search engine and interfaces for Indigenous users who seek knowledge to develop community projects. These included government resources relating to their own community and information on projects that worked in other communities based on site-specific features. However many government reports, studies and analyses about Indigenous communities are not available to the community although these documents are highly relevant to the funding and support of community development.

Government employees also express concern that seemingly successful policies cannot be extended beyond single implementations. They expressed this as due to the lack of connection between policy and the factors in the communities they are aiming

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to support. Local communities are themselves the best able to describe their conditions for devising community based programmes.

2 HCI Models

We first looked at the factors in interactions between humans and the IT environment. Nielsen and Norman [3] argue for a goal directed understanding of interaction by users, as users will ignore distractions that interfere with their aims. March [3] indicates that one of the primary ways in which individuals develop goals is through beliefs formed from their own actions and responses. This includes issues of trust within a the online environment.

We need to consider the ecological constraints and affordances within HCI. The constraints refer to structures in the online world that guide people's actions rather than those that are determined by internal cognitive processes. The term affordances, in the context of HCI, have been used to refer to attributes of objects that allow people to know how to use them.

As interfaces become more ubiquitous and pervasive new design paradigms are emerging [4] as well as the possibility of creating affordances within these interfaces in a manner that may not relate to pre-existing real-world objects or interactions.

One approach used to analyse human activity within an external and social environment is the Activity Theory Model [5] that divides the study of the interface into the separate elements of the model, to study any tensions within or between elements during the activity.

Another approach is the ecological cognition framework, which provides a structure to evaluate and develop designs from three levels of user modelling. Users act out of desire; evaluate the community at a cognitive level according to their goals, beliefs; and interpret and interact with their environment based on their perceptions.

3 Previous Research in Visualization and Search Engines

Pirolli and Card [6] have conceptualized searching for and making sense of information, using concepts borrowed from evolution, biology, and anthropology together with classical information processing theory called the information foraging food-theory (IFT). They describe searching strategies in terms of making correct decisions on where to search next, influenced by the presence or absence of "scent." By presenting the problem from a new aspect, it has enabled designers to rethink the field of information visualization, graphical representations and browsing tools.

We provide a conceptualisation or representation of search engines from the perspective of Indigenous learning within the corroboree setting, where the re-enactment of the real environment assists the user in the construction of their knowledge. Also Rogers & Scaife's [7] developed guidelines for studying users interactions with different kinds of graphical representations (including diagrams, animations, and virtual reality) when carrying out cognitive tasks. We use their properties and design dimensions to determine which kinds and combinations of graphical representations would be effective for supporting different activities.

Support for the users' external cognition arises from the interaction between internal and external representations when performing task that reduce the user's cognitive effort through the use of external representations, without reducing the information provided [8].

4 The Users' History

We look first at previous activities and consciousness-forming experiences of Indigenous communities and people that affect motive or intent, perception or awareness, desires and beliefs, as well as familiar forms of knowledge sharing, and consider how to transfer this experience to online use. From previous research into Aboriginal use of the Internet ([9] and [10]) the main issues for online mediation are:

- Trust – knowledge can be misused or misinterpreted if used out of context,
- Access – mobile access as mentioned above is vital for many users,
- Language – the language used on sites must be simple written English or audio,
- Immersion – ease of navigation and practical presentation of the themes
- Relevance – the interface, choice of content matter, and handling of material
- Issues relating to learning context and engaging Indigenous users.

The software was developed with the following design criteria, which was extracted from repeated consultation with government workers who wished to search existing material in their policy area, and communities who had successful projects they wished to share initially through face-to-face meetings.

4.1 Trusting the System

The trust in the web is related more to Aboriginal people's past experience prior to computing, rather than the short time they have engaged online. The user interface for these services is merely a gateway to the computer network, which is controlled by and accessible to mostly non-Indigenous people. There is a long history of the acquisition by non-Aboriginal people of knowledge about country, such as the location of good pasture land and mineral resources that led to the land being taken away from Aboriginal control. Hence the placing of knowledge in the public domain is of concern to many Aboriginal people.

To improve trust the main concern is community control, where the user feels that they know what the service is doing and how it was set up, a requirement that is increasingly difficult with movement towards knowledge in the cloud. For services outside the cultural domain such as banking and music sharing, the value of the service outweighs any security concerns. We are not considering these services, but focus on the goal of sharing community knowledge where trust is dependent on an understanding of Indigenous protocols and developing appropriate access controls (see [11]).

Two solutions that have been proposed relate to:

Willingness to share – communities needed to feel their project would be respected as their design and their work e.g. retaining clear tagging of original of material.

Value of others contribution – making previously existing government reports accessible through the site was important to stimulate further contribution.

4.2 Access for Indigenous Users

Many rural and semi-remote communities do not have access to Internet services due to lack of affordable or public Internet connections. Also many urban households rely on Internet cafes for access. As is common across all areas of Indigenous affairs, it is not possible to deal with one issue in isolation. In this instance, we cannot solve the issue of culturally appropriate learning if there is no access to the new tools that enable this.

Mobile phones are often used to access learning material, particularly audio and visual such as podcasts and to provide feedback and discussion through mobile uploads. While mobile services are ideal for the collection of information, the formation of knowledge and the linking of information to provide relevant contexts for learning require more substantial web access.

4.3 Language in Use

The site was developed as a visual interface showing links between related documents and different components presented as a 'chocolate chip cookie' to help navigation into greater detail then returning to top layer. Icons were developed in consultation with government and community users.

Alternatively there are efforts to provide online resources for language translation and sharing that support a range of language groups. The often-small number of full-language speakers for many languages, and the lack of support for audio content management hamper this. Also attempts to use existing text to speech services are hampered by the complexity of the Indigenous languages. However audiovisual interfaces support learning [12].

4.4 Immersion in Site

We are looking for ways to make access to the service intuitive for people who learn through experience rather than abstractions. User immersion tends to be governed by issues relating to the interpretation of the online environment. Here we wish to emulate the users' mediated relationship with their real world environment, and the immersive, practical and discovery learning used in this domain. This involves incorporating cultural and personal relevance in learning [13].

For instance much learning is done traditionally in the community through performance, where the knowledge covered is selected as appropriate to the occasion, the audience present, and the knowledge holders present who have authority to present particular stories [14]. Web services provide a form of mediation that is representational and more static than previous methods of knowledge sharing [16] however this does prevent user adaption, with unexpected benefits for knowledge sharing.

4.5 Relevance of Site

Internet sites and their content must be relevant to the desires and goals of the users. There is a great cultural divide in Australia between Aboriginal and non-Aboriginal people and the former's engagement in the mainstream services is often limited [10]. Aboriginal people have established their own legal and health services and frequently do not engage consistently with mainstream schools.

A similar interchange exists online. While some use is made of social networking sites and events calendars, this is usually shared only within Indigenous networks. Hence more resources need to be made available to service information sharing within these networks, such as oral history sites, and audio and video archive sharing.

4.6 Learning Context

The learning context is related to the success in developing immersion in a site. The differences between Aboriginal and Western belief systems are many, and these influence the knowledge that is valued and taught, as well as the way it is taught. For instance immersion will require the inclusion of spiritual concerns and general well-being in learning, as part of providing relevance to the learner and their culture [14].

The approach to learning support on the web should focus on greater respect for the learner as knowledge holder through including their contributions. As mentioned, the unique nature of traditional Indigenous learning is strongly linked to the story telling, narrative form. To convey Indigenous Knowledge online would be invalid without the contributions of the Indigenous community through their 'translation' of their experiences into the new context. In particular, we need to reverse the present attitude to oral history as "unreliable" and the "systemic undervaluing of local knowledge and Aboriginal culture, a deeply ingrained unwillingness to 'see' more sophisticated Aboriginal knowledge and processes" [17 p. 105].

5 Suitable Learning Context

The above categories provided an interacting checklist for evaluating the users activities on the search portal prototype, and some guidelines for the initial design. This approach is however more prescriptive than generative. We aim for a more proactive role, providing guidelines for the initial design of web services that start with the user model, rather than relying on an interaction model of functions we believe the user requires [18].

A problem with establishing effective programmes for Indigenous well-being is the lack of involvement of Indigenous people in this process. Indigenous people wish to search online the material relating to the theme or region of their interest. The searches themselves need not be stored; the site can act as a portal. However users often have further information that can be added as annotations that will be stored in a repository for others users to access if granted this privilege. This annotation will allow sharing of knowledge between communities on the details relevant to re-use of successful projects across sectors.

While many open source search engines exist, to add a visual search interface and provide more specific feedback from searches, the interface needs to be tailored to the specific user group. Search interfaces have been developed for industrial sectors and company intranets. This design is for a broader community and will be available for other users to extend, through the open source programming community.

While access by many Indigenous users will be through low bandwidth mobile services, we need to allow contributions of audio and video material. Also security of access will need to be through organisational affiliation and this community of registered users will handle the moderation.

5.1 Conceptualisation

We wish to develop a conceptualisation of search engines and artefact annotation in an online community, when used for Indigenous knowledge sharing. While the work of Pirolli and Card [6] is relevant to search engines, we are focusing on enhancing the information retrieved, rather than seeing it as the final ‘feed’. This conceptualisation relates to more traditional forms of knowledge search and interchange in community learning. This form is the corroboree, or story telling through dance, performance and music. The concept is hard to envisage online, as in real life the process requires many hours of preparation by the elders gathered to organise the ceremony.

Their discussions prior to the ceremony cover the three levels of the ecological cognitive framework. They discuss their desires: the context of the corroboree, what is significant in the present situation for the people, which is related to the user’s desires within the environment. They evaluate the community’s goals and beliefs: this involves considering the themes that need to be covered for learning about the present context, which links to the audience’s goals. They interpret and interact with this environment: this develops the cohesion of the narrative, what will be presented for the social and creative linkage of information. So they decide what will be performed.

Once this corroboree has started individuals contribute stories or songs relating to how their own knowledge fits into the previous narrative and so select the stories that are shared. The rendition of these stories will be through various performances.

5.2 Taking the Conceptualisation Online

There will be no ‘elders’ or over-arching knowledge holders online to tie the information together into knowledge to be understood. In effect the system provides isolated packets from which the user has to draw sense. The interface design framework we provide here has been developed around this need to design the interface format (context), information selection (thematic content) and information linkage (cohesion) to create a knowledge repository.

We now use this conceptualisation to develop a design framework using the criteria and experience of Rogers & Scaife [7], which focuses on the visual aspects of the design. The aim of the visual design is to reduce the cognitive load in learning through:

- representations within real world, or juxtapositions that can represent processes in real life narratives. This provides the narrative for the user to follow.
- external representations of temporal and spatial constraint that provide constraints and affordances to assist the search enquiry. This forms the theme of the activity.
- graphical elements which provide affordances or constrain the kinds of inferences that can be made about the relevance of the search artefacts. This provides a context for the user's search activity.

The design concepts that we developed from these approaches were divided into the three main activities on the portal. Firstly the user searches for relevant material. Then within the results of that search they want to explore the search results, including any accessible annotations attached to these artefacts. Finally they may want to add their own annotations and notes for future searchers. As a future enhancement, we also considered benefits that may arise if government employees tag reports before putting them online. If there were benefits for the community users, the government staff may consider this work valid use of their time.

The design concepts listed by Rogers [4] are presented here implemented in this new domain.

Explicit and Visible

- Search enquiry: Use icons or dropdown lists in searches. Initially users can update these by entering other criteria. Select locally suitable icons to represent the theme.
- Search results: Use of visual representations, such as an image of chip cookie to show containment of search result groups.
- Annotations: The portal needs to provide web services for the direct upload of audio or visual comments, such as community and record the relevant bookmark.

Salient Features

- Search enquiry: Collect themes for searches that are relevant for the community, noting which aspects are most significant in determining the different types of users needs, for instance language group may be a first selection before location of user.
- Search results: Image and audio artefacts with suitable tags should be displayed first. Also text results should be displayed as complete paragraphs rather than sentence fragments to provide users with enough context for comprehension of the relevance of the artefact, in both terms of content and presentation style.
- Annotations: When users add annotation these should linked to visual 'bookmarks' within the artefacts, e.g. highlighting or boxing the text, which can be re-created on the retrieved artefact when viewed by other users.

Cognitive Trace

- Search enquiry – The portal will require some access procedure to assist with the protocol issues and security on government reports in the Indigenous area. Also we are tracing user processes to provide some support such as audio cues to ask if users want to refine a search or start a new one when they enter a new criteria.
- Search Results: Users can select favourite results, those items that they realise will be useful often to them, and they may want to go back to, without finding where they saved them on the computer.
- Annotations: Annotations are tagged to assist in the ordering of annotations within a single document. As well as the location within the document they reference, the tags can contain some user data and authority levels within the domain of the theme searched. The user selects their authority level.

Ease of Production

- Search enquiry: Use visual models of search preferences that is open to changes from the user.
- Search results: Use local shared caching that retains access authorisation.
- Annotation: The use of annotation is proportional to the ability to link that annotation to further material, or to make use of the information.
- Help resources: As well as the use of screen images to develop help documents on the site, there should be a phone service and workshops with local community groups to demonstrate the use of the site, in relation to the interests of those attending.

Combine and Modify

These tools link data on the portal to make the artefacts more cohesive.

- Refine searches: Allow users to search the artefacts returned from one search, rather than re-search with a refined criteria.
- Link resultant artefacts: Annotation can link more than one searched artefact.
- Link different annotations: Users may wish to annotate others contributions, so a second level of reference can be built in. This is done in a threaded style of presentation, to reduce visual load on the interface.

6 Pattern Language

The purpose of this work was to generalise the design requirements to future software development. The process to generate the pattern language from the original user model is illustrated below showing the mapping from interviews with users to model the user and the final pattern language of the interface, using the visual categories developed by Rogers & Scaife's [7].

Using the initial search enquiry we show the pattern language that was developed to describe the items used to create this interface. The same process was used to expand the description of search results, annotation tool and help documents.

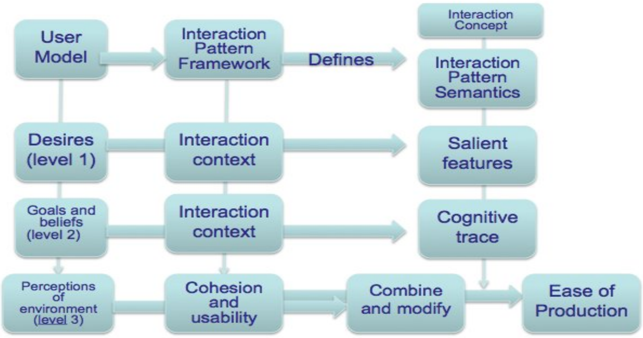

Fig. 1. Generation of patterns from user model

Table 1. Pattern Language for Searching

Semantics	**Pattern**	**External representation used**	**Representation in real life narrative**	**Temporal and spatial constraining**	**Graphical constraints**
Salient features	Search enquiry	Circle for encompassing and zoom for detail	Context relevant to the theme	Refinement of search over time	Relevant visual input and feedback
Cognitive Trace	Search enquiry	Focus search around icons	Stories of individual experiences	Stories linked to theme not time	Use of links to guide search
Combine and modify	Search refine	Provide visual cues for authority level	Provide a memory/cache	Select common themes over time	Depth of links shown as a tree
Ease of Production	Search enquiry	Relate to community projects	Placing story within a narrative	Highlight items	Visual cues for record and upload

7 Conclusion

Indigenous community organisations and government employees, who expressed a need for such an information coordination service, formed the initiative for the portal development. In particular, people noted the lack of clarity of government in reporting on Indigenous affairs, which limits accountability. They feel disempowered by their lack of understanding in how to deal with policy or apply for funding under programmes, and how their lack of IT skills exacerbates these problems.

Furthermore, government employees are required to regularly present reports on progress under existing policy or programmes. These reports may carry across a variety of mainstream government departments or cover many communities. There is a need for the documentation from these communities to be more easily collated, for example to explain difference in program implementation.

Our initial focus was on community users, as this is where the more informative contributions will come as annotations if the users find the site useful, informative and engaging. In particular the provision of related information in many media formats in a single interface assists knowledge sharing and comprehension.

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Design and Evaluation of Collaborative Learning Management System (CLMS) Framework for Teaching Technical Subject

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Abstract. This paper discuss the design and usability testing of a proposed Collaborative Learning Management System (CLMS) framework for technical subject teaching. The design and development of the system are based on ADDIE model. The web based learning platform was assembled using an Open Source Learning Management System (LMS). Sixty five student teachers in Bachelor of Teaching and Design Technology programme participated in the study. The results show that the system is usable to assist collaborative learning activities for teaching technical subject, support classroom learning, support communication with peers and instructors, increases motivation to discuss course work, coordinates learning materials and able to recall prior knowledge. Technical (Distributed Denial of Service attack (DDoS attack)), low graphic editing skill and netiqutte issues were encountered during the usability testing.

Keywords: Learning Management System, Computer-Supported Collaborative Learning, Technical Subject Teaching, Rasch Model Measurement, Usability testing.

1 Introduction

Web 2.0 applications have been adopted by many educators as their online teaching platform. YouTube, Wikipedia, Twitter, Craigslist, Wordpress, Flickr and Blogs are amongst the most popular Web 2.0 user generated content applications used [1]. Is it possible to adapt the Web 2.0 feature to the existing Learning Management System (LMS)? User generated content applications enable students to generate new content by adding new entries, commenting on entries, uploading multimedia postings and sharing of digital resources. The current phenomena trails back to the cooperative learning strategy whereby students works together to achieve learning objectives. This strategy enhances collaborative effort [2], develops creative and critical thinking skill [3], develops knowledge and meaningful learning, reflection and gives an impact as an educational transformation [4].

Designing a Collaborative Learning Management System (CLMS) framework for technical subject may require specific pedagogical approaches. Practical oriented subject demands a learner to develop manual dexterity in accomplishing spesific task

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with the help of online resources, tutor guidance, peer contribution and other learning methods as well as being familiar with the use of materials and machines in the laboratory [7]. In practical experience training courses, students put theory into practice and learn by solving typical problems encountered in real environments [8]. Technical subject also requires the students to innovate and create new ideas as a product of their learning outcome [9]. Emphasising on product innovation, new product creation and technical skills process acquisition becomes the major focus of learning outcomes in technical subject learning. Planning an eLearning programme for academic subjects or skills-based subjects will need to consider the learner needs [10]. Considering these demands and the current trends of Web 2.0, educational designers and teachers may have to meet the challenge to redesign learning so as to include online monitoring and collaborative engagement.

This paper is structured as follows: The next section explains the basic concept in designing a Collaborative Learning Management System (CLMS) framework based on instructional design model, pedagogical approaches and eLearning models. Section 3 describes the usability testing of the proposed Collaborative Learning Management System (CLMS). Section 4 presents the findings. As to conclude, section 5 discuss the findings and problem faced during the usability testing of the system.

2 Designing a Collaborative Learning Framework

This section will discuss the Instructional Design (ID) model for learning design, theories related to CLMS for teaching technical subject and adapting Collaborative Learning Framework into Learning Management System.

2.1 Instructional Design (ID) Model for Learning Design

Instructional design model ADDIE has been used as the basis of many frameworks for computer supported learning design. ADDIE stands for Analysing user needs, Design, Development, Implementation and Evaluation. Some designers may often be tempted to start with content but it is recommended to consider the target audience first [24]. Visioning the needs of the teacher and the learners in the initial phase will make students centered learning possible [11]. A suitable instructional design for learners, teachers and their online educational needs might be further divided into subgroups with their specific needs [24]. A well-designed learning material or learning objects [12] and appropriate technical platform will help avoid problems later [10]. A simple framework for an eLearning programme proposed by [10] involve analysing the learners and programme content; designing; development; pilot testing and implementation of the programme. The following paragraph describes the development and implementation phases of the proposed framework.

Analysis Phase: In this phase, students and the course instructors' needs were identified; demonstration was found to be the main teaching method used [8]. Main learning strategies used include cooperative work for practical training, group assessment and report writing. Tools such as computers, digital cameras and handphones are also used in the learners' daily tasks for project documentation. It was observed that the internet connection are stable but certain sites were blocked by the system administrator.

Design and Development Phase: These two stages were combined to suit the iterative design-development method. Three parallel components were designed i.e Pedagogical component, Collaborative component and Management component. The CLMS support component was added later based on the user requirements feedback received during the usability testing. Pedagogical component consists of the course content, technical training procedures, machine use, safety, project planning, costing, digital resources, collaborative activities instructions and innovation criteria. The management component consists of user administration, security, task management and content management tools. The collaborative component includes the communication and collaborative tools such as Blog, message and email. The CLMS prototype was assembled based on the Food Management and Technology training course syllabus. One topic was selected to be the learning content. The instructional design and system development phases were developed iteratively to ensure pedagogical elements were well adjusted in the system. Laboratory observation and discussion with the course instructor were held regularly as part of the system developmental process.

Implementation Phases: The system was demonstrated to the students before the actual usibility testing was conducted. During this stage, feedback from the users were gathered for future improvement of the system.

Evaluation Phase: The usability testing was conducted after the students had completed their collaborative learning activities. Fig. 1 shows the proposed CLMS framework based on ADDIE model.

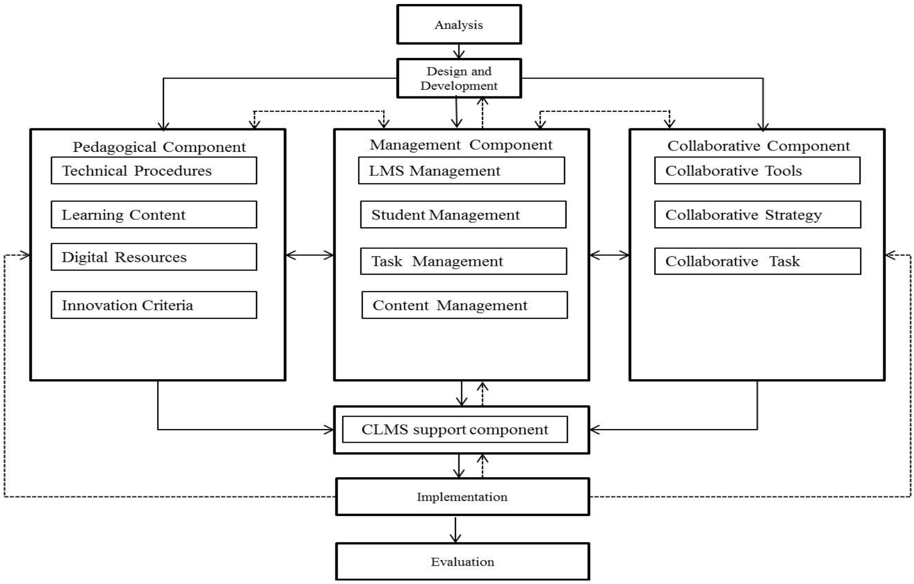

Fig. 1. The proposed Collaborative Learning Management System (CLMS) Framework based on ADDIE model

2.2 Theories Related to CLMS for Teaching Technical Subject

Technical and vocational subject teaching focuses on the development of cognitive and psikomotor skills and uses demonstration as the main teaching method. The student observe his teacher performing a task, then he/she will be supervised to perform the same task until he/she masters the skill [7]. Demonstration of how to operate a machine or a hand tools can be captured using a digital camera to assist the learner for skill refinement later on. The learner can observe the documented procedures repeatedly until he can perform the task successfully. This process is seen as a change from instructivist to constructivist pedagogical approach. A constructivist perspective views learners as actively engaged in making meaning, whereby students can analyse, investigate, collaborate, share, build and generate based on what they already know, rather than what facts, skills, and processes they can parrot. Teachers will continually adjust their actions to engage students in learning, using constructivism as a referent [13]. Social constructivism approach employed during the online collaborative session with friends and teachers help refine the skills learned and promotes construction of the learners' own meaningful learning in the subject area. Computer Supported Collaborative Learning (CSCL) field provides many guidelines for collaborative work for educational purposes. The essential aspects in any collaborative learning application are collaboration, communication, coordination and awareness [5]. CSCL is concerned with meaning and the practices of meaning making in the context of joint activity, and the ways these practices are mediated through designed artefact [6].

2.3 Adapting Collaborative Learning Framework into Learning Management System

The CLMS design integrates both static and dynamic web pages. Static web pages are based on HTML codes and contents are updated by web developer. Dynamic web pages allow constant changes and are written in PHP, ASP or JSP codes. These pages contain "server-side" code which allows the server to generate unique content each time the page is loaded [14][15]. We used reusable open source software to design and develop the website. Reuse software are based on generic programming (GP) which has emerged over the last years to facilitate the possibility of reusing tried and tested parts of a software product rather than developing them from scratch. Generic programming attempts to make software as general as possible without losing efficiency [5]. Engineers have brought together design and implementation reuse application frameworks; these can be considered as the skeleton of an application that can be customized by the application developer. However, components must be easy to connect with each other to make a new system that is customisable and efficient [16].

This study assembled open source software for LMS, called Modular Object Oriented Dynamic Learning Environment (MOODLE). MOODLE application [13] is constantly upgraded to a better version by the GNU community. Well-known commercial LMSs are WebCT, Blackboard and FirstClass OLAT [8]. MOODLE application was selected due to its strong online technical forum support for independent web instructional designer, economical factor and suitability to the iterative design-development method used in the proposed framework. MOODLE also provides collaborative tool or Blog for collaborative work which resembles social networking application in Web 2.0. In MOODLE, students activities are monitored automatically. Other features of an eLearning systems are course materials, discussion boards, mails systems, chat, contents management, artefact sharing [6], communication and collaborative tools [3][8][20][21]. The combination of these features enables a teacher to monitor the students learning outside the classroom. Our research focuses on online collaborative work whereby exchanging of knowledge, information and learning resources are carried out while working together. The students also give feedback, engage in structured discussion, examine and reviewing peers work in order to reach a common objectives of building new knowledge of their course content. This also implies sharing of background knowledge, mixing heterogeneous disciplines, reciprocal transferring of experience, mutual enrichments, thinking and working with others [22].

3 Usability Testing

A usability test intends to observe the user interface usefulness from the users' perspective [23], effectiveness, efficiency and satisfaction in a specified context of use and in a condition that involves a user doing something with a product or a system [25]. The test on the CLMS prototype, named *eKolaborasi* (http://cendekiawan.net/ekolaborasi) was conducted at the end of development phase of the system development life cycle (SDLC). The test was separated into four stages with four different groups of users. Problems encountered during each stage were identified and solved before the next stage. Three tasks were assigned to the groups. The first and second tasks were completed immediately during the test. The third task was assigned after the students had completed their laboratory work and progress with the online collaborative activities in the system. The usability of the system were tested after the completion of collaborative activities between the instructors and students. Approximately four weeks were given to three groups (G2, G3, and G4) to complete the third task.

3.1 Test Design

Four groups of student teachers from Bachelor of Teaching with Honours (Design and Technology in Primary Education) program participated in the usability testing. The first group (G1) consists of 17 students (N=17), second group (G2) consists of 16 students (N=16), the third group (G3) consists of 14 students (N=14) and the fourth group (G4) consists of 18 students (N=18). Overall participants N=65.

3.2 The Task and Instruments

The first task requires the students to enrol in their assigned course by registering themselves and explore all menus and web pages of the *eKolaborasi* system. Once in the system, the students will be able to view the course site and participates in the course's blog. They were given a personal page as their blogging space. The second task requires the students to collaborate among themselves by sharing learning resources and ideas. They were required to add new entries and follow the collaborative instructions provided. A checklist was used as the guideline and the time of completion of both tasks were recorded. The third task is to answer a survey on the overall usability of the system.

4 Evaluation Results

4.1 Task 1 and 2

Only 58 users (N=58) were able to complete tasks 1 and 2. The average mean time for all the groups to complete tasks 1 and 2 is 25 minutes. Due to internet connectivity problems encountered during the test on the first group (N=17) only 10 users from the group managed to finish task 1 and 2, thus the third task data from the first group (G1) was not available and only the time was recorded. Table 1 shows the summary of task completed in the test.

Table 1. Number of users completed the test and time recorded

Test group	Number of users (N=65)	Number completed Task1 and 2	Per cent completed Task1and 2	Task 1 and 2 Time (Mean)	Number completed Task 3
G1	17	10	58.8	35 minutes	0
G2	16	16	100	30 minutes	16
G3	14	14	100	15 minutes	14
G4	18	18	100	20 minutes	18
Total	65	58	89.2	25 minutes	48

4.2 Task 3

A total of 48 users (N=48) from G2, G3 and G4 groups managed to complete task 3. They are 27 male students (56.2%) and 21 female students (43.7%) aged between 22 to 23 years old. Forty seven participants (97.9%) own Facebook accounts but only 12 (25%) own Blog accounts. One participant do not own either a Blog or a Facebook account. Table 2 shows the daily internet usage among the participants .

Table 2. Participants' daily internet usage

Usage	Number of participants	Percentage
1 to 5 hours	41	85.4
6 to 10 hours	6	12.5
More than 11 hours	1	2.0

In the third task the students were requested to rate the usability of the system based on their experience while using the system using a rating scale of between 1 to 5 (1-strongly disagree, 2-disagree, 3-almost disagree, 4-agree and 5-strongly agree). The questionnaire items adapted from [29][30] consists of 11 items as shown in Table 3. Findings indicate an agreement (overall mean=4.05) of the system usability as a tool for collaborative activities of technical subject teaching and learning.

Table 3. The usability questionnaire items

Items	Mean	Standard deviation
u08_The system supports classroom learning	4.13	0.55
u10_The system supports communication with peers and instructors	4.20	0.68
u09_The system increases motivation to discuss course work	4.18	0.49
u07_The system coordinates learning materials	4.10	0.55
u06_The learning content enables recalling prior knowledge	4.08	0.49
u11_The system is suitable for on-line collaborative learning activities	4.06	0.59
u01_The system is easy to use	3.93	0.63
u04_The menu layout is understandable	3.84	0.54
u03_The task are easy to execute	3.83	0.55
u02_The site pages are easy to navigate	3.79	0.74
u05_The interfaces have enough graphic, well coloured and animated	3.79	0.58

The data were also analysed using Rasch Model Measurement. Rasch Model is based on two requirements [26]. The first is that of unidimensionality [27] meaning that the person's ability and item difficulty will be meaningful only if each and every question contributes to measure of a single attribute. The second requirement is of local independence. The local independence is attained when relationship between responses is non-existent. Fig. 2 shows that the person reliability is .86, indicating good spread of person perception [28]. This means that person perception differs and the instruments are reliable to separate the person perception apart. The measurement for item or reliability is slightly lower at .83, which means that the items are well understood and sufficient to be measured. The reliability of item difficulty estimates on a 0 to 1 scale, is similar to Cronbach's Alpha [27].

```
NPUT: 48 Persons  21 Items  MEASURED: 48 Persons  11 Items  5 CATS        3.68.2
--------------------------------------------------------------------------------

     SUMMARY OF 48 MEASURED Persons
-------------------------------------------------------------------------------
|          RAW                             MODEL         INFIT        OUTFIT    |
|          SCORE      COUNT     MEASURE    ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-------------------------------------------------------------------------------|
| MEAN      85.7      21.0        2.66      .44       1.02    -.1   1.01    -.1 |
| S.D.       7.0        .1        1.31      .04        .56    1.7    .58    1.7 |
| MAX.     102.0      21.0        6.31      .65       2.91    3.8   2.73    3.5 |
| MIN.      61.0      20.0        -.80      .30        .21   -3.1    .19   -3.3 |
|-------------------------------------------------------------------------------|
| REAL RMSE    .49  ADJ.SD    1.21  SEPARATION  2.48  Person RELIABILITY  .86 |
|MODEL RMSE    .44  ADJ.SD    1.23  SEPARATION  2.78  Person RELIABILITY  .89 |
| S.E. OF Person MEAN = .19                                                     |
-------------------------------------------------------------------------------
          VALID RESPONSES:  99.9%
Person RAW SCORE-TO-MEASURE CORRELATION = .98 (approximate due to missing data)
CRONBACH ALPHA (KR-20) Person RAW SCORE RELIABILITY = 1.00
(approximate due to missing data)

     SUMMARY OF 11 MEASURED Items
-------------------------------------------------------------------------------
|          RAW                             MODEL         INFIT        OUTFIT    |
|          SCORE      COUNT     MEASURE    ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-------------------------------------------------------------------------------|
| MEAN     192.6      47.9         .28      .29        .92    -.3    .92    -.3 |
| S.D.       8.2        .3         .70      .01        .19     .9    .19     .9 |
| MAX.     209.0      48.0        1.10      .30       1.18     .8   1.22    1.0 |
| MIN.     183.0      47.0       -1.12      .27        .46   -2.7    .45   -2.7 |
|-------------------------------------------------------------------------------|
| REAL RMSE    .29  ADJ.SD     .64  SEPARATION  2.18  Item   RELIABILITY  .83 |
|MODEL RMSE    .29  ADJ.SD     .64  SEPARATION  2.23  Item   RELIABILITY  .83 |
| S.E. OF Item MEAN = .22                                                       |
-------------------------------------------------------------------------------
```

Fig. 2. Questionnaire Items and Person reliability analysis result using Rasch Model summary statistic

Fig. 3 shows the result of students responses (as the system user) which was tabulated in WinSTEPS software. The Person-Item Distribution Map (PIDM) shows the correlation between person and the questionnaires item labelled on the same linear scale called *logit* plotted on the map. Codes and item were labelled accordingly. The person reliability is plotted on the left and the item reliability is plotted on the right. Lower left represents the least satisfied user of the system meanwhile the upper right represents the most satisfied user. Lower right area represents the easiest item to agree while the upper right area represents the most difficult item to agree.

Interesting findings from PIDM shows that the least satisfied user (1520) whom uses the Internet 15 hours a day only agree on the system function as a support to learning. The most satisfied user is participant labelled (427). The most difficult item to agree as usable were u02_navigation, u03_task, u04_menu and u05_ interface design. Other items were agreed as usable by all users were u01_ease of use, u06_prior knowledge, u07 media, u09 aesthetic, u11 usable and u10 collaborative tool. All participants agree that the system support their learning (u08_ support learning).

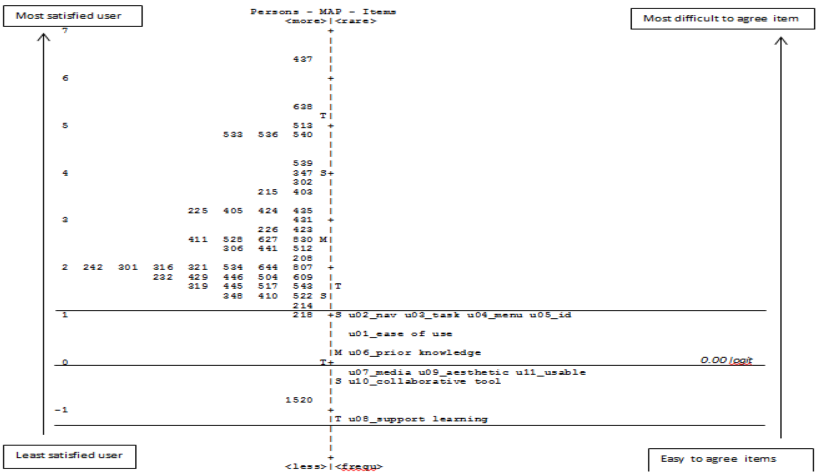

Fig. 3. A Person-Item Distribution Map (PIDM)

5 Discussion and Conclusion

Results from the findings show that the proposed CLMS supports technical subject learning. The navigation, menus and interface design would be more effective with customised items instead of the standard features provided by the software. Three main issues were encountered during the usability test. The first issue is the Distributed Denial of Service attack (DDoS attack) encountered during the first stage of the usability testing involving group 1 (G1). The connection to the hosting server was interrupted just after the students log in to the system. This problem occurred due to multiple user attempts to upload, download or edit a web page that causes the server to deny service and hold a connection time out [17]. The dynamic web pages design on the online collaborative work may have contributed to the problem. This problem had demotivated the participants (G1) from continuing with the usability questionnaires.

The second issue was large picture size shared by students in their discussion Blog. The picture size had caused slow access to the digital materials for the purpose of peers and instructors evaluation of the students practical sessions work. Therefore graphic must be edited, saved into smaller file sizes and formatted into the recommended extension such as .png or .jpeg prior to the uploading process. Netiquette [11] is the third issue encountered. Short forms, informal language and symbols used during discussion in the Blog could hardly be understood by the teachers. Formal language is highly encouraged in the online collaborative learning environment since the platform is shared among students and teachers. A standard language should be endorsed as it is understood by all participants in the online learning community. It is practical to include a netiquette guidelines as part of collaborative learning instruction.

In conclusion, training the required collaborative skill to learners is a difficult task [8] which should be taught before any online collaborative initiatives is pursued [18]. An educator may need to observe closely the classroom or laboratory routine in the preliminary analysis stage as to map the actual collaborative activities process being conducted. These observation may reduce some outstanding issues faced during the actual online collaborative initiative. Selecting a collaborative platform for learning varies depending on learners and educational needs, technical expertise and cost related issues. There is “no one size fit all” solution for an eLearning application and there will never be [24]. Understanding the overall process of technical, costing, administrative, educators and learners needs are the basis for any web based learning initiatives.

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A "Milky Way Research Trend" System for Survey of Scientific Literature

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Abstract. Research trend survey is an essential preliminary step for any academic researches, but many beginning researchers have difficulty because they are still foreign to appropriate keywords in his/her research field. We constructed a support system for research trend surveys not only to accelerate the preliminary step but also to let students have a better grips of trend progresses and keyword transitions. Our system assumes a fair amount of data accumulation, for which we employed KAKEN database excerpts, but does not assume manual keyword registration or any other heuristic preprocesses: with an associative search module, it dynamically searches relevant words that are frequently used in the targeted academic field and gives users effective visualizations to understand trend transitions. Preliminary evaluations suggest that the trend transitions that our system presents are effective for trend surveys.

Keywords: Research trend, Searching engine, Data mining, Learning analysis, Scientific literature, Discovery learning.

1 Introduction

With the development of the technology, the longevity of paper literature has become very short. We are constantly required to update our skills and knowledge in order to keep up with technological advancements and meet the needs of scientific research Therefore, it is essential to conduct surveys to have a wide and deep understanding of related research.

Especially for those students who are just beginning to engage in academic research, doing a academic research survey will help them collect the information needed, and guide their planning phases of their projects.

This paper targets on students who are just beginning to engage in research. In order to help students complete a scientific literature survey, with data-mining technologies, using the data of KAKEN [1] (Grant-in-Aid for Scientific Research of Japan), we propose create a search engine to help students to do a scientific research survey.

In 1775, Samuel Johnson said: Knowledge is of two kinds, we know a subject ourselves, or we know where we can find information upon it [2]. This search engine suggests students where to look for solutions to practical problems. At the same time,

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our system proposes to enable the students to master some of the basic concepts andmethods of scientific literature survey during the process of document retrieval. Students can master research trends through the retrieval results and its analysis.

This research is advocated by pedagogical theories such as discovery learning. Discovery learning is an inquiry-based, constructivist learning theory that takes place in problem solving situations where the learner draws on his or her own past experience and existing knowledge to discover facts and relationships and new truths to be learned. Students interact with the world by exploring and manipulating objects, wrestling with questions and controversies, or performing experiments [3].

Bruner suggested that students are more likely to remember concepts if they discover them on their own. This search engine realizes discovery learning and help students learning by themselves. Utilizing this search engine, students can carry out some relevant scientific literature surveys, which broadens their sources of knowledge, and improves their self-learning ability. The role of the instructors is changed from givers of information to facilitating student learning.

2 Related Works

Previous studies have used content analysis method to identify research trends in e-learning field [4]: Based on the methodology of content analysis, the research topics were first categorized into several tentative categories and sub-categories, and refined manually and continually by using constant-comparative method. By employing scientific papers (abstracts and information) from the five major educational SSCI journals, all those articles are then coded manually to different types of categories referring to its abstract. In addition, highly cited papers are further selected to analyze their research participants, research setting, research design and methods.

Moreover, some researchers used bibliometric methodology to analyze the trends and forecasts in different domains, such as e-commerce, supply chain management and knowledge management [5,6,7]. Using a bibliometric approach, Tsai and Yang analyzed data mining and CRM research trends from 1989 to 2009 by locating headings "data mining" and "customer relationship management" or "CRM" in topics in the SSCI database[8]. Especially, it used categories such as publication year, citation, country/territory, document types and the like to explore the differences in the two fields.

As mentioned above, these researches require a lot of time to carry out a relevant scientific literature survey. According to statistics, it often costs one-third of the entire time to consult the scientific literature survey in the research process. Doing a research survey is essential, especially for the students who are just beginning to engage in research.

This search engine provides students with a literature survey tool, which not only shows the retrieval results, but also the analysis. Our system does not assume manual keyword registration or any other heuristic preprocesses: with an associative search module, it dynamically searches relevant words that are frequently used in the targeted academic field and gives users effective visualizations to understand trend transitions. This search engine provides a new method to visualize the research trends as "bundles of keywords". We refer to the bundles as "trend milky way".

3 Categories of Published Scientific Literature

A scientific literature survey is a document retrieval method which focuses on literature. It is indispensable for students to master an effective method to carry out a literature survey.

There are many kinds of published literature, such as books, journals, proceedings, sci-tech report. There is some other literature we have not described in this paper such as patent literature. The characteristics of the published literature are as follows (Table 1):

Table 1. Comparison of published literature

	Latest progress	Detailed Data	Publish speed
Books	×	×	Slow
Journals	△	○	Fast
Proceedings	○	×	Very fast
Sci-Tech Report	○	○	Very fast

1. Books: Poor time is the problem of with books, it needs a longer period to write and publish. Therefore, books are not suitable to keep up to date with the latest progress. Books are suitable to obtain a general knowledge of a specialized domain, to master the basic content of a specialized problem or method in a short time, to obtain a preliminary understanding of the unfamiliar problem.

2. Journals: Journals focus on a specific discipline or field of study. Journals have characteristics like: 1) strong content innovation, 2) speed report, 3) large amount of information, and 4) it can timely reflect domestic/international science and technology. Therefore, journals are basic form of scientific information transmission and exchanging the academic. Journals are suitable to keep up to date with the latest progress or provide a deep understanding of a specialized field.

3. Proceedings: Generally, conference proceedings have strong academic literature, and it represents the latest achievement in a specialized field. Most of the proceedings are only presented by the results and it is not an inconvenience for knowing specific information. They are suitable to keep up to date with the latest progress.

4. Sci-Tech Report: Sci-Tech Report refers to the government or research departments announced on the official report of research results or actual record of progress during the study phase. The Sci-Tech Report is usually about one year earlier than the journal. It has reported that the original information and results, and had detailed and reliable data. It is suitable to keep up to date with the latest progress. It reflects the National and International trends and technology level.

In this paper, the Sci-Tech Report (The report of KAKEN) is selected as a data recourse, as it suitable to keep up to date with the latest progress and it has detailed and reliable data.

4 Data-Processing

There are three necessary steps for developing a search engine. They are: accumulate data, search algorithm, and provide information. We develop our search engine following these three steps.

$$Search\ Engine = Accumulated\ Data + Search\ Algorithm + Information\ Provide$$

The present paper describes a search engine for project documents by Japanese university researchers. As of May 23 2011, there 74,929 projects are registered in the "KAKEN" database. University researchers can apply their project to obtain research fund from the ministry of education, science and culture of Japanese government. If a proposal is accepted, the researcher can obtain a fund for 2–5 years, depending on their proposal. Those projects are kept in "Kaken" database and are publicly available on the Web. The titles of the projects are listed at the beginning of the project. Progress reports and final reports are shown as short outlines. Each project document contains the following components.

(a)Identification number of the project
(b)The name of the project
(c)The name, Id and affiliation of the principal researcher
(d) The name, Id and affiliation of project members
(e)Subject Category of the project
(f)Keywords
(g)Duration of the project
(h)Budget of the project
(i)Abstract of the project

As a basis of research trend analysis, we constructed a search engine for those project documents, where keywords are extracted from (b), (g) and (i). If a project lasts for several years, for example 1995--1998, the four keywords "y:1995", "y:1996", "y:1997" and "y:1998" are registered as yearly indices.

We employed GETA to realize a search engine dedicated to our system. Information of keyword occurrence as kept as Term-Document Matrix as shown Fig.1. GETA is an associative retrieval engine, specializing in search tasks. It was developed by the Research and Development Center for Informatics of Association, National Institute of Informatics, Japan [9].

The data processing is formed from the following 3 segments:

(i) Data Collection
(ii) Construction of a Search Engine
(iii) Analysis using the Search Engine

"KAKEN" database provides a function to retrieve the project documents by specifying the query. However, it does not provide any tool for high level analysis of the documents obtained. The system proposed in the present paper, initially collets the project documents from the "KAKEN" database (process i). At the next step, we construct a special search engine for the focused documents that are obtained at the process (i). This search engine provides several functionalities for detailed analysis of research trends that can be observed in the target documents.

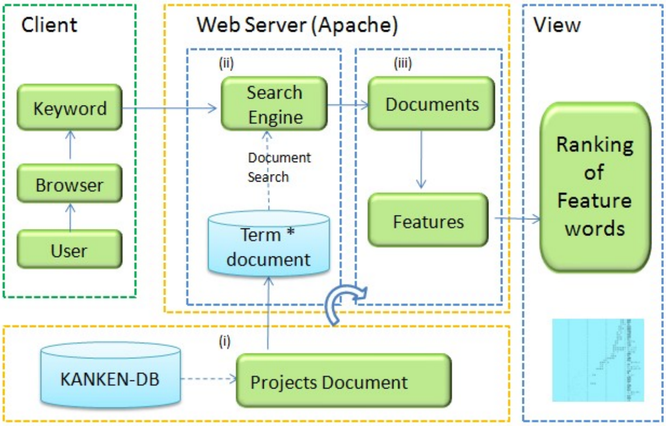

Fig. 1. Search and Feature Extraction

5 The Implementation of the "Trend Milky Way" System

We used Apache as the server and ran it on Linux, and used Perl to develop the "trend milky way" search engine. As shown in Fig. 2, it is the interface of the system. The learner enters the keywords about his research field and searches for it on the system. A list of the search results will be displayed on the page. The "Research Trend Milky Way" system allows you to search either by “Research Field” or by “Time Range” or by “Sort Key”.

5.1 System Description

1) Advanced Setting. Advanced Setting allows you to change the following features categorized as:

Search condition: “Research Field”, “Time Range”, “Sort Key”.

Display Option: “Increase/Decrease Graph”, “OR Search”, “Time Series”, “Left Top->Right Bottom”, “Top ? feature words for each year”, “Total number of results”.

2) Research Field. You can select a research area from the pull-down menu next to the “Research Field”, such as "e-learning", "Text mining". Next to this pull-down menu, there are two time range options. With these two time range options, you can customize the set of time ranges that you view and select from the drop down menu when you search.

3) Sort Key. You can select a sort keyword from the pull-down menu next to the “Sort Key”. There are two sort keywords. One is “weight”, another one is “Frequency”.

4) OR Search. There is a "OR Search" option. OR Search collates the results to retrieve all the unique records containing one term, the other term, or both of them. The more terms or concepts we combine in a search with OR Search, the more results we will retrieve.

5) Time Series. There is a "Time Series" option, when you choose this option. The following will display a time series analysis graphics.

6) Search. Type the research area of your interest in the textbox next to “Research Field” and click Search Button. The “Research Trend Milky Way” System will display a feature keyword list of related research areas. They are the top slice by keywords frequency or weight. The "Research Trend Milky Way" system allows you to search either by “Research Filed” or by “Time Range” or by “Sort Key”.

7) The number of top ranked feature words for each year. This option means how many top ranked feature words are shown for each year. You can select a number form the pull-down menu next to the “The number of top ranked feature words for each year”.

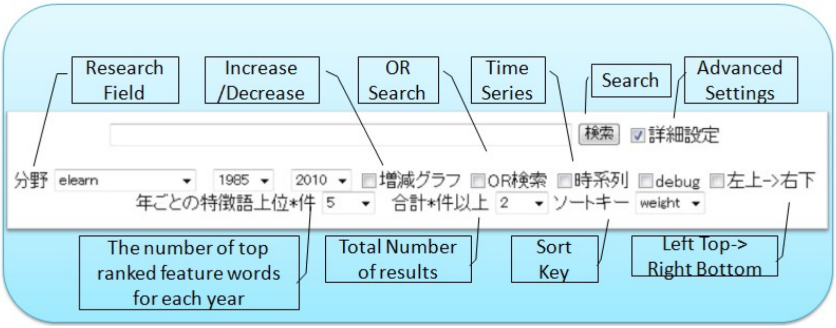

Fig. 2. The interface of “Research Trend Milky Way”

5.2 System Functionalities

Using this system, students can perform trend analysis, automatic extract the outline from literature, and analyze project documents as time-series. This system has the functionalities in the following:

1) Research Trend Milky Way. The Milky Way is drawn as several marks in a plane, where the x-axis designates the year and the y-axis designates a keyword. Imagine that a keyword wj appears as a top-K ranked word in the documents of the year yi. Then a mark "*" is shown at the position (i,j) of the map. Most of the projects last 2 or 3 years, so that the marks appear from left-lower corner to right-upper corner. These occurrences of marks look like a part of the Milky Way. If several projects study the similar subjects, the bundle of keywords that occur in common forms a wider and longer milky way. Two examples are shown in the next proceeding section.

2) Automatic extraction of outline from literature. In order to help students to grasp the outline, problem, method and solution of the literature efficiently, this system provides a method of extracting sentences describing problems automatically from literature abstracts using clue words.

5.3 System Features

There are 3 features of this literature survey system: 1) This system can help learn literature retrieval and analysis of knowledge and methods. 2) This system can help train independent study and build survey literature ability. 3) This system helps students speed up their pace of scientific research and get scientific research achievements early.

6 Analysis by "Research Trend Milky Way"

6.1 Trend of "Educational Engineering"

The first example concerns 2,886 project documents which contain the keyword "Educational Engineering" from 1998 to 2010. Fig. 3 displays the trend analysis with all of these documents. The system provides several control parameters to choose characteristic features. In Fig. 3, we chose only top 3 keywords for each year and excluded infrequent keywords that appear less than 20 project documents. This graph are basically consistent with Watanabe's investigations [10].

We can see several changes of research trends as follows. The keywords that appeared before 2000, such as CAI(Computer Aided Instruction), Personal Computer, MultiMedia, WWW and Internet, do not occur after 2000. New keywords, such as Distance, Distribution, BBS, Web and Learning appear around 2005. These keywords remind the Web-based distance learning. We can see ICT, SNS, Advancement, Accuracy and Verification as the recent keywords.

We can imagine that educational environment was started using computers in early days, and achieved a progress to distance learning with information sharing between students using BBS and Web. The current ICT trend of SNS influences the educational system as well. A guess with the keywords Advancement, Accuracy and Verification would be that many researchers are considering seriously the evaluation of their system for supporting education.

These observations are just the authors' hypothesis and are not confirmed yet if they are true or not, at the moment. To justify these observation, we need to read the project overview and follow related scientific articles by those researchers. However, this process of generating hypothesis and confirmation of the hypothesis is very important process of study in the era of internet and search engine. The authors think that most of students in young generation are studying this way, in some degree. They use search engines before they read books. They have some impression or hypothesis, which might be wrong after all, before they actually learn something. We think this is how they learn by searching.

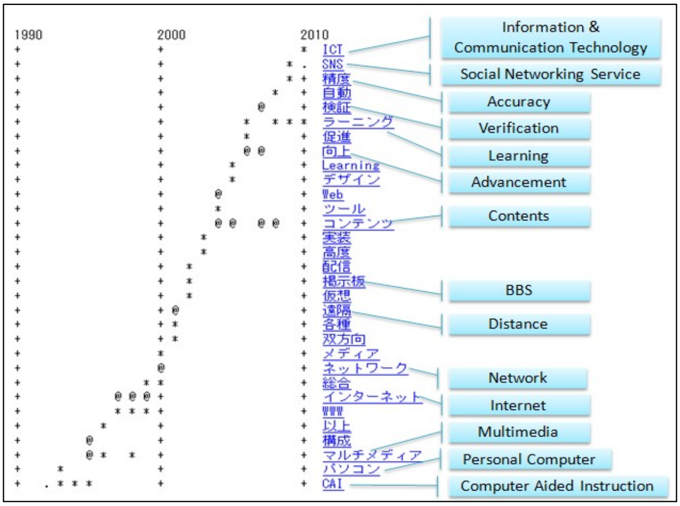

Fig. 3. The interface of "Research Trend Milky Way"[1]

6.2 Trend of "Foreign Language" and "Education"

We constructed another search engine based on 3,034 projects documents that contain "foreign language" and "education". We checked the increase and the decrease of the projects which contain each keyword. It turned out that "English" is among the keywords that increased drastically after 2000. Fig. 4 displays the "trend milky way" of 1,138 documents that contain the keyword "English". This observation is justified by the following information:

Japanese Ministry of Education issued a statement in 2003 regarding the establishment of an action plan to cultivate "Activities in a foreign language [English])" [11].

We can see the words "elementary school", "junior high-school", "listening" and "guidance" as feature words of the documents around 2005. An implication of this may be that communication skill of English in elementary schools are most active research area in foreign language education. This observation is justified by the following information:

In 2008, the Japanese Ministry of Education has determined that English be taught in Japanese elementary schools as part of the obligatory educational system. [12]

These two observations are interesting not only in the fact themselves but in the sense that research trends have been greatly influenced by the policies of the government.

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[1] *The horizontal axis represents years and a list of feature words was shown in the vertical axis. The area was divided by vertical lines which were drawn perpendicular to each other like '＋', these lines represents the years 1980,1990,2000,2010; "@" means that of a frequency greater than 50 times; "*" means that of a frequency greater than 10 times, and less than 50 times;"." means that of a frequency greater than 1 time, and less than 10 times.*

We constructed another search engine based on 3,034 projects documents that contain "foreign language" and "education". We checked the increase and the decrease of the projects which contain each keyword. It turned out that "English" is among the keywords that increased drastically after 2000. Figure 6 displays the "trend milky way" of 1,138 documents that contain the keyword "English". This observation is justified by the following information:

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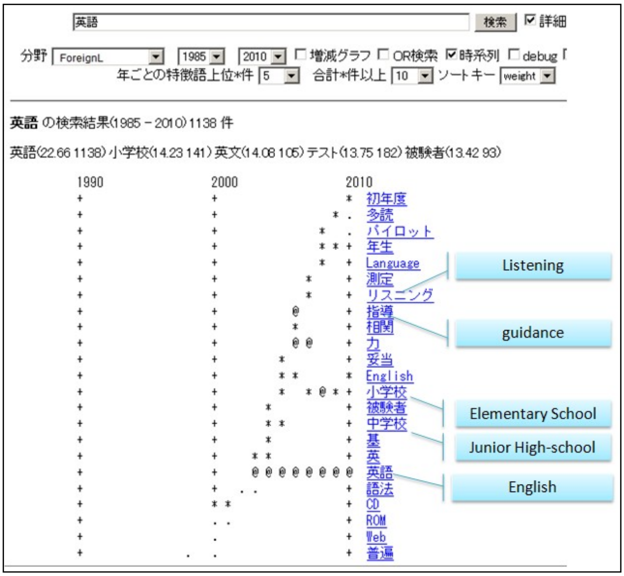

Fig. 4. Trend Milky Way of "Foreign Language Learning"

7 Conclusion and Future Works

For the students who are just beginning to engage in research, it is essential for the students to carry out a academic literature survey. In this paper, we propose a system for a research trend survey of scientific literature. With this system, students can perform trend analysis, automatically extract the outline from literature, and analyze project documents as time-series.

We also give some examples to illustrate how effective the system is. We use this system to analyze the trends in the field of "Educational Engineering" and "Foreign Language". Some interesting observations are found such as "research trends have been greatly influenced by the policies of the government".

This is just a prototype system. In the future, we are planning to improve our system to help trend analysis more easily. We plan to analyze other research areas such as data mining, search engines, and then evaluate the results of the analysis by experts/ professors.

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A Personalized Quiz Game Based on Multi-Agent System

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Abstract. The intelligent agent based systems have existed for many years, only recently its surge of mainstream popularity motivated researchers to acknowledge its educational value. With the increasing usage of educational games, using intelligent agents in the game to provide reliable personalized services has become more critical. Quiz game is a game genre which is easy to develop and doesn't have limitation to any subject and user group. Multi-agent based system is flexible and can save resource. This research designs a quiz game based on multi-agent architecture, the game is therefore so-called multi-agent based Quiz-MASter. Beside the quiz game, this paper also presents a framework of personalized assessment game. With the Quiz-MASter and the framework, the instructors can aware of students' playing status and experiences while the students playing the game and don't feel that they are taking exam/quiz at all.

Keywords: Multi-Agent Ssystem, Assessment game, Personalized Assessment.

1 Introduction

Game based learning(GBL), which is a popular and potential learning method in e-learning. And there are more and more research issues have been proposed. Just like edutainment and serious games introduced a new important marketing direction to practical technologies such as agent technology, human-computer interaction, multimedia interaction and ubiquitous computing. This exciting outcome also pointed out the educational potential using computer games or video games. Several commercially succeeded games, although not intentionally designed, have interesting learning, socializing, and interacting strategies embedded in the games. In game based

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learning scope, how to let students learning with game awareness not learning awareness. This is a very important issues. Like lots of commercial games or online games, it attracts many people into game scenario. If we can design some educational games which motivate students not only in the game but also out of the game. It will helps students learning with more game awareness not learning awareness in educational game.

Agent technology have existed for a long time, but less researches combined with educational values or educational technology. Because we want to develop software that is open, intelligent, and adaptive, and modeling a system as agents gives us a way of establishing flexible boundaries for automated system[16].Hence, we integrate agent technology into game based learning system. In the system, agents have been developed to monitor the use of software by students as captured by the log files, and matching teacher models of learning activities with actual student behavior extracted from log files gives powerful information to teachers. Besides, less researches discussed about personalized feedback by intelligent agent. If we use agent technology to assist e-learning system or other educational system. The students and instructors will get more complete and personalized feedback from agents.

In this paper, our research focuses on developing a Multi-Agent System-based educational assessment game that would help students get familiar with the course contents through friendly competitions. We explore the use of software agents in educational applications, in particular, the use intelligent software agents to provide appropriate feedback and personalized materials to students.

Conceptually, QuizMASter is designed similar to a TV game show, where a small group of contestants compete by answering questions presented by the game show host. Contestants score points by correctly answering questions before their opponents do. The answer given, along with the length of time taken to respond, is transmitted back to host agent. Scores will be tallied, and the feedback on a player's standing will be provided to motivate the player. This is the reason why quiz game show is popular on TV and PC game [11].

In QuizMASter, students naturally take the place of game contestants, however the game-show host has been replaced with an intelligent software agent. By studying the reaction of students to the game, and by altering the feedback provided by the game show host, we hope to determine the degree of success the agent has at motivating the player [11].

In this paper, we will discuss the game and assessment in section 2, and introducing the multi-agent based quiz game in section 3. In section 4, we will describe how the agents work in the game. At last, we will discuss the research issues and make conclusion about the research.

2 Game and Assessment

2.1 Game Genre

Actually, there are too many game genres in current game market. But most of taxonomies can be divided into following categories: (1) Action games (2)Adventure games (3)Fighting games (4) RPG (5) Simulations (6)Sports games

(7)Strategy games[13]. In fact, most of games can't be classified to specific one game genre. For example, the basketball game, it not only belongs to sports game, it also can classify to strategy game too. Because there are many tactical plays based on the defense of competitor. Once the competitors change the defense, you should change your tactical play on the court. Besides, Different games genre may have different learning effects. Hence, there is a research issues about what kind of learning effects do the different game genre have?

2.2 Assessment Methods

In traditional test, due to the technology was not ripe, only paper-based test can used in class. With the progress of technology, more and more learning material can used in computer or other portable devices. Of course, it includes the assessment material. There are lots of assessment methods can use in computer-based test and paper-based test. We just list some of methods below: (1) single choice, (2) multiple choice, (3) order, (4) associate, (5) match, (6) gap match, (7) inline choice, (8) text entry, (9) extend text, and (10) hot text[12].

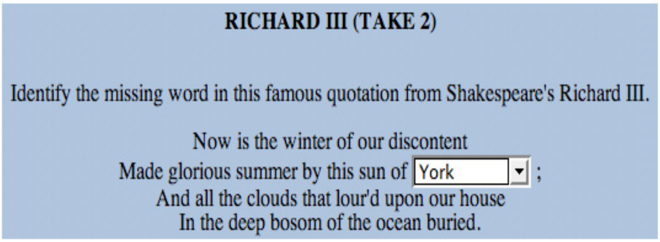

Fig. 1. The example of inline choice [12]

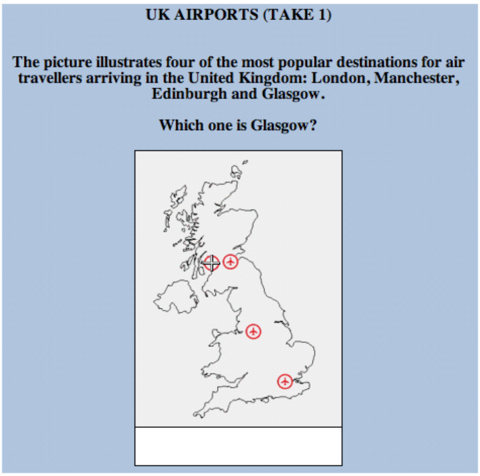

Fig. 2. The example of hot spot [12]

And some graphical-based types are: (1) hot spot (2) select point (3) graphic order (4) graphic associate (5) graphic gap match (6) position object (7) slider (8) drawing (9) upload (10) auxiliary files[12].

In fact, the quiz game can display most of assessment methods which don't need more responded time. With different kinds of methods in quiz game, students have different interaction with host. And it may cause better game playing efficiency.

2.3 Educational Game for Assessment-Quiz-Master

Few people would deny that TV Game shows are popular recently. Since their first appearance in the 40's and 50's, TV game shows have attracted a large and steady audience that among teenagers and older audience [8]. While there are many educational games available, many are targeted to a younger learner. We believe the TV quiz game show format will not only appeal to young leaner but also appeal to older student. The Quiz-MASter game [8] is one of the quiz game show. And our framework design in this paper is following by the idea of Quiz-MASter.

This game is a small group of contestants that compete by answering questions presented by the game show host. And the contestants score points by correctly answering questions before their opponents do. Finally, the contestants who get higher score in the game is the winner. In this kind of competitive game, players are engaged by when their competitors got the points during the game. It will make user concentrate more on the game material due to the competition. Because most of player want to win the game. This is why the quiz game so popular for a long period time. The Quiz-MASter game was designed with the sense of competitive. It will let user have the motivation to win the game and concentrate during the game playing.

2.4 Multi-Agent System (MAS)

To model a system as agents gives us a way of establishing flexible boundaries for automated system [2]. Because we want to develop software that is open, intelligent, and adaptive [3]. Hence, we use multi-agent system as our system tool. Multi-agent system is a system composed of multiple interacting intelligent agents. And using the multi-agent approach can address the issue of scalability by separating reasoning capabilities from other functionality of the system [10]. In the use of e-learning, the agents will be able to communicate with the learner, prompt and store user preferences and to arrive at a reasoning mechanism to relay suitable, interesting, and useful information to the learners[7]. Besides, the MAS are flexible and saving source. Firstly, if you want to revise the service in the system, you don't have to revise for all the system. Only the agent with the service should be revised. Secondly, the agents only work when the system need services from the agent. If the agents don't work, it will be in hibernation. And it helps system to save resource.

3 Multi-Agent Based Personalized Quiz Game

This system architecture is designed to adapt user's learning/game playing behavior during their game play/learning then give the suitable game material/learning material to the user. The system is a multi-agent based which can divide into following six agents and three databases. We will describe each agent and database on following paragraph. The goal of this system is building a framework to build personalized assessment games and maximize the learning performance via collaboration and personalization [5]. The following figure 4 is the conceptual design of system architecture:

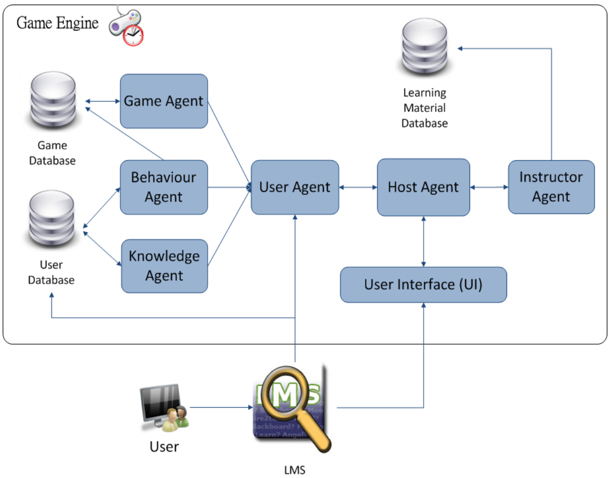

Fig. 3. System architecture of Multi-Agent Game

◆ Agent

1. Host Agent:

   The host agent, just like the host in TV quiz game show. And give user the personalized game content. With the similar knowledge level of competitor, the user can feel the sense of competitive that will let user focus on the quiz game. And its task as below:

   ■ Ask player questions in the quiz game

   ■ Arrange similar knowledge level of competitor into same match

   1. Designated computer player (NPC)
   2. Put human players together

2. Behavior Agent:

   The behavior agent will detect the following information during the game. And send the information to user agent.

   ■ Response time

   ■ Answer that student selected in quiz

   ■ Test score

3. User Agent:

   User agent's task as below:

   - Distribute the appropriate user model to the user[4]
   - Ask and collect the information form following agents
     1. Behavior agent
     2. Knowledge agent
     3. Game agent
   - Send the following information it collect from other agents to host agent
     1. Preference content type
     2. Student level

4. Instructor Agent:

   The instructor agent sends the request from host agent as follow. And also provide the related learning material or other external material that are recommended to students (ex: website, files...)

   - Suitable subject for the user
   - Suitable quiz difficulty for the user
   - Suitable content type for the user

5. Game Agent:

   The game agent respond in following task in the game, then send the information to host agent.

   - Game ranking in the game
   - Game playing history of each user
   - Manage mechanism of rewards and penalties in the quiz game

6. Knowledge Agent:

   The knowledge provides the user's knowledge background from which subject or quiz difficulty have user learn. And analyze knowledge background by user's learning situation that base on which subject has good test performance in the game. Finally, send the those information we mentioned to the host agent.

◆ Database

1. Assessment Material Database

   This database use to store the related assessment material. When the instructor agent receiving the request from host agent. The instructor agent will provide the assessment from database to host agent.

2. Game Database

   This database use to store different game paying information from different user which includes game ranking, game playing history, game reward mechanism.

3. User Database

   This database use to store related user information which personalized game need, such as preference subject, user model

Based on previous system architecture of multi-agent game, we also design a flow of personalized assessment game(see figure 4) which game users have personalozed feedback after playing multi-agent quiz game. The order of personalized assessment game as below:

1. Learner survey
2. User need
3. Questionnaire
4. Game playing
5. Learning activities in LMS
6. Gaming experience/history

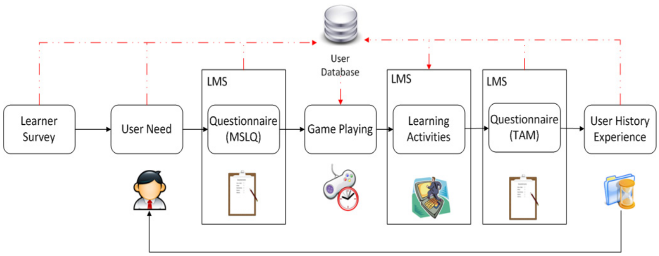

Fig. 4. Flow of Personalized Assessment Game

- Learner survey
This learner survey only take in first time, and it focuses on game attitude, computer attitude, learning experience and learning style. In the beginning of personalized game, we have to know whether the game users are good at game playing or computer operating. And also realize the learning style and learning experience of users. Because the personalized quiz game, we need to know related background from users. Getting more related background from users, more personal feedback give to users.
- User need
In second step, we will ask following questions from user.(1) Which subject or knowledge does the user need or prefer ? (2) Which game content type is user need or prefer ?
In first question, we can realize the knowledge or subject that users are interest in. And integrating the default value and game playing results that will give users more complete feedback.
In second question, we can realize what kinds of game content type are user need or prefer. Because some users are used to read text content, some users are used to read figure content. This is why we asking this questions.
- Questionnaire
In questionnaire step, we use the following questionnaires to user.
(1)TAM (Technology Acceptance Model)
(2)MSLQ (Motivated Strategies for Learning Questionnaire)
Those questionnaires are use to check technology acceptance and motivation from users.
- Game playing
In step, users are going to play multi-agent based game, educational Game for assessment. And the agents will collect game behaviors from user when game playing. Those game behaviors will help agents give more adaptive feedback to users.

- Learning activities in LMS
  In this step, we use some learning activities in LMS, such as forum (asynchronous), chat (synchronous) and shared resources. The learning activities will enhance interactions from student to student and student to instructor. More learning interactions lead better learning efficiency.
- Gaming experience/history
  After game playing, the agent will collect some information from game playing from user, such as which subject/competitor they have played? and the score, game duration during the game. When user playing the personalized game after first playing time, it will give user related personalized game content or game information from previous game playing information. No doubt, more data from user will give himself/herself more accurate feedback.

4 Scenario in Multi-Agent Quiz Game

In this section, we will give a scenario in multi-agent quiz game. Firstly, user Peter login to the LMS, and the LMS will trigger the multi-agent assessment game system. Due to the LMS has the login information of user, LMS will sends the user information to the multi-agent system. The system asks related information from other agents for the user. The detail process of assessment game as below:

1. Host agents asked user agent for related game material about user
2. Since the past game playing history that recorded in database, knowledge agent, behavior agent and game agent will provide game playing history to user agents, such as test history, score history, competitor history.
3. After user agent getting related information from other agents. It analyzes what kinds of quiz should be accessed in this tournament by the user, such as what difficulty? Which subject?
4. The user agent sends the information analyzed by itself to host agent. The host agent transfers those information to instructor agent.
5. The instructor agent provides related game material from database to host agent.
6. Host agent assigns the quiz to user by the material which provided by instructor agent. Host agent also arranges the match which involve similar level of user.

5 Research Issues Discussion

The implement to the integration of multi-agent system and personalized assessment game is our core work in the future. We discuss our future work in the following two parts: multi-agent system and personalized assessment game.

In the aspect of multi-agent systems:

(1) How many agents used in the system is optimal?
(2) How does the agent communicate with other agents in saving resources way?

In the aspect of personalized assessment game:

(1) The mechanism of personalized assessment. Such as how to generate suitable quizzes to the players/learners? How to provide suitable hints to the players/learners?
(2) How many students are suitable in each competition?
(3) How many quizzes in the game are suitable to the student?
(4) How to define a user level and user model in the personalized assessment game?

At last, as pointed out in [9], there is an important issue about game based testing. If students have good performance in the educational game, how do we know the student who is good at game playing or good at game content (subject)?

In the future work, we will focus on those research issues we mentioned before. Our research goal is using multi-agent system to implement personalized assessment game. And the game can provide adaptive subject and adaptive game content style to the user. Besides, system can save resources due to the multi-agent system.

6 Conclusion and Future Work

In this paper, we proposed the framework of personalized Quiz-MASter assessment game and the flow of personalized quiz game. It used intelligent multi-agent system to implement, and included following six agents and three databases: (1) user agent (2)behavior agent (3)knowledge agent (4)host agent (5)instructor agent (6)game agent (7) assessment material database (8)game database (9)user database. Those six agents have their specific service in the system, and only work when the system need. With the services provide by intelligent agent, user can play the personalized assessment game by the flow of personalized quiz game. Actually, the personalized game or adaptive game based learning have become very popular in game based learning and game based testing. Hence, it may be of interest for future research that personalized content type for quiz game and develop a multi-player multi-agent based Quiz-Master. In the future, we will implement those system architecture and focus on the learning/game playing behavior from user. Then analyze those information and give user more personalized and more accurate feedback.

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Development Research on Instructional Design Competencies Testing Scale for Student Teachers

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Abstract. This paper aims to develop the instructional design competencies testing scale development for student teacher. The preparation is divided into two parts scale and revised scale. The research sample is 242 Normal School students, of which 122 liberal arts, and 120 sciences. The results showed that Cronbach α reliability of the scale is.98; correlation of subscale and total scale is .88 to 0.93; and the correlation of total scale and personal teaching efficacy is 0.634**, which indicating the scale satisfies the reliability and validity requirements. This scale contains six dimensions, 36 test items. The testing scale will help the student teachers know their deficiency in the instructional design work. The current technology environment can give them more opportunity to improve those deficiencies.

Keywords: Instructional Design Competencies, Scale Development, Student Teachers.

1 Introduction

The study aims to development a testing scale to measure the student teachers the competencies in instructional design work. Student teachers can take use of it to know their problems in preparation of instruction before they go into the primary or secondary school. Meanwhile, they can learn more skill or strategies about how to design the instruction which they will engage at the support of the current technology.

Lots of domestic and foreign scholars have done lots of research on instructional design, abroad such as Gagne[1], Smith and Reagan[2], Kemp[3]and other scholars who emphasize the use of systems approach into instructional design to specific the process teaching plans. Domestic, such as Wu[4], He[5] and Yang[6] and other professors, they believe the use of systems approach into instructional design of teaching is much more explicit, which includes learners, learning content, learning objectives, teaching methods and teaching strategies, teaching evaluations etc. In this study, combined with domestic and foreign scholars view, we define that instructional

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design competencies is the use of systems analysis methods to complete the teaching problem, determine the learning objectives, analysis learner characteristics, analysis learning content, design teaching activities, organize teaching activities and design teaching evaluation series operation capability required.

Preparation of instructional design competencies is to investigate the current capacity of student teacher, and then analyze problems in order to develop the instructional design competencies. Through literature research, we found that there are still many deficiencies and problems in instructional design of primary and secondary school teachers, mainly in: (1) insufficient attention and weak preparation to teaching objectives (Zhang et.al.[7]; Jiang et.al. [8]; Hong et.al.[9]; Liu et.al.[10]); (2)lack of teaching object analysis competencies (Zhang etc. [7] ; Liu[11]); (3)relatively weak of choosing and using teaching media;(4) teaching strategies are still teacher-centered;(5) teaching evaluation is relatively simple. In addition, we also found that there are differences between groups of teachers in instructional design capability, such as seniority, discipline, etc. (Liu[11]; Yang[12]). Because of long-term content analysis and research, the results of analysis in teaching tasks and assessment performance well. Though those research, we can see that most scholars use a few, self design questions about designing objective analysis, learner analysis, and other issues in instructional design competencies to research the status quo, with little preparation of the contest form to conduct a study table. These investigations are mostly based on different theories, leading differences results. Different findings of research tools are a major cause of disagreement, a lot of survey data is not easy to explain the results of the survey. To this end, the preparation of uniform survey instrument is necessary. Self-report "instructional design competencies test scale" can reflect the level of instructional design competencies in student teacher at a large extent, easily implementation, will help carry out large-scale research. Therefore, the preparation of instructional design competencies test scale has important practical and theoretical significance, not only help to deepen understanding of the relevant theoretical issues, but also provide a tool for the researching of instructional design competencies.

On structure of instructional design capabilities, the United States Education and Communication Technology (AECT) and the International Training Performance Teaching Standards (IBSTPI) are typical examples abroad. AECT (2000) divided instructional design capabilities into: design, development, utilization, management and evaluation of five dimensions. In the same year, IBSTPI (2000) published the third edition of instructional design capabilities standard, they divided design capability into: the basis of professional planning and analysis, design and development, implementation and management of four dimensions.

The two agencies are not exactly the same dimensions in analysis instructional design capabilities but build the foundation dimensions of the composition for us. Chinese scholars made the following analysis, summarized in Table 1.

Table 1. The analysis dimension of instructional design capacity from different researchers

Research-er(Time)	Analysis Dimension	Proposed Process and Limitations
Zhengkun-Qin(2001)	Teaching analytical skills - teaching strategies and design skills choice - teaching practice and control of activities	According to the occur order of teaching and learning activities, experience method
Jinghuan-Zhang etc.(2004)	Teaching task analysis - teaching object analysis - preparation of teaching objectives - teaching methods choose and use - teaching media choose and application - evaluation the results of teaching	According to the occur order of teaching and learning activities, experience method
Yujiang-Wang etc.(2007)	Teaching task and objective analysis - teaching objectives design - teaching strategies choose - teaching media choose - design and evaluation of classroom teaching	According to the occur order of teaching and learning activities, experience method
BingLi-Liu(2007)	Analysis (analysis of learner characteristics and teaching objectives) - Design capacity (design capacity of teaching strategies and learning environment) - evaluation capacity (design capacity of learning assessment and results evaluation)	Delphi method
Yuan-Qi(2009)	Teaching objective analysis skills - learner characteristics analysis skills - teaching evaluation design skills - classroom management design skills - teaching content design skills - teaching methods and teaching strategies design skills	Behavioral event interview
Zhi-ping Liu etc.(2009)	Analytical skills - Design skills - Evaluation skills - Research and Adjust skills	The study suggests that instructional design skills in the mathematics subject contend knowledge and awareness

According to relevant literature, domestic research devises the instructional design though its process has a strong practical significance, reflecting the characteristics of teachers in instructional design. This study divide instructional design competencies into six dimensions, including the analysis of learning objectives, learner analysis, teaching content analysis , learning activities design, teaching organization and teaching evaluation design. The six dimensions of the structural relationship shown in Fig.1., analysis of learning objectives, learner analysis, and content analysis are the foundation; on the basis of these three dimensions we design learning activities, a common target for the completion of the teaching service; according to the laws of teaching we organization teaching with learning activities and tasks; teaching evaluation design throughout the instructional design process. We start writing test questions after determine the latitude.

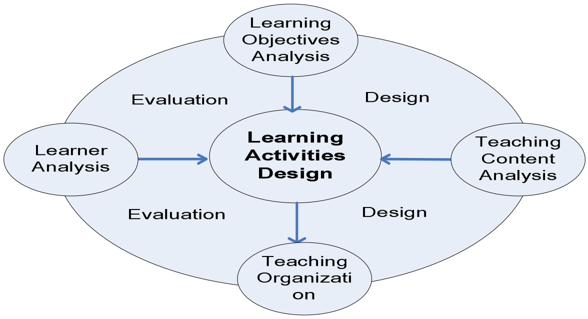

Fig. 1. Structure of Instructional Design Competencies

In addition, this study uses Tao Xin's teaching efficacy scale (1996) to test validity of instructional design competencies. Yu (1999) study shows that, regardless of expert or intern teachers, there has significant correlation between personal teaching efficacy and teaching behavior; expert and intern teachers' personal teaching efficacy dimensions has a strong predictive effect of teaching behavior. Therefore, teachers with high teaching efficacy tend to have better performance than lower teaching efficacy in the teaching process.

2 Method

2.1 Population and Sampling

All subjects in this study were selected by a random sampling method. They are juniors and seniors student teachers who have some teaching experience. The study was divided into two tests, which measured at the beginning of 53 valid questionnaires; official test taking liberal arts and science subjects were 250 people, 242 valid questionnaires, with effective rate of 96.8%, of which 122 Arts, 120 Sciences ; 82 boys and 160 girls.

2.2 Tool

We used Tao Xin's teaching efficacy scale, which internal consistency coefficient α is 0.77, with general education-efficacy subscale internal consistency coefficient α of 0.74, personal teaching efficacy subscale internal consistency coefficient α of 0.84.

2.3 Research Procedures

Firstly, preparation of "instructional design competencies test scale" (draft). Based on Yuan Qi(2009) prepared scale of instructional design competencies, combined with the competencies dimensions, and its detail content to describe the dimensions of comprehensiveness, clarity of expression and other aspects of multiple discuss, we finally formed 70 test items. In the implementation of the test, we increased eight projects for personal background information.

Secondly, small sample tests for the first draft of scale. Take educational technology juniors and seniors student teacher, which paid 60, 53 valid questionnaires. The data on the recovery process through the following: (1) reverse the scores of the reversed item; (2) sum the various subjects on the scale of the total score; (3) sort the total score though high to low; (4) identify high and low groups with more than 27% of the score as the next critical points (270); (5) scale score divided into two groups with the critical points, then use independent samples T test method for testing. Weed out the item independent samples T-test when sig> 0.05, with total deleted of 22 items, we has 48 issues a formal test scale.

Thirdly, in January 2011 to March, we take a large sample testing for official scale. In a formal test, the subjects were asked to complete all items of the scale accordance with the guidance language, and complete teaching efficacy scale.

2.4 Statistics and Data Analysis

This statistical analysis using SPSS 13.0 software for exploratory the structure of instructional design competencies, using LISREL 8.7 statistical software for confirmatory factor analysis.

3 Results

3.1 Testing Item Assume

According to the preliminary test results, we form 48 items for the questionnaire. It used scoring 6 points, option number 1 represents "Totally non compliant", 2 represents "does not meet the basic", 3 represents "half do not meet the", 4 for "half line", 5 for "generally consistent", and 6 for “Totally compliant."

3.2 The Structure of Scale

Explore the Structure of Instructional Design Competencies

Firstly, use exploratory factor analysis after remove the subject of the preliminary test data. Use the KMO test and Bartlett test to test the applicability of factor analysis, the results shown in Table 2. KMO coefficient of the sample adequacy indicator is 0.966, close to 1. It means the data is suitable for factor analysis; correlation between each item of the scale is no big difference. Bartlett spherical test sig value is less than 0.001, means spherical hypothesis is rejected, that is not independent between the questionnaire items, and the value is valid. These two indicators have indicated that scale test data suitable for factor analysis.

Table 2. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.966
Bartlett's Test of Sphericity	Approx. Chi-Square	8879.021
	df	1128
	Sig.	.000

Then using principal component analysis method to extract factors, the results of factor analysis of the total variance shown in Table 3, we can see that six components are greater than 1 as we designed.

Table 3. Total Variance Explained

Component	Initial Eigen values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	24.161	50.336	50.336	24.161	50.336	50.336
2	1.968	4.100	54.436	1.968	4.100	54.436
3	1.569	3.268	57.704	1.569	3.268	57.704
4	1.245	2.593	60.297	1.245	2.593	60.297
5	1.102	2.296	62.593	1.102	2.296	62.593
6	1.058	2.203	64.796	1.058	2.203	64.796

Extraction Method: Principal Component Analysis.

According to the six dimensions of the competencies with the specific content, we give each dimension a name. The naming of various factors including the scale item number is shown in Table 4.

Table 4. Component Named and Item Number Included

Component	Component Named	Item Number Included
ID1	Learning Objectives Analysis	A1, A2, A3, A4, A5, A6
ID2	Learner Analysis	A7, A8, A9, A10, A11, A12
ID3	Teaching Content Analysis	A13, A14, A15, A16, A17, A18
ID4	Learning Activities Design	A19, A20, A21, A22, A23, A24
ID5	Teaching Organization	A25, A26, A27, A28, A29, A30
ID6	Teaching Evaluation Design	A31, A32, A33, A34, A35, A36

Validate the Structural of Instructional Design Competencies

Use the data of formal investigation to validate six dimensions instructional design model whit exploratory factor analysis. The purposes of confirmatory factor analysis are: model validation, testing the six dimensional models that is able to get another sample of data support; model comparison is that compare all items on the scale model of the structure may contain to determine whether the six dimensional models is the optimal model. Though the model generation process generate a total of two competing models, namely first-order model and second-order model which fit indices shown in Table 5.

Table 5. the results of confirmatory factor analysis on Instructional Design Competencies Structure

Model Type	CMIN	*DF*	CMIN/DF	RMSEA	SRMR	NNFI	CFI
First-order model	1133.18	579	1.957	0.063	0.05	0.903	0.911
Second-order model	1133.20	587	1.930	0.062	0.05	0.906	0.912

As can be seen from Table 6, there is no significantly worse on second-order model than the first-order model, based on simple but effective principle, from statistical the second-order model is a better model. Therefore, the second-order model is an ideal structural model of instructional design competencies.

And in this model, there was the correlation between the estimate of item23 and item 24 because the two items have the close meaning in order to try to investigate their skill of teaching methods and strategies.

3.3 The Reliability of Scales

Then carried out on the scale reliability analysis, this study use Cronbach α coefficient to examine the consistency of the scale homogeneity reliability. The results shown in Table 6 total scale α coefficient of 0.98, close to 1, indicating the total scale has good consistency, subscale α coefficient from 0.86 to 0.93, confidence levels are high.

Table 6. the reliability coefficient of Total scale and subscale

	Total	ID1	ID2	ID3	ID4	ID5	ID6
Cronbach α	0.98	0.91	0.86	0.90	0.93	0.90	0.92

3.4 The Validity of Scales

The validity of the questionnaire includes content validity, construct validity and criterion validity. Content validity refers to the scope of the item content or conduct sampling are appropriate. We use the test subject experts to determine the test project and is concerned with the scope of compliance is higher.

In this study, construct validity of the questionnaire were investigated by the relevance of subscale and total scale, results in Table 7, concentrated in the 0.88^{**} - 0.93^{**}, description the high correlation between the subscales and the total scale.

Table 7. Correlation of Total scale and subscale

	ID1	ID2	ID3	ID4	ID5	ID6
Total	0.88^{**}	0.91^{**}	0.92^{**}	0.93^{**}	0.92^{**}	0.90^{**}

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

The results of correlation between each subscale are shown in Table 8, the correlation coefficient in the 0.68^{**}-0.84^{**}, with most around 0.75. By comparison we can see that each correlation of subscale is less than the overall coefficient between the subscales and total scale, we can see six subscales between certain relative independence, but also with representatives of teachers' instructional design competencies level of the total scale scores are highly correlated. Therefore, we can see that the scale has good construct validity.

Table 8. Correlation matrix among subscales

	ID1	ID2	ID3	ID4	ID5	ID6
ID 1						
ID 2	0.78^{**}					
ID 3	0.77^{**}	0.81^{**}				
ID 4	0.79^{**}	0.80^{**}	0.84^{**}			
ID 5	0.75^{**}	0.77^{**}	0.79^{**}	0.84^{**}		
ID 6	0.68^{**}	0.79^{**}	0.77^{**}	0.81^{**}	0.83^{**}	
Total	0.88^{**}	0.91^{**}	0.92^{**}	0.93^{**}	0.92^{**}	0.90^{**}

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

In this study, we use the teachers' teaching efficacy scale for criterion validity of instructional design competencies test scale. Select the total scale and personal teaching efficacy to do correlation analysis, the results shown in Table 9. Though the sig value we can see, the total table and personal teaching efficacy was significantly correlated, with the correlation coefficient of 0.63^{**}, which means the preparation has a high validity correlation with personal teaching efficacy scale.

Table 9. Correlation of Instructional Design Competencies and Teaching Efficacy

	Total scale
Personal teaching efficacy	$.63^{**}$

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

4 Summary

The preparation of this study include of 36 items, six dimensions, including learning objectives analysis, learner analysis, teaching content analysis, learning activities design, teaching organization and teaching evaluation design. The number of test items of the six dimensions was 6. The reliability coefficient of the scale is 0.98; the correlation between subscale and total scale are concentration of 0.88^{**} - 0.93^{**}; and the correlation coefficient of total scale and personal teaching efficacy is 0.63^{**} shows the scale meet the reliability and validity requirements, can be widely used.

As the instructional design competencies is a professional capacity of teachers, so the use of instructional design competencies test scale, subjects were asked to have some basis knowledge for instructional design, so that test items can truly understudied. Student teachers can use it to measure their deficiency in instructional design work and get more knowledge and strategies to design instruction at the support of technology.

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Preliminary Study to the Inquiry Learning Social Network Supported by the Internet of Things

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Abstract. Traditional WebQuest-oriented inquiry learning cannot help students develop good scientific literacy, because students are very dependent on network resources. They cannot obtain reliable evidence, and they also cannot think independently. The result is that they cannot explore science deeply. With the development of the Internet of Things and social network, in this paper, we propose a preliminary model of learning-oriented social network. It targets on inquiry learning and makes use of the Internet of Things. Specifically, in order to accomplish the purpose of inquiry learning by observing the real world, our model adopts advanced technology to uniquely mark research objects, uses wireless sensors to measure the parameters of research objects, and takes advantage of the description and discussion of social network to explore the changes of research objects. At the end of this paper, we come up with the organization pattern and software structure of this kind of social network and also put forward the method of implementing inquiry learning based on this model.

Keywords: Internet of Things, Inquiry learning, Social network.

1 Introduction

Inquiry learning is not only an important way to improve students' scientific literacy and innovative ability, but also one of the main styles of learning carried out by Chinese basic education reform currently [1]. However, through the practices over the past few years, we found that even though there are a lot of demonstration projects about inquiry learning, nearly all the teachers and students are still fail to initiatively view it as a daily habit of study. Instead, they consider it as a tool to implement scientific demonstration research. Obviously, this way of practice cannot develop continuously and obtain optimal results [2]. We think some main reasons are as followed:

1. The style of inquiry learning is too single. Now, WebQuest is the most frequently used method of inquiry learning. Although it is easy to operate and has a wide range of applications, WebQuest weakens students' ability to think independently, simplifies the process of scientific exploration and makes students neglect team spirit.

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2. The objects of inquiry learning are too limited. There are some projects of inquiry learning that require field research, but they are usually limited to a narrow space. Due to students' limited ability and the restriction of technical conditions, projects that need comparative analysis of data in different places or long-time tracking analysis are too difficult to be implemented.

3. The regional differences of inquiry learning are significant. Since inquiry learning requires that teachers are very instructive and schools are very well equipped with better hardware, the implementation of inquiry learning are far from balanced between different places. This furthers the unbalance of education and results in the polarization of education.

Consequently, we want to take advantage of the Internet of Things and the concept of social network to build a new inquiry learning model. Our model allows explorers to better perceive the real world through the technology of the Internet of Things, gets learners from different places to communicate with each other through the social network and fulfills the purpose of exploration by mutual assistance. Since people are driven by the same question, our model helps them to cultivate cooperative spirit. In addition, as the information about explored questions gets richer and the number of users is increasing constantly in this social network, its role in inquiry learning will be more and more obvious.

2 The Model of Inquiry Learning Social Network Supported by the Internet of Things

Social network is currently one of the most popular models of network applications on the internet. Its main idea is to transplant the model of exchanging information of the real world to the internet. It closely interconnects users by taking advantage of the similarity of the content people pay attention to. Consequently it creates a better way of communication and more economic value.

Obviously, during the process of inquiry learning, objects of learners get more unified and the necessity of mutual assistance and communication becomes more obvious. In addition, since regional comparative inquiry learning requires to be implemented in different places, there is a high possibility that participants are unknown to each other, so it is rather difficult and complex to practice offline. However, social network is the right way to solve this problem. Admittedly, applying social network to inquiry leaning is a rather new area, but it has indeed been used in education.

In 2010, Beijing Education Online brought out a student social network named "The home of growing", a network community specifically designed for students in primary and middle schools. It comprehensively records the growing process of students with multi perceptive. For teachers and education administrators, it provides references to assess students comprehensively. At the meanwhile, it supplies them with a convenient way to organize and manage teaching process. For parents, it provides them with valuable references to know their children comprehensively and also a platform to help their children to show themselves. As the number of its users increases, the application effects of this social network deserve positive recognition [3].

In 2011, the IT department of Rajasthan India put forward an educational social network with all the standard features of social network such as games and photos, but it primarily focuses on education cooperation. In this network, there are many experts who will answer users' questions as well [4].

In 2010, many universities in Shanghai began to promote and popularize social network on campus, which is known as "easy class". Integrating with BBS, social network, blog, microblog, E-mail, network disk and applications on the mobile phone, "easy class" is a virtual network community mainly used by college teachers and students, through which we can know current hot news, communicate with our teachers and classmates, upload photos, write blog, exchange all kinds of information and resources of our life and study, and participate various activities on campus. Now, the "easy class" has become a must-network of nearly all the students [5].

As can be seen from the descriptions above, current educational social network doesn't pay much attention to the implementation of education, instead, it views social network as the derivative of interpersonal communication more. It plays a much less noticeable role in spreading knowledge and fostering capability. We consider that this is mainly due to the person-centered essence of social network. For inquiry learning, explored questions, explored objects (the sources of evidence for exploring questions such as a specific plant in exploring the growth of plants), learners and instructors are indivisible factors, so how to let these four factors to make full use of social network and at the same time play their own role respectively become rather important. Therefore, we will make the most of the Internet of things in inquiry learning social network. We will turn the explored objects into virtual human in social network, turn the explored questions into virtual activities in social network software, and consequently integrate the process of inquiry learning and social network organically.

2.1 The Internet of Things

The Internet of Things is a huge network consisted of the internet and all kinds of necessary information such as sound, light, heat, electricity, mechanics, chemistry, biology, location, and so on. Information are collected by real-time acquisition of any objects and processes that needs to be monitored, to be connected or to be interacted with. Acquisition is implemented through various information sensing device and technology like sensors, radio frequency identification (RFID) technology, global positioning systems, infrared sensors, laser scanners and gas sensors. The Internet of Things aims to connect things and things, things and people, things and network, so that it is convenient for us to recognize, manage and control all the items [6]. Technically, the Internet of Things is the sum of all the existing information technology, but in the study of this paper, we mainly utilize radio frequency identification (RFID) technology, two-dimensional bar code technology and wireless sensor network technology.

RFID technology and two-dimensional bar code technology are primarily used to uniquely mark research objects such as animals, plants and geographic areas that are to be observed. Although the roles of these two are equivalent, we still recommend two-dimensional bar code technology in practical utilization, since it is relatively cheap and easy to read data, but it requires to be read optically and closely. For a long-distance reading, RFID technology is a better choice. Owing to RFID technology and two-dimensional bar code technology, the participants in inquiry learning social network are able to accurately connect the information and corresponding explored objects, so that they can continue the process smoothly.

Wireless sensor network is mainly used to sense attributive data of explored objects like environment information, including temperature, humility and air quality. With the wireless sensor network, we will be able to turn the explored objects into virtual human in social network and let wireless sensor nodes instead of participants to obverse objects and share data repeatedly and automatically, so that learners will have enough time to think further rather than to repeat a large amount of observation, which is less valuable.

2.2 The Learning Social Network

The learning social network is a kind of social network platform which aims at the optimization of knowledge structure and promoting common learning. It is implemented learner's sharing under the concept of social networks [7]. Because the value of this social network lies in that participates must have much in common, it cannot be used to promote the learning of complex structured knowledge. Current learning social networking basically has the following categories:

Language learning social network. Communication and sharing are good ways to promote language learners' ability, especially for foreign language learners. A lot of language learning social networks has been created, such as italki (http://www.italki.com/learn-english/zh-cn) and Livemocha (http://www.livemocha.com/Livemocha).

Curriculum resources sharing social network. This kind of learning social network focuses on the exchange of learning resources instead of some certain learning content. The scope of the resources is adjustable, which means that it can be a complete course, or a very small piece of knowledge. Considering the convenience of access to the Internet, such social networking sites, such as taoke (http://www.taoke.com) and kaiyue (http://www.openyue.com/), generally target at college students.

Existing successful cases tell us that using social networking to promote learning is an inevitable trend. However, we think the learning characteristics of the above two application models are not outstanding. Using general social network platform can also achieve the same goal. In addition, it is very hard for learners to find the common goals and necessary connections between themselves. However, inquiry learning is different, in which communication and sharing about the whole process of science inquiry are indispensable, so using the concept of social network will affect the learning results more.

2.3 The Model of Inquiry Learning Social Network Supported by the Internet of Things

During the process of inquiry learning, explored questions, explored objects, learners and instructors are interrelated. In addition to unstructured data of social network, information is also organized in the form of structured data of inquiry research, so the model of inquiry learning social network is rather different from a traditional one. The following figure shows how information is organized in inquiry learning social network.

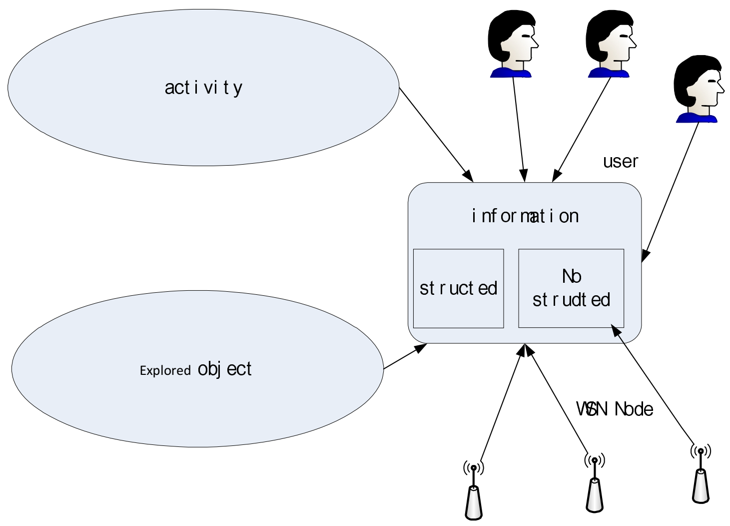

Fig. 1. Organization model of information in inquiry learning social network supported by the Internet of Things

Under this model, explored questions correspond to the activities in social network. A learner can participate in more than one activity, and there are also many explored objects related to the corresponding question in one activity. In addition, an explored object can also connect with more than one activity. These connections are built by the creator of the group, who is also the instructor of inquiry learning. Of course, any learner has the right to add a new explored object he thinks necessary, but this must be approved by the instructor. An explored object contains many attributes. In this social network, information including unstructured data like text, image, sound, video and structured digital data such as temperature, humility, CO2 concentration, PH value and other environmental information, is provided by participants and wireless sensor nodes. In addition, information must be relative to the explored object.

According to the whole process of inquiry learning, specific steps to implement it under this model are as followed:

1. Pick up the problems to inquire. According to the level of the participants in the explorative study, they can put forward their own problems and start the implementation of high-level exploring activity according to the existing resources in social networking platform. Also, they can directly join in the existing exploring issues on the platform. For the former, participants must specify the explored objects of this problem and response for instructing other participants.
2. Obtain necessary evidence for analyzing this problem. The participants of explorative study share the information resources related to the explored issues in their own mind through social networks.
3. Analyze the evidence and explain the results. Based on the information provided from virtual human (wireless sensor network) nodes and shared from real participants, drop the final conclusion by constant sharing and communication with other participants in the social network.
4. Evaluate the explanation from the learners and release the results. As an instructor, the teacher who participates in the activities should give an indispensable evaluation to the explored results and release the examined results in the social network. The process and the results of the whole activity will be kept to provide necessary support for follow-up study.

3 Specific Implementation of Inquiry Learning Social Network Supported by the Internet of Things

Considering the possibilities of application and popularization of inquiry learning social network supported by the Internet of Things, our software platform will be consisted of two parts: One is mobile-phone client based on Android, which is used to share and exchange information. The other is full-function social network platform through re-developing based on open source social network software. We choose ucenter@home open source social network as the foundation of our development. This platform holds extensive customers in China and possesses strong functions, which will fully meet our requirement of inquiry learning. The structure of the whole system is as following:

For the server plug-ins of inquiry learning, there are two main tasks: One is to offer web service port for Android client in the system, which primarily deals with the supply and exchange of all kinds of data. The other is to realize the plug-ins with the following functions based on the features of inquiry learning social network supported by the Internet of Things:

- Add user-defined attributes for people in the social network (including wireless sensor network) and display structured data in the form of figure.
- Receive and save the information shared by the nodes of wireless sensor network automatically.
- Establish connection between all the shared information and explored objects, and display in categories on the interface.

All the other functions can be fulfilled with the help of ucenter@home. The software snapshot is as followed:

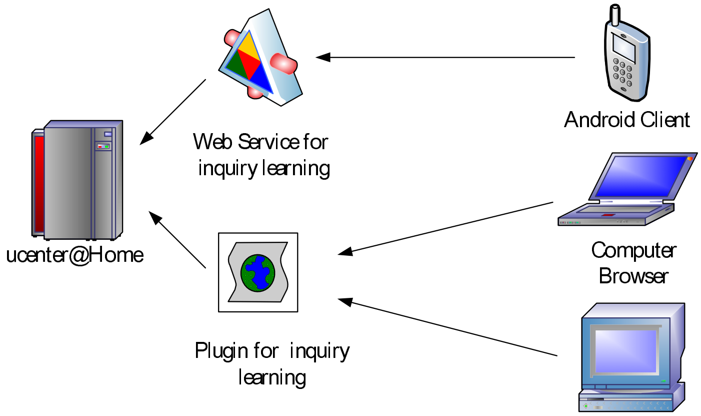

Fig. 2. Software structure of inquiry learning social network supported by the Internet of Thing

Fig. 3. Web page of inquiry learning social network supported by the Internet of Things

节点名	平均温度	最高温度	最低温度	光照强度	湿度	降水量	日期
校园的樟树	13	19	8	5876	38%	0	2011-9-22
校园的樟树	16	24	11	6016	41%	0	2011-9-23
校园的樟树	17	26	13	5976	43%	0	2011-9-24
校园的樟树	16	24	14	5845	36%	0	2011-9-25
校园的樟树	15	23	12	3876	84%	53	2011-9-26
校园的樟树	15	22	10	4778	67%	10	2011-9-27
校园的樟树	14	21	11	5525	45%	0	2011-9-28
校园的樟树	15	20	11	5476	40%	0	2011-9-29
校园的樟树	17	22	11	5526	38%	0	2011-9-30
校园的樟树	17	23	12	5945	40%	0	2011-10-1
校园的樟树	16	25	10	6571	35%	0	2011-10-2
校园的樟树	15	21	11	4876	42%	0	2011-10-3
校园的樟树	14	20	10	5276	45%	0	2011-10-4

Fig. 3. (*Continued*)

Considering that customers involved in the inquiry learning supported by the Internet of Things maybe only possess smartphones, the convenient intelligent devices, selection among various kinds of the smartphones and the development of client are of great importance. Based on the requirement of sharing and communication of information of inquire learning, this kind of collection should have the following functions: taking pictures, recording sounds, obtaining location information, supporting network and so on. Consequently we choose Android smartphone as our developing platform. An Android smartphone which costs 700 RMB can meet all the requirements mentioned above. We will fulfill the following functions on the Android client:

- Collect and share nature information including text communication and multimedia information sharing like recognizing two-dimension bar code, taking pictures and recording sounds.
- Analyze and utilize social network data, including the analysis of structured data related to explored objects and the sharing of information among participants.
- Other necessary functions of social network, such as the list of personal activities and the collections of photos.

The software snapshot is as followed:

Fig. 4. Android client of inquiry learning social network supported by the Internet of Things

Fig. 4. (*Continued*)

4 Conclusions and Expectation

Inquiry learning social network supported by the Internet of Things is still a new field and the whole research is also in the exploration stage. We consider that if learners could make sense use of this platform, they will be able to better display themselves through inquiry learning and cultivate scientific spirit and innovative capability during the process of conscious learning. Consequently, the application prospects of inquiry learning social network will definitely be increasingly bright.

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Blended Learning Support with Social Media Empowered by Ubiquitous Personal Study

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Abstract. In this study, learning support in a blended learning environment integrated with social media is concentrated on. A method is proposed to integrate the S-UPS (Socialized Ubiquitous Personal Study), which is utilized to collect and manage social stream data, into a blended learning system so as to combine the best aspects of both face-to-face and online instructions for the improvement of learning efficiency and enrichment of learning experience. Based on these, an empirical study is conducted to show the feasibility and effectiveness of our proposed method. Experimental evaluation analysis of the system reveals the enhancement of learning process in the blended learning environment.

Keywords: Social Learning, Social Stream, Social Media, Blended Learning.

1 Introduction

The idea of blended learning has been presented for many years. It refers to a mixing of different learning environments, which combines traditional face-to-face classroom methods with modern computer-mediated activities, in order to form an integrated instructional approach and further provide more efficient and effective instruction experience."Dezure [1], Buckley [2],Barr and Tagg [3], and others note that the confluence of new pedagogies (for example, the change in emphasis from teaching-centered to student-centered learning paradigms), new technologies (for example, the rapid spread of the Internet, World Wide Web, and personal computers), and new theories of learning (for example, brain-based learning and social constructivism) are enabling entirely new models of teaching and learning and that this change is of sufficient magnitude to be described as an educational transformation or paradigm shift" [4].

As more and more of populations are engaged into the SNS (such as facebook, twitter) environment, learning through a variety of social networking media has become increasing popular, which can be called as social learning. Social learning focuses on the learning that occurs within a social context, which considers that people learn from one another, including such concepts as observational learning,

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imitation, and modeling [5].That is, people can learn by observing the behavior of others and the outcomes of those behaviors [6].Comparing with conventional learning, social learning emphasizes more on learning through interaction and collaboration in a community or across a social network, rather than learning merely from teachers or by people themselves. Moreover, these well-developed social media technologies mentioned above have attracted more faculty members to look for ways to engage and motivate their students to be more active learners [7]. Continuously, a variety of social media tools (such as microblogs, video-sharing sites, and social networking) that contain a tremendous amount of social stream have aroused the interest in integrating them into learning process [8].

Meanwhile, with the high accessibility of these social networks, we are being surrounded with more and more personal contents consisting of feelings, experience, knowledge, and so on. Either these stream data in the cyber world or life log data from the physical world represent different aspects of people's information behaviors and social activities, which we call social streams. Likewise, in a blended learning environment, learning activity, which "may be loosely described as an instructional event or events embedded in a content resource, or as an aggregation of activities that eventually resolve to discreet content resources with their contained instructional events" [9], is so flexible in both web-based teaching and learning that can be also viewed as a kind of social stream. Due to the diverse nature of the social stream carried within social networking sites, these stream data can only be viewed as raw data streams, which could further be meaningfully organized in order to assist learning process.

In our previous study, we have proposed Ubiquitous Personal Study (UPS) [10]: a framework for supporting personalized information access and sharing. We have introduced metaphors for a set of information collections used in UPS, and defined V-Log as a Personal Chronicle, which traces all activities conducted within UPS, Internet accesses via UPS, and real-world information behaviors via both RFID and UPS. Continuously, we proposed a Framework of Organic Streams [11] and further developed a mechanism to meaningfully reorganize these stream data with two algorithms [12].Based on these, we socialized UPS toward an individualized information portal in order to organize and integrate these social streams which include Life streams and Life logs [13]. In this study, we try to integrate S-UPS into the blended learning environment in order to utilize the reorganized social streams to improve the learning quality and efficiency, which can further enhance the learning process for both professors and students.

The rest of this paper is organized as follows. A brief overview on the related issues and works is introduced in Section 2. In Section 3, after a brief description of the socialized UPS, a blended learning environment integrated with social media is built to show how our method can support the learning process for both teachers and students. The mechanism to develop this blended learning system is also proposed. Based on these, evaluation with analysis of this blended learning environment in accordance with the empirical statistics and the investigation of students are discussed in Section 4. We conclude this study and give some promising perspectives on future works in Section 5.

2 Related Works

There are many applications of social streams in SNS (such as twitter) [14-16]. SignoriniAlessio et al. showed that twitter can be used as a measure of public interest or concern about health-related events by examining the twitter stream to track rapidly-evolving public sentiment and activity [14]. Analysis of twitter communications in [15] showed the experimental evidence that twitter can be used as an educational tool to help engage students and to mobilize faculty into a more active and participatory role. A study addressed in [16] examined the impact of posting social, scholarly, or a combination of social and scholarly information to twitter on the perceived credibility of the instructor, which may have implications for both teaching and learning.

In 2002, Soller et al. analyzed and assessed online knowledge sharing conversations during collaborative learning activities, and gave out their conclusion that their approach can improve the effectiveness of knowledge sharing [17]. A question-based method was used in their study. In addition, Huang et al. proposed a prompt response monitoring system to support collaborative learning activities [18]. Activity streams provide us an opportunity to share learning activity cross different systems to create advanced reuse of learning process information to deal with the questions in various learning systems, such as learning management system, social network, etc. [19].

Research works have been tried to make use of stream data to support teaching, enhance learning, and create Social Semantic Microblogs, or use Semantic Webs to link and reuse stream data across Web 2.0 platforms [20-25]. Ebner showed how a microblog can be used during a presentation to improve the situation through instant discussions by the individuals in a class room [20]. Reinhardt, et al. tried to use the microblog, in addition to traditional conference tool, to enhance the knowledge among a group by connecting a diverse online audience [21]. Ebner, et al. indicated that a microblog should be seen as a completely new form of communication that can support informal learning beyond classrooms [22]. Studies have also been tried to create a prototype for distributed semantic microblogging [23]. SMOB is a platform for open, semantic and distributed microblog by combining Social Web principles and state-of-the-art Semantic Web and Linked Data technologies [24]. Bojars, et al. used the Semantic Web to link and reuse distributed stream data across Web 2.0 platforms [25].

3 Supporting Blended Learning with UPS Empowered Social Media

In this section, we will first give a brief review of UPS, including those fundamental functions such as collection and organization of individual identity and personal information. Based on these, we build a blended learning environment integrated with social media to show how our method can benefit the learning process for both teachers and students.

3.1 UPS: Personal Information Portal [10,13]

In the previous research, we have proposed a framework for supporting information access and sharing: Ubiquitous Personal Study (UPS) [10], a personal virtual study (following the analogy of study room) as a personal information portal. In this study, the UPS has been utilized to process personal information access and share in a blended learning environment, which can be manageably controlled by users themselves, in order to enhance the social learning.

UPS collects individual information by organizing individual identity and personal information in each UPS. Information that one wants to see or to be shown is brought together in one place. Personal information is organized with metaphors, such as V-Book, V-Bookshelf, V-Desktop and V-Note. V-Bookshelf, V-Desktop and V-Note are also defined as information layers which represent the whole set, the subset that is accessed recently, and the minimal set that is accessed currently, respectively. This helps a user to extend the maximum possibility to connect the user's device with a reasonable data size in ubiquitous computing environments.

We interconnect a number of UPSs with each other by the XSNS (Cross Social Network Services) module to build a distributed UPS community. The UPS platform may be integrated with functions that aim to establish relationships by exploring friend matching, recommend information, and share information with others. In addition, UPS provides an environment for collaborative activity via the Internet.

To utilize the social streams to benefit users, UPS has been designed ona cloud-based architecture. Likewise, repositories are divided into V-Bookshelf, V-Desktop and V-Note, which can better fit the data structures and make the data acquirement more quickly. The Stream Portal, which consists of Social Stream Aggregator and Social Stream Organizer, is added to process social steams. Furthermore, a Stream Publication module and a Stream Deliverymodule, which connect to the Stream Portaland Community Portal, are also integrated into UPS Portal in order to interconnect UPS with other websites to perform distributed streaming automatically. The Social Stream Aggregator is employed to collect social streams and go further to contribute to several preliminary processing works, such as updating, classifying and filtering. The Social Stream Organizer is used to socialize UPS in order to manage social streams, which contains the major functions, such as Feature Extractor, Statistical Generator, and Ripple Generator. As to the Ripple Generator, social streams are extracted in accordance with users' current interests andneeds, which are further reorganized into meaningful contents (we call them associative ripples) to satisfy users' one specific task [12].

A number of UPS based systems are interconnected with each other by UPS-XSNS module to build a distributed UPS community. That is, a user does not need to think which SNS to post when posting messages on his/her UPS. The target SNS will get user's ActivityStreams which has followed the user's UPS.

As what discussed above, the socialized UPS, which has been integrated with functions of collecting and managing social streams, can be further utilized in a blended learning environment in order to assist learning process for both professors and students.

3.2 A Blended Learning Environment Integrated with Social Media

We have employed the blended learning system integrated with a microblog (we are using status.net[1]as a test bed)into a class (a lecture called *Introduction to Information Systems*) with 40 students to publish comments, to raise questions, and discuss with the professor and/or other students. This will show if they understand the lecture and help the professor to monitor and regulate the progress of learning activity.

The blended learning environment built with microblogging in this study is shown in Figure 1.

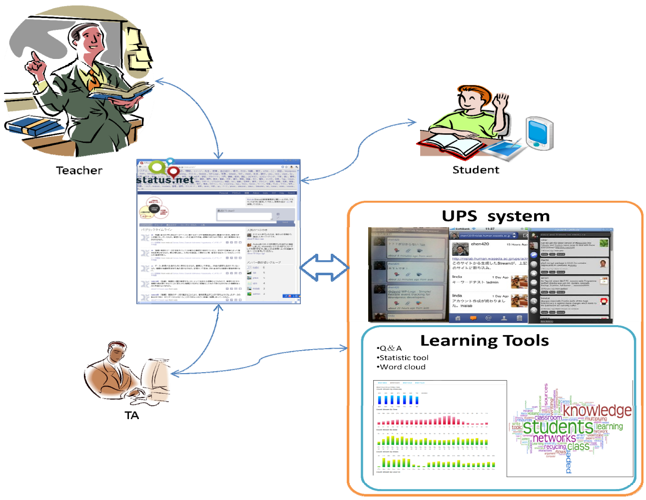

Fig. 1. A Blended Learning Environment with Social Media

During the 90 minutes lecture, students may have a variety of questions and topics to discuss with each other. If each student may publish 5 to 6 messages, the total number of messages could be up to 200 to 240 which would be a big number of learning stream data and difficult for both the professor and students to read, follow and analyze. We try to use our method to benefit both students and professor for the facilitation of information management in this learning process.

As shown in Figure 1, comparing with the traditional face-to-face classroom methods, we integrate microbogglingwhich is connected with UPS into the learning process, so that the best aspects of both face-to-face and online instruction can be combined together to enhance the learning process. That is, classroom time can be used to engage students in advanced interactive experiences, while the online portion of the course can provide students with multimedia-rich content at anytime and anywhere the student has Internet access. Meanwhile, due to the help of UPS, the social streams generated both in a classroom and on the Internet can be collected for further utilization. For instance, students in a classroom can save their learning note at any time, which can be shared with other students owing to the utilization of

[1] http://nislab.human.waseda.ac.jp/statusnet/

amicroblog system called status.net which is an open source software system with the same functions and features as twitter. Furthermore, these saved learning stream datacan be reorganized into meaningful contents in order to benefit both professors and students for specific tasks.

For a student, when he/she wants to seek for a specific question among the messages posted by all the students, through the analysis of the social stream data posted by him/her, some hints would be discovered. That is, some other students who may have the same need or interest would be recommended so that they can discuss together to figure out the answer. Furthermore, those related stream data would be extracted and organized to provide to this user as the preliminary answers for that question. After a class, all these learning data including those discussions among students will be collected and organized together as a lecture note for the review of this class, which then can also be shared between each student via UPS for the further improvement. For the teaching assistant, the teaching assistance work can be facilitated on account of the statistics from the UPS. For example, the teaching assistant can arrange the note for every class more easily based on the tag cloud posted on the status.net automatically, which shows what students are really interested in during this class, such as the hottest topic, the most interesting question and so on. This arrangement can also benefit the professor, for instance, if there are a host of questions to ask in a session, the professor can sort the list of questions based on the arrangement from the teaching assistant, then choose the most popular one to explain and solve first. Meanwhile, the professor can further know whether the students in this class really concern what he/she is talking about, so that the professor can decide whether he/she should change his/her teaching style to catch the students' interests, or what he/she should talk about in next session.

All these discussed above can engage and motivate students to be more active participants, as their learning interests are also aroused by the enrichment of learning experience. In this blended learning environment, the professor can control the learning process better arising out of the better interactions with students, which can further improve the learning quality and efficiency.

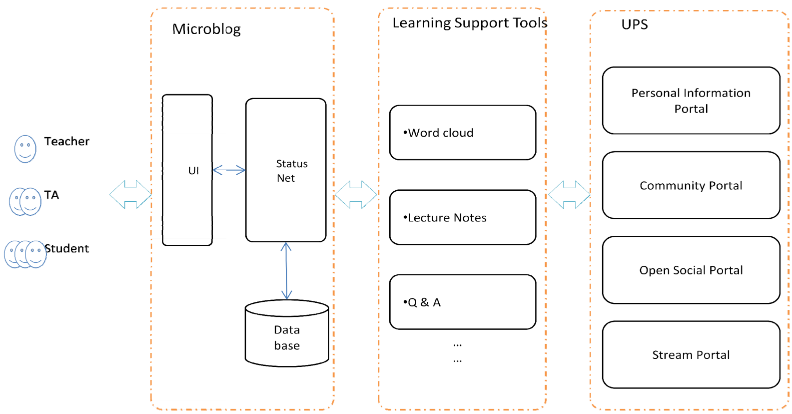

Fig. 2. Architecture of the Blended Learning System

The major functional modules of the blended learning system integrated with social media are shown in Figure 2.

As shown in Figure 2, this blended learning system, which benefits for teachers, teaching assistant and students, consists of three major components: Microblog, Learning Support Tools, and UPS. The Microblog component contains two sub-components: User Interface and StatusNet. User Interface is used to interact with teachers, teaching assistant and students, while StatusNet connecting with the database is employed to save all the stream data. As to UPS, which includes Personal Information Portal, Community Portal, Open Social Portal and Stream Portal, is utilized to manage users' personal information and the related social streams in order to assist the stream accessing and sharing. It also connects with other social media tools (such as twitter) to contribute to the enrichment of user experience. Learning Support Tools are responsible for reorganization of social streams collected from all users, which further aim at generating meaningful contents, such as word cloud, lecture notes and Q&A, for learning assistance.

4 Empirical Study and Results Analysis

In this section, a series of empirical results with analysis are given to evaluate our proposed blended learning environment as follows.

Fig. 3. Statistics of the Total Posts

Figure 3 shows the total posts in this blended learning system during the whole course. It indicates directly that, the amount of posts in one class was 70 at first, which then went to about 100 and further up to around 200, finally it got to 356 per one class. That is, the amount of interactions among students or between students and professor has increased in this blended learning process, which may imply that students have been motivated to be more active.

Table 1. Comparison between Face-to-Face Course and Distance Course

Questions \ Answers		Yes	A little	Almost not	No
1. Did you read the posts of the others?	face-to-face	15(48%)	15(48%)	1(3%)	0(0%)
	distance	7(23%)	17(53%)	3(9%)	4(13%)
Questions \ Answers		**Before Lessons**	**In Lessons**	**After Lessons**	
2. When do you read posts of others? (Multiple choice)	face-to-face	0(0%)	31(100%)	5(16%)	
	distance	3(10%)	16(52%)	17(55%)	
3. When do you post on statusnet? (Multiple choice)	face-to-face	0(0%)	31(100%)	5(16%)	
	distance	0(0%)	22(71%)	12(39%)	
Questions \ Answers		**Yes**	**A little**	**Almost not**	**No**
4. Do you think this system distract your concentration?	face-to-face	1(3%)	9(29%)	18(58%)	3(10%)
	distance	1(3%)	9(29%)	12(39%)	9(29%)
5. Do you think the post of others useful?	face-to-face	14(45%)	16(52%)	1(3%)	0(0%)
	distance	8(26%)	17(55%)	6(19%)	0(0%)
6. Do you want to use this system in other Course?	face-to-face	14(45%)	15(48%)	2(6%)	0(0%)
	distance	11(35%)	14(45%)	6(19%)	0(0%)

Table 1 shows the comparison between face-to-face course and distance course (three classed were given by CourseN@vi, a web-based distance learning system) based on the survey of students. It indicates that: first and foremost, students use this system well both in face-to-face course and distance course. Secondly, students post and read posts more during the class time, which means students may be more active when they meet together. Last but not least, this learning system looks positive and useful in the assistance of learning process because about half of the students want to use this system in other courses.

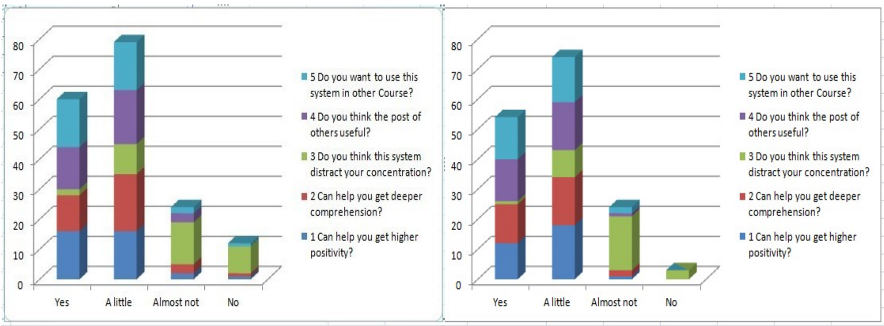

Fig. 4. Comparison between the First and the Second Survey

Two surveys have been done during this course, one of which is at the middle of the course, while another is at the end of the course. As shown in Figure 4, comparing these two surveys, more students said that they had got higher positivity and deeper comprehension due to the system. Meanwhile, the number of those students who were distracted their concentrations by this system decreased. Moreover, the number of the students who got more benefits from this system increased.

All these discussed above reveal that our proposed blended learning system has run well for this course and supported students in their learning process.

5 Conclusions

In this study, we have proposed a blended learning system integrated with socialized UPS and social media in order to enhance the teaching and learning process for both professors and students.

In this paper, we first introduced the UPS with a series of socialized functions, such as Social Stream Aggregator and Social Stream Organizer. Based on these, we built a blended learning environment integrated with socialized UPS to combine the best aspects of both face-to-face and online instructions in order to improve the learning quality and efficiency. After that, the empirical statistics and investigation were conducted to analyze and evaluate our proposed system, which show that the learning process has been enhanced by our system in this blended learning environment.

As for future work, this blended learning system can be further improved to be adaptive. Besides, more efforts should be made in the organization of meaningful stream data.

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Activity Theory as a Design Framework for Collaborative Learning Using Google Applications Technology

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Abstract. Collaborative learning involves small groups of students working together to solve problems for the purpose of learning. A large number of studies have focused on the technical aspects of computer-mediated environments for collaborative learning. This research distinguishes from other studies by employing a social learning approach. In this research, activity theory was used as a design framework for collaborative learning in a Web 2.0 environment using Google Applications technology. By employing an activity-oriented design method, a collaborative platform was developed to facilitate social learning activities that are mediated by artifacts and collaborative tools using the Google Applications environment.

Keywords: Activity Theory, Collaborative Learning, Google Applications.

1 Introduction

Despite the growing interest in Web 2.0 applications and Internet-based collaborative learning technologies, research investigating the relationship of these aspects to design frameworks for collaborative learning has been limited. Web 2.0 can be described as an "architecture of participation", which facilitates ease of usage, gives immediate feedback on the user interface and structural levels, and values each user's contribution. Recently, we have experienced a significant increase in the number of users who voluntarily engage in Web 2.0 activities. Examples of activities relating to Web 2.0 applications include blogs, wikis, tagging, RSS feeds, file and media sharing, social networking, and online messaging. These technologies are often associated with social communication as well as rich user experiences and opportunities for playfulness.

The widespread proliferations of online collaboration tools allow communities of common interest to share content and commentary via online participation with wikis, discussion forums, and through various file formats that can be shared or edited online. As of 2010, the collaboration tools of Facebook have attracted 450 million users. Social networking sites such as Facebook has increasing influence over university students with usage rate of over 90% per year at most campuses [6]. Educational institutes are starting to prepare students to collaborate in a world in

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which various tasks can be accomplished with an abundance of available collaborative tools through the Internet. Researchers in the areas of e-learning in Web 2.0 environments emphasize the importance of learner-centered approaches while considering the use of self-publishing, peer driven online leaning, and social networking. This suggests a greater focus on student-generated content, students' use of collaboration tools such as Web 2.0 applications, and modular tutoring. These innovative disruptions [2] are prompted by the development of Web 2.0 technologies that force us to think in new ways in preparation for the new challenges brought about by these changes.

Collaborative learning technologies refer to a set of tools for task-specific collaborations, and are associated with goal and work-oriented activities. Collaborative technologies such as Google Applications - the so-called “Applications of the Web" - have triggered a new wave of free online wikis, word processing, spreadsheets, presentations and discussion forum software since they were introduced in 2005 [10]. They bring a level of functionality originally associated with desktop applications to a Web browser, introducing ubiquitous possibilities for content creation, editing, and sharing.

2 Background of the Study

Collaborative environments in education involve small groups of students working together to solve problems for the purpose of learning. Google Applications consist of a set of tools developed by Google to facilitate collaboration. They incorporate features found in traditional office applications, as well as providing a common, shared space for collaborative work. There are three main applications provided by Google that facilitate collaboration: Google Docs, Google Forms, and Google Sites. Google Docs technology is a common platform for sharing documents in Google accounts. Google Forms facilitate a kind of spreadsheet document that can be used for developing online forms and surveys. Google Sites technology provides a tool for developing Web sites for collaborative work, handling documents, managing updates and wikis, and hosting forums for discussions.

The Google Applications platform was introduced at the Hong Kong Polytechnic University to be used for courses involving collaborative projects in the Bachelors of Arts in Marketing and Public Relations program. To enhance students’ effectiveness in using this collaborative technology, the current study investigated the relationship between Web 2.0 tools and education involving collaborative projects. In greater detail, this study aims at developing a design framework for collaborative learning using Google Applications Technology.

3 Theoretical Perspective

There have been a large number of researches that focus on computer-supported collaborative work. Previous researches on collaborative technologies focus on the technical aspects of the computer-mediated environments. Research that focuses on the context of learners in the environment has been limited. It has been recognized that a design framework can be benefited from an understanding of the context in which the users work [9]. In a computer-supported learning environment, a study of the context in which the technology is implemented helps in understanding the domain in terms of relations among individuals, artifacts, and social groups. Internet-based collaborative technologies are implemented with complicated interactions among participants and learning materials. It is therefore important to understand knowledge building involved in collaborative tasks.

Knowledge building refers to “the practices of meaning-making in the context of joint activity” [11]. Activity theory provides a theoretic lens to understand knowledge building and activity-oriented design method (AODM) [7] offers a comprehensive method for capturing the relationships that are derived from individual and group perspectives. Activity theory originates from the socio-cultural theories of Vygotsky and is articulated by Engeström [4][5]. It provides an analytic lens to understand complex leaning environments, especially for those that are mediated by tools. According to Vygotsky [12], humans do not interact directly with their environment. They do so by interactions that are mediated by signs and tools. According to Vygotsky’s theory of mediated action, social activities articulate the developmental transformation of internalized cognitive structures. Engeström also established a simple structural model of the concept of activity and cultural mediated relationships. According to Engeström [3], “activity is the smallest and most simple essential unit that still preserves the essential integral quality behind any human activity."

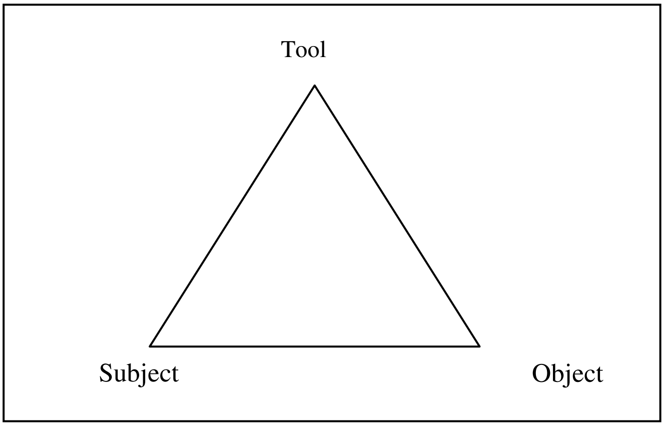


Fig. 1. The Basic Mediational Model

A common reformulation of Vygotsky’s mediational triangle is depicted in Fig 1. In the basic mediational model, an activity system consists of a subject and the object of the activity, and the community in which the subject is constituted. The relationship between the subject and object is mediated by a tool or artifact.

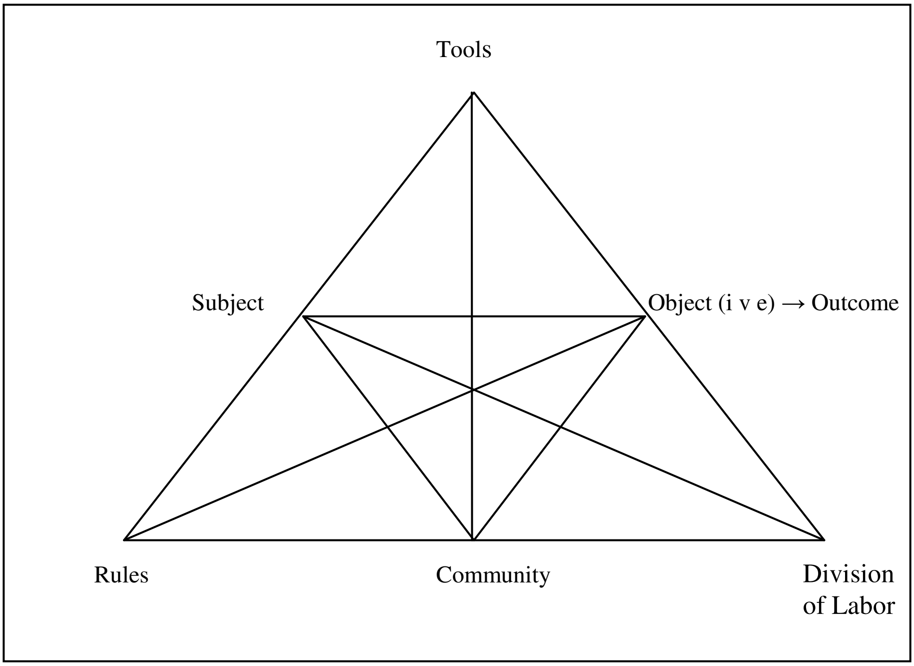


Fig. 2. The Activity System

Activity-oriented design method provides a useful framework for the design of collaborative learning environments because it posits that learning takes place as learners engage in activities. The goal of activity systems is to transform the object (objective) into an outcome through a mediated tool or artifact.

The activity system established by Engeström is shown in Fig 2. It contains the components that are organized to accomplish the activities of the activities subsystems, including subjects, objects and their associated outcomes, tools, rules, community and division of labor. The subject represents the individual or groups of members engaged in the activities. The object represents the motive or problem space and the goal of the activity system to transform the object (objective) into a useful outcome. The tools represent the artifacts used in the human activity, including physical objects and other resources. Rules represent the explicit regulations, policies, norms, expectations and conventions that constrain the means by which the activity is carried out. The community consists of individuals and groups of members who engage their efforts on the object. Division of labor refers to the construction of roles and responsibilities among the members of the community. The activity system shown in figure 2 is an expanded form of the basic mediational triangle developed by Vygotsky. In the activity system, the relationship between subject and object is mainly mediated by tools; the relationship between subject and community is mainly mediated by rules; and the relationship between community and object is mainly mediated by division of labor.

4 The Google Applications Project Environment

To avoid overgeneralizations, this study concentrates on the development of design frameworks for collaborative learning environments in a given course context, where the consequences of design changes can be analyzed in-depth by the researcher. The subject "advanced marketing research (AMR)" taught in blended mode at the Hong Kong Polytechnic University was being selected for implementation and evaluation. In this subject, students worked for a marketing research project for selected companies in groups with five to six students. The evaluation was wholly based on continuous assessment, which consisted of five project-based assignments. The assessment components included participation in Web-based activities, sharing of information and collaborative documents in project work.

The type of collaborative learning undertaken in this project is commonly known as computer-mediated collaborative work. The Web-based platform for supporting collaborative learning integrates the five components of Google Applications. They are implemented using Web 2.0 facilities, including Google Docs, Google Forms, Google Sites, Google Group Forums and Google Drive Share Space. These facilities promote interactions and collaborative learning between the participants. Students not only learn by participation, they also see how other students work in the Web 2.0 environment. The Web 2.0 environment promotes a "meaningful discourse" to the learning activities, where knowledge is constructed through the collaboration facilities provided by Google Applications.

Fig. 3. A Student Project Web Site Implemented with Google Applications Technology

The Google Applications collaborative learning platform is developed using an Activity-Oriented Design Method (AODM) [7]. Based on AODM, this research focuses on developing a comprehensive Web 2.0 environment that facilitates collaborative learning among the course participants. In this approach, individual and group perspectives are involved in the development and deployment of collaborative learning environments. The research illustrates the challenges involved in designing e-learning environments based on activity theory. Activity-oriented design method posits learning as located in contexts and relationships rather than merely in the minds of individuals, and that learning drives from participation in joint activities and social practices that are mediated by artifacts and collaborative tools. This research integrates Web 2.0 research and collaborative learning. As shown in Fig. 3, the collaborative environment integrates Google Sites, Discussion Forums, Google Docs, Google Forms, Google Sites and Google Drive shared file space for group-based projects.

5 An Activity-Oriented Design Framework for Collaborative Learning

5.1 Learning Tasks and Activities

In the advanced marketing research class, student groups with five to six members were required to work on a "real-world" case study, decide on a research topic and conduct an empirical research for a selected company. For example, a student group may work on a research topic “Predicting Online Purchase Intentions for Taobao.com”, and work as a group to conduct research with 100 consumers who have made purchase with taobao.com [8]. They were required to collaborate with their team members to conduct a real-world research project, produce a market research report and provide presentation to demonstrate their understandings of the research issues involved in the marketing process.

The subject was assessed by five assignments, with the associated tasks, objects, communities, rules, division of labor and tools listed in table 1. A detailed form of the activity system from the perspective of the class is shown in Fig. 4. In the activity system, the tools are elaborated to include artifacts, practices and technological components required for designing a Web 2.0 environment to support project-based collaboration activities.

Table 1. The Group Project and Five Assignments

	Grp Prj	Assgn1	Assgn2	Assign3	Assgn4	Assgn5
Task	Market Research Project	Project Proposal	Literature Review	Questionnaire Design (Survey)	Data Analysis Report	Final Project Report
Object	Develop conceptual and practical knowledge of marketing research methods	Focus on a topic to make a research proposal	Focus on market research issues and research framework from literature	Develop a questionnaire based on a research framework & conduct survey	Understand advanced data analysis techniques for quantitative research	Practice professional report writing, skills, addressing reliability and validity issues
Comm-unity	Among student peers/research participants/ lecturer	Project group/ lecturer	Individual members in a project group	Project Group, 100 research participants and online communities	Project group	Project group
Rules	Empirical research based on a research model	The topic should relate to research issues	Literatures need to relate to a consolidated research model	Need to relate to market issues & constructs developed in the research framework	Data analysis need to address the research questions	Project leader/members communicate with lecturer to ensure that the research is well-focused.
Division of Labor	Project groups members are required to distribute responsibilities and learn from peers	Required among project leader/ members	Required among project leader/ members	Required among project leader/ members	Required among project leader/ members	Required among project leader/ members
Tools	Quizzes, Group Project Presentations Group Project Web site, Wiki, email and RSS feeds, mini-blogs, Google Docs, forums, and shared document space, Teaching Web site	Project Web site mini-blogs SPSS	Project Web site, mini-blog. research proposal, Google Scholar, Google connect document sharing, Google PPT for presentation	Frameworks from literature, Google forms, Online survey tools from Google	Project Web site. Mini-blogs, SPSS, Google Doc	Project Web Site, mini-blogs Google Drive, Google Doc

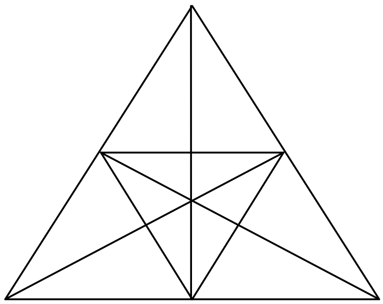
<table>
<tr><th colspan="4">Artifacts, Tools & Practices</th></tr>
<tr>
<td>Social
- Collaborations with small group project work
- Individual literature review consolidated among group members to derive a research framework</td>
<td>Assignments
- Quizzes
- Group-based marketing research project
- 5 assignments
- Weekly discussions in forums
- Rubrics
- Group project presentations</td>
<td>Cognitive
- Critical review of literature
- Data Collection Instruments
- Comparing project outcomes with other teams
- Peer critiquing, and collective aggregation</td>
<td>Technological
- Group project Web site
- Wikis
- Emails
- Google Docs for collaborative writing, and developing online surveys
- RSS feeds
- Mini-blogs
- Forums
- Shared document space
- Google sites sharing between different groups to share project practices
- Teaching Web site for downloading lecture notes</td>
</tr>
<tr>
<td>Subject
Class of Advance Marketing Research Students</td>
<td colspan="2"></td>
<td>Object
Develop knowledge of marketing research methods
→ Outcome
- Students become professional market researchers
- Integrate knowledge developed in the course to become researchers</td>
</tr>
<tr>
<td>Values, Rules & Conventions
- Students define and work on the empirical research based on a research model from literature
- Students learn among their peer groups and from other group members from Web-based collaborative facilities
- Evidence of collaboration and participation in the Google Web site and activities logs, which accounts for 15% of course assessments</td>
<td colspan="2">Community
- Student peers
- Research participants
- Lecturer and instructors</td>
<td>Division of Labor
- Project groups members are required to distribute responsibilities and learn from peers
- Students complete 5 group-based assignments
- Groups complete final report together
- Leader is responsible for the focus of the research and the lecturer guides the direction of research</td>
</tr>
</table>

Fig. 4. The Teaching and Learning Activity System from the Perspective of Students

5.2 Collaborative Learning and Investigation of Contradictions

With the objective of providing a collaborative project environment for implementing project-based activities, the activity system can also be analyzed with reference to the sub-activity of the activity system. There are three basic components of a sub-activity, which are: the identified object of the activity system, a particular actor (e.g., subject, Community), and a mediator (e.g., tools rules, division of labor). To provide an illustration of the process of analyzing the sub-activity notation using one sub-activity, consider the following research question generated from the analysis of the sub-activity:

> “How does the distributed responsibility for the group assignments (Division of Labor) affect student’s (Subject) development of practical and conceptual knowledge of marketing research methods and practices (Object)?”

The above activity-oriented question highlights the important contractions that might exist within activity system. The contradiction that can be derive from this sub-activity is that by having the division of labor for a group-oriented task, some students become free-riders and do not participate (as shown from the analysis in Fig. 5). Using AODM, it is possible to identify the possible contradictions that exist within the activity system by analyzing all the sub-activity triangles. The details of other contradictions that exist within the teaching and learning activity system are reported in another publication [1]. It also highlights the solutions for e-learning designer to deal with the problems that arise from these contradictions.

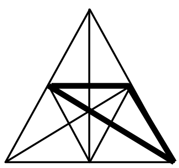
Subject-Div. Labor-Object 	Question: How does the distributed responsibility for assignments affect students’ development of practical and conceptual knowledge in marketing research and practices?	Possible area of contradiction: Some group members act as free riders and do not participate actively in the group project assignment.

Fig. 5. An Example of Contradiction Generated from the Sub-Activity Question

6 Conclusion and Evaluation

In this research, activity theory was used as a design framework for collaborative learning in a Web 2.0 environment using Google Applications technology. An activity system was used to analyze the relationship between the basic components, which include: the identified object of the activity system, a particular actor (e.g., subject, Community), and a mediator (e.g., tools rules, division of labor). These components are used in the activity-oriented design method for collaborative learning. By employing an activity-oriented design method, a collaborative platform was developed to facilitate social learning activities that are mediated by artifacts and collaborative tools using the Google Applications environment. This research distinguishes from other technical-oriented studies because a social learning approach was used in the research framework. The socio-cultural approach adopted in this research facilitates understanding of the relationships between the components in a collaborative learning environment from a community-building perspective. Future direction of research could focus on the resolution aspects generated from the contradictions between different communities and sub-activities.

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A Framework for Integrating Motivational Techniques in Technology Enhanced Learning

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Abstract. Motivation is a key factor in education. While there exist some learning system that consider techniques for motivating learners, these systems implement only one or few techniques and assume that the respective technique(s) work well for all learners. However, learners are motivated differently and what is motivating for one learner can be demotivating for another learner. In this paper, we introduce a framework of motivational techniques, which suggests motivational techniques that can be included in learning systems, discusses the relationships between these techniques, situations where the techniques might be demotivational for learners, and requirements of the techniques to be integrated into a course and learning system. This framework aims at providing guidelines on how to implement a set of motivational techniques into learning systems and is the basis for providing personalization based on motivational aspects in learning systems, presenting learners only with motivational techniques that work well for them.

Keywords: Motivation, personalized learning, personalized learning systems.

1 Introduction

Motivation is the reason that someone engages in a certain behavior [1, 2] and therefore a key aspect to be considered in different domains such as business, health, and education. A lot of research has been conducted by educational psychological researchers on motivational aspects in the context of education, aiming at facilitating motivation in the educational domain and resulting in several theories and models [e.g., 1, 3]. Based on such theories and models, some learning systems have been developed that use particular techniques (e.g., rankings, avatars) to enhance learners' motivation [e.g., 4, 5]. However, most of these systems integrate only one or very few motivational techniques and assume that they can motivate each learner in a similar way. Only little research has been conducted on personalizing motivational techniques and enabling systems to recommend learners motivational techniques that enhance their motivation most.

The first step towards providing personalization based on motivational aspects in learning systems is to develop a framework of motivational techniques that can be easily integrated into learning systems and online courses. In this paper, we introduce

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such a framework, which suggests a set of motivational techniques that facilitate the enhancement of motivation in an online course. These techniques are domain and course independent, making the framework easily applicable to different systems and courses. Requirements and characteristics of the techniques are discussed with respect to personalization issues.

In the next two sections, we provide an introduction into motivational models and theories for education as well as introduce related works on integrating motivational techniques into learning systems. Subsequently, our framework is presented and our conclusions and plans for future work are discussed.

2 Background on Motivation

For every behavior someone engages in there may be one or more influencing motivational factors, which can range from being motivational to being demotivational [1, 2]. Motivation is subjective and can be based on personal beliefs, feelings, and/or personal preferences. In education, motivation is a causal factor of learning [7] and it can be used to direct a student's behavior towards a particular goal, increase a student's applied effort and energy, increase a student's initiation and persistence in activities, enhance cognitive processing, and it can lead to improved student performance [8].

A student's level of motivation can be enhanced when the student exerts personal control for their learning and takes responsibility for it [6]. Students with an increased motivation to learn have a greater learning effectiveness [2] and those who are more persistent are more likely to achieve their goal [9]; however, too much control can lead to negative motivational effects [10]. Instructors and technology-enhanced instruction cannot control a student's motivation, but they can influence a student's motivation, either positively or negatively [11].

Intrinsic motivation is key to the success of a student since students with high intrinsic motivation have an increased curiosity and demonstrate behaviors that are explorative, self-regulated, and reflective, and typically outperform those students who are not intrinsically motivated [12, 13]. Furthermore, students in technology enhanced learning environments have been found to typically have a greater intrinsic motivation than those in face-to-face environments [14].

There exist numerous motivational theories which aim at explaining why people are motivated. From these theories, several motivational techniques can be derived to be used to enhance motivation in technology enhanced learning systems. In the realm of education, some of the popular theories include attribution theory, expectancy-value theory, and goal theory. Furthermore, motivational techniques can be based on theories from non-educational domains, such as reciprocation theory, consistency theory, social validation theory, persuasiveness of liking theory, and discrete emotions theory [17].

One of the main motivational models in education is Keller's ARCS model [3], which is used to design motivational strategies into instructional materials to improve the motivational appeal. The ARCS model consists of four conceptual categories (attention, relevance, confidence, and satisfaction) which are conditions that need to be met for people to become and remain motivated. The attention category includes perceptual and inquiry arousal. The relevance category includes goal orientation, motive matching, and familiarity. The confidence category includes learning requirements, success opportunities, and personal control. The satisfaction category includes intrinsic reinforcement, extrinsic rewards, and equity.

3 Related Work

There are different motivational techniques implemented in technology enhanced learning environments; however, there is not a lot of information in regards to combining these techniques, as well as technique comparisons. The following are some examples of systems that include one or more motivational techniques.

Huett et al. [15] developed a mechanism for distributing ARCS-based e-mail communications as a motivational technique, consisting of supporting motivational techniques, such as an introduction, overviews of existing set goals, reminders, words of encouragement, and multiple points of contact to improve the motivation and retention of online students. The students who received the communications compared to those who did not, showed an increase in overall motivation; they also had a higher retention rate and a lower failure rate than the control group.

Code et al. [16] created a Goal setting kit (GSK) for gStudy, an e-learning tool that supports knowledge construction. The GSK is a motivational technique that allows students to set and manage their goals in an e-learning course and it records all of the activities of the students.

Comtella is a file and bookmark sharing system that enables researchers and students to share and exchange resources, such as links and research papers [4, 21]. The system includes motivational techniques, such as an online community, hierarchical memberships, rewards, top users, best papers of week list, personalized messages, ratings, community news, etc. [4, 21]. The system consists of a set of hierarchical memberships and rewards active users with better quality of service.

iHelp is a system that supports learners by providing asynchronous and synchronous facilities [17] as motivational techniques. The system includes supportive motivational techniques, such as emoticons, a marketplace, a top helper list, scored postings, etc. Smiley [19], an animated avatar with a human voice, was implemented on the system to respond to student performance. Vassileva [17] also implemented a marketplace for learning resources, where the helpees pay and the helpers earn system credits redeemable for prizes at the end of the term. In addition, the postings with the highest scores had a higher visibility.

Kim is an application-based interactive caring agent (displayed as an avatar) whose aim is to help students deal with negative emotions, and advise the students on overcoming English as Second Language obstacles [20]. The agent is a motivational technique that has a mentoring personality and also uses facial expressions, body gestures, and dialogue based on empathy, memory, and personality, to communicate with the student. Another agent-based system is eQuake, which is an electronic Question and Answer Knowledge Environment that includes motivational techniques such as multiple agents and a knowledge-base in the form of an online discussion forum [18]. The system also includes supportive motivational techniques, such as notifications, message ratings, and an internal market. Students use the system to post questions, answers, comments, or ideas: when students ask a question, a knowledge agent intercepts question and searches the knowledge-base for any existing related questions that may satisfy the student.

4 Framework for Incorporating Motivational Techniques

The framework introduced in this section describes a set of motivational techniques which we identified as most suitable for the incorporation into learning systems. These techniques are based on motivational theories and models and most of them have been successfully implemented in particular learning environments. The techniques have been selected based on a comprehensive literature review and with respect to their capabilities to motivate learners. Furthermore, another selection criterion was that the techniques are domain independent and content independent, aiming at creating a generic framework that can be easily integrated in different systems and courses without rewriting or extending the content of these courses. Therefore, techniques that require learning material to be presented in a certain way (e.g., through videos, game-based learning, adaptive content presentation etc.) have not been considered in this framework.

In the following subsection, for each motivational technique a description is provided about the aim of the technique, why the technique is motivational, what has to be considered so that this technique is not demotivational, and the requirements for the course and system to integrate this technique.

4.1 Motivational Techniques

Progress Timeline. The *progress timeline* technique aims at (1) providing learners with information about their progress in the course based on predefined milestones such as assignments, quizzes, exams, projects or other graded components in the course, and (2) showing them their progress in relation to the progress of the class in anonymous as well as accumulated format.

This technique builds on the confidence and satisfaction categories of Keller's ARCS model [3]. This technique can motivate learners by providing them with a tool to assist with their personal time management and therefore can support a learner's belief that he/she can master the learning tasks. In addition, the technique allows learners to reflect on what they have successfully completed. Furthermore, this technique can provide learners with information on how they have progressed through the course in relation to their class mates and can motivate learners to work at the same or quicker pace. In addition, it can help to locate learners at the same milestone and facilitate communications between learners. Besides the motivational impact of this technique, it can also be demotivational for some learners if they feel as though they have fallen behind in the course and may not be able to catch up. Learners may also be demotivated if there appear to be too many milestones remaining for them to complete. Furthermore, learners may feel demotivated if they have a peer question but there are no active learners at the same milestone.

To implement the *progress timeline* technique into a learning system and course, the respective course has to have measurable milestones and the system must be able to track learners' completion of milestones and access the start and end dates of all learners for the course.

Progress Annotation. The *progress annotation* technique is used to display to the learner their progress through the course content. This technique allows learners to (1) tag their active position in the course content and (2) tag the completed content.

This technique builds on the confidence and satisfaction categories of Keller's ARCS model [3]. The *progress annotation* technique can motivate learners by allowing them to view and track their progress through the course and to reflect upon their progress. In addition, the technique empowers learners by displaying their exact position in the course content and it can be used to assist learners with their time management. Learners can be demotivated by this technique if they feel as though they are not progressing fast enough through the course, even though they are putting in a lot of effort.

To implement the *progress annotation* technique into a learning system and course, the respective course must have content and the system must be able to keep track of a learner's progress through the course content.

Rankings. The *ranking technique* is used to sort learners based on certain criteria. Learners can be ranked, for example, based on their performance, their participation, their interactions with others, and the amount of time that they spend online. For example, Comtella ranks learners based on the quality and quantity of their contributions [21] and iHelp displays a top helper list [17]. In addition, learners can be ranked based on multiple criteria, where a formula can be used to assign any weights and/or relationships.

This technique builds on the satisfaction category of Keller's ARCS model [3], as it allows learners to be rewarded or satisfied by displaying statistics, providing the learner with a scale to compare themselves to. Some learners will use this information to continually try to improve. Depending on the criteria, one learner may be satisfied being in the lower half of the course, while another learner is ranked second and is demotivated by the position, because he/she is not in first place. This technique can also be demotivational to some learners if they feel as though they should be doing better than they are or if they do not feel as though they have a sense of control. Since each ranking can be motivational to some and demotivational to others, personalization is an important issue for this technique.

To implement the *ranking* technique into a learning system and course, the course must have a minimum number of people enrolled; if there are too few people, the rankings may not be significant. The course must also have criteria that can be used to rank the learners. The learning system must be able to keep track of the learners' activities and achievements based on the ranking criteria.

Awards and Achievements. The *awards and achievements* technique supports learners by providing them with incentive and/or recognition. Awards and achievements are either achieved or not achieved, or they can be based on a scale or levels, such as different forum user types based on the number of posts a learner contributes. For example, Comtella awards active users with better quality of service [21] and iHelp awards higher visibility to the postings with the highest scores [17]. The *awards and* *achievements* technique can be based on various course components, such as grades, participation, and the completed content.

This technique builds on the satisfaction category of Keller's ARCS model [3], as it rewards the learner. Awards and achievements are motivational as they provide recognition to a learner and a sense of accomplishment. Awards and achievements can be a demotivational if a learner does not have the time to allocate to additional learning or processing, if the learner finds flaws in the methodology, or if the learner does not get the recognition that he/she believes he/she deserves.

To implement the *awards and achievements* technique into a learning system and course, the course must have components that associate awards/achievements with them.

Discussion Forums. The *discussion forums* technique is a tool used for asynchronous communication between learners as well as between learners and their instructor. Discussion forums allows for learners to post questions, comments, and/or concerns and respond to existing posts and have been used, for example, in [17, 18, 21].

This technique builds on the confidence and attention categories of Keller's ARCS model [3], as it empowers and supports learners by facilitating peer assistance and they can be used to promote active participation of the learners. Discussion forums can be demotivational if the forum lacks content or if the amount of content is overwhelming. If the content is overwhelming, the learner may not be able to keep on top of all of the posts due to sheer volume. Also, some learners prefer to not communicate in a public forum.

Discussion forums are a standard component included in many technology enhanced learning environments. To implement the *discussion forum* technique, the learning system needs allow the integration of discussion forums into a course.

Communications. The *communications* technique is used to communicate course information to the learners, as demonstrated, for example, in [15]. These communications can be sent by various systems and protocols, such as e-mail, e-learning system message, SMS, and/or RSS. Communications provide learners with information from the instructor and/or the course environments, such as announcements, solutions to problems and exercises, updates on their goals, and/or advice if they are falling behind or if they are having problems in the course.

This technique builds on the confidence and satisfaction categories of Keller's ARCS model [3], as it promotes learner self-confidence and provides feedback and reinforcement to the learner. In general, communications are motivational as they keep learners informed and up-to-date on the course and any potential changes or additional information that is being provided. Communications can be demotivational if they contain too much content, if they are sent too frequently or not frequently enough, or if the learner finds the communications to be spam.

To implement the *communications* technique into a learning system and course, there must be content to communicate to the learners and means (the protocols) to send the communications.

Knowledge Agent. A knowledge agent is an agent on the system that is responsible for directing learners to the most appropriate information based on a request, as for example implemented in [18]. It acts as a broker between the learner and the information available on the system. A knowledge agent is asked a question by the learner and returns the most appropriate information to the learner in response to his/her question. A knowledge agent has access to all course information and documentation such as the course content, the forums, a knowledge-base and/or list of frequently asked questions, and any other manuals and documentation.

This technique builds on the confidence category of Keller's ARCS model [3], as it supports and empower learners. The knowledge agent is motivational as it allows the learner to easily navigate to the most appropriate information based on their query. The agent can be demotivating if the agent does not answer the questions appropriately.

To implement the *knowledge agent* technique into a learning system and course, the knowledge agent must have access to various course information and documentation to draw its responses from.

Caring Agent. A caring agent is an agent on the system that is responsible for emotionally supporting, identifying with, and assisting learners. The caring agent is displayed as an avatar on the system and it presents supporting information to the learner in an informal manner, as for example shown in [20]. The agent can advise learners on course deadlines and progress, any timelines that the learner is trying to meet, how the learner is progressing, or if additional learning materials have been uploaded. Also, the caring agent can interact with the knowledge agent to gather additional information to support the student. The caring agent can be used to support learners if they are doing poorly on practice materials by providing the learner with hints to assist the learner in successfully answering questions and by providing additional hints if they are not successfully answering a question.

This technique builds on the confidence and satisfaction categories of Keller's ARCS model [3], as it supports and empowers learners by coddling them. The agent can be demotivating if it does not properly support the needs of the learners or if the learners are distracted by the agent. It can also be demotivational if learners find that they are being overly coddled or if the agent is perceived as being annoying. The avatar can be demotivational to some learners based on its look and feel.

To implement the *caring agent* technique access to information about the learner and course needs to be available.

Posting Solutions. The *posting solutions* technique consists of posting the best solutions to problems or exercises in the course.

This technique builds on the satisfaction category of Keller's ARCS model [3], as posting solutions to problems and exercises is motivational when learners receive recognition for having the best answer and when learners are supported by being provided with a solution to a problem that they may not have been able to fully answer on their own. The *posting solutions* technique can be demotivational if a learner believes that his/her solution was better than the posted solution or if a learner never has the best solution.

To implement the *posting solutions* technique into a learning system and course, there must be graded activities and the course should be paced so the learners all have the same submission deadline.

Goal Setting. Goal setting encourages learners to set a plan to meet an objective, which causes learners to think about and understand various components of the course, as for example shown in [16]. Goals are set for personal gain and can be implemented for many facets, such as planning timelines for assignment submissions and exam write times; to achieve a certain grade, to beat a certain % of class, to get passing grade, etc.

This technique builds on the relevance category of Keller's ARCS model [3],as it allows leaners to establish a connection between the instructional environment and the learner's personal goals, which gives them a feeling of comfort and preparedness. Goal setting can be demotivational when the learner dislikes planning or is overwhelmed.

To implement the *goal setting* technique into a learning system and course, learners must have one or more course components to set goals based on.

Emoticons/Emotions. Emoticons are pictorial representations of facial expressions (such as pleased, happy, sad, surprised, angry, or neutral) and can be used to display extra meaning to the learner, as for example used in [17, 20]. For example, they can be used as an auto-response to a learner's interaction with the system or to add meaning to course content. Emoticons can be used in the course content, such as when a learner works on a practice exam. On the other hand, emotions can be displayed by avatars on the system when interacting with learners. Avatars can modify their facial expressions in response to a learner's interaction with it.

This technique builds on the satisfaction category of Keller's ARCS model [3], as it provides feedback and reinforcement to the learner. Emoticons can be demotivational if they are found to be annoying, unrelated, or insulting to the learner.

To implement the *emoticons/emotions* technique into a learning system and course, there needs to be content and/or activities for the emoticons to be integrated into or for the emotions to be related to.

4.2 Relationships between Motivational Techniques

Each of the introduced motivational techniques can be implemented as an individual technique. However, several optional dependencies exist, where one technique can support and enhance another technique, leading to more comprehensive capabilities of the respective technique. Furthermore, by combining motivational techniques and benefitting from their relationships, a technique that was previously demotivational to a learner may become more appealing. For example, the *ranking* technique can use inputs from the progress timeline, goal setting and others in order to provide more comprehensive rankings. While ranking based on only one aspect can be misleading and therefore demotivational for some learners, the consideration of multiple course facets can lead to more accurate ranking and therefore to an increased level of motivation. By implementing the proposed techniques and making use of the dependencies between techniques, a richer environment for motivating students can be provided. Figure 1 shows the optional dependencies between each technique, using arrows to indicate the direction of dependency.

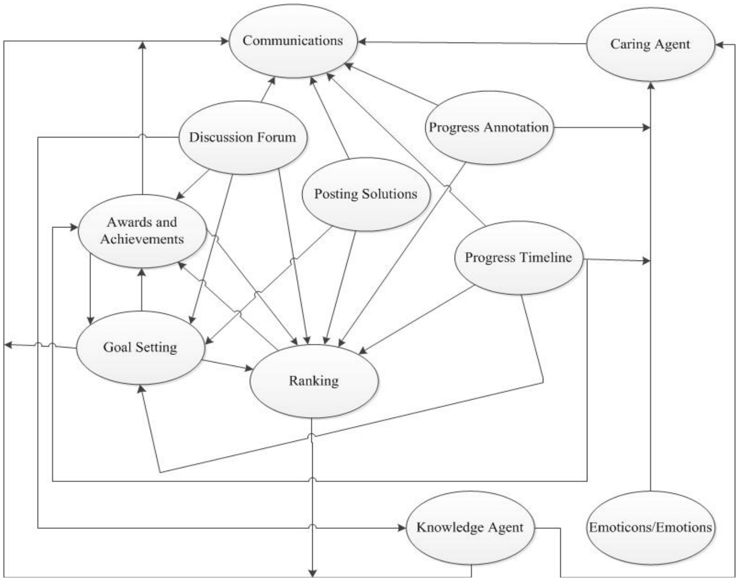

Fig. 1. Optional dependencies between motivational techniques

5 Conclusions and Future Work

This paper proposes a framework of 11 motivational techniques to be integrated in learning systems in order to enhance learners' motivation. Each technique is described with respect to its aims, why it is motivational, possible demotivational effects, and the requirements for the system and course to integrate the respective technique.

This framework contributes to the area of technology enhanced learning in two ways: First, it proposes a domain independent and course independent set of techniques to be integrated in learning systems to enhance learners' motivation. By integrating the proposed set of techniques and considering their dependencies, learners can select between different motivational techniques that can increase their motivation at different stages and in different situations in the course. Second, the proposed framework is the basis for automatically providing learners with personalized motivational techniques that fit their motivational preferences and current situations.

Our future work will use this framework as basis for developing an adaptive mechanism that presents learners with motivational techniques that work best for them.

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Different Roles of Agents in Personalized Programming Learning Environment

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Abstract. Researchers had recently begun to investigate various techniques to help learners to improve learning effects using e-learning systems. In this paper, we propose an e-learning architecture with a recommendation module consisting of several different kinds of pedagogical agents which actively participate in learning processes, provoking learners and motivating them to learn more effectively. Different kinds of agents can be introduced in order to support scaffolding activities in learning programming languages and problem solving.

Keywords: e-learning, harvester agents, pedagogical agents, content personalization.

1 Introduction

Recently, in different learning environments there has been a trend of using adaptive and intelligent web-based educational systems. These systems can use different recommendation and scaffolding techniques in order to increase motivation for learning and to suggest online learning activities or optimal browsing pathways to learners, based on their different preferences and levels of knowledge. Their main objective is to adapt and personalize learning to the needs of a learner as much as possible [33].

The task of delivering personalized content is often framed in terms of a recommendation so some recommender systems have been applied in e-Learning environments for recommending objects or concepts that learners should study next [10].

Another approach in designing and developing educational tools include employment of different kinds of agents. For the purpose of our research we distinguish two groups of agents. The first group consists of *pedagogical* agents with diverse functionalities and potential. The second group includes *harvesting* agents employed in educational environments with the main goal of collecting different learning resources.

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Pedagogical agents have been defined as “lifelike characters presented on a computer screen that guide users through multimedia learning environments” [13]. Their main design goal is to engage, motivate, and guide learners through the learning process. According to [14], one of the main characteristics of pedagogical agents is interactivity. That is, they not only provide answers and additional learning material, but also generate questions and propose solutions. Our proposed architecture is based on two types of pedagogical agents, described later.

In general, a *harvester* is an object that collects resources and metadata records from remote repositories. The main advantage of using agents as harvesters is parallel execution of federated searches in heterogeneous repositories [8]. Additional benefits come from inter-agent communication and mobility, which, respectively, provide the means for exchanging the harvested material and reducing the load imposed on the central repository. Recently, our research has been concentrated on exploring various ways of using harvesting agents in order to improve learning quality in our tutoring system [15]. The proposed architecture is designed to employ software agents that dynamically recognize and propose possible learning material as additional learning objects to learners. In the future, our intention is to combine various harvested learning components into highly-personalized additional teaching material.

In this paper initial ideas on how to incorporate different kinds of agents – *Harvesting*, *Provoking*, and *Zestful* – into an existing personalized learning and tutoring environment will be presented. The role of each proposed agent is adjusted in order to increase learners’ motivation and improve the quality of learning, increasing in such a way the amount of acquired knowledge. In particular, we are concentrating on learning programming languages and solving programming tasks. For our ideas we have used an improved web-based learning system architecture presented in [19]. The proposed architecture, which provides adaptive courses using hypermedia and recommendations, rose from an existing web-based Java tutoring system *Mag* [32].

The rest of the paper is organized as follows. In Section 2, an overview of work related to our research is given. Section 3 outlines the vital functionalities of the web-based e-learning architecture, the starting point for our current research. Section 4 describes *MagMAS*, our proposition of the e-learning architecture which incorporates three kinds of agents. Section 5 concludes the paper and outlines possible future work.

2 Related work

As our primary goal is to incorporate different kinds/roles of agents in an existing personalized learning environment for programming languages, in this section we will shortly discuss agent-oriented learning systems that can help us to distinguish and tailor our own agents and their particular roles.

A critical analysis of e-learning with hypertext and hypermedia presented in [1] indicates that the usage of this form of learning material can be very challenging for learners. Hypermedia learning environments should, therefore, incorporate scaffolding in order to help learners in overcoming the obstacles imposed by complex and challenging topic. The introduction of agent-based support for scaffolding activities is one of the primary goals of our approach and the proposed architecture incorporates two kinds of scaffolding agents.

The majority of tutoring systems for learning programming languages are just well-formatted versions of lecture notes or textbooks. Some of these systems *Java-Bugs* [27] and *JITS* [29, 30], are used for learner assessment, while others like *Jeliot 3* and *Logic-ITA* [3, 17], offer basic tutoring. One of the interesting systems for our research is *Java Intelligent Tutoring System* (*JITS*) [30]. *JITS* implements *Java Error Correction Algorithm* (*JECA*), that enables compilers to identify source code errors more clearly, and to intelligently fix the code accordingly. In our approach some of these functionalities will be included in two kinds of agents (*Provoking* and *Zestful*). *Jeliot 3* is a program animation tool that displays graphically the execution of Java-based object-oriented programs. In the future work, a similar functionality will be added along with our pedagogical agents.

Agents are used as means of extending intelligent tutoring and course recommendation in different systems: *Educ-MAS* [11], *MathTuthor* [5], and *ABITS* [4]. Instead of using harvesting agents, however, these systems usually offer metadata authoring tools. Some of these concepts, combined with our own experience in developing educational environments [16, 19, 23] are incorporated in our proposed agent architecture which includes *Harvesting*, *Provoking* and *Zestful* agents.

Agent Based Search System (*ABSS*) [22] and the *AgCAT* system [2] represent more complete agent-based frameworks for harvesting learning objects. *ABSS* seems to be more powerful as it uses *Personal Agents* to offer personalized search capabilities, customized presentation of the available material, etc. The general architecture which encompasses harvesting agents used in our approach [15] is similar to *ABSS* and *AgCAT*. However, while metadata harvesting agents in *ABSS* and *AgCAT* constantly monitor the changes in remote repositories, harvesting agents in our system are dispatched to remote LO repositories in response to an automatically detected decline in learner's performance. Additionally our system includes agents that monitor the learner's progress through a course, and obtain new learning material as needed.

In order to assess motivational and learning impact pedagogical agents have on learners, an in-depth analysis of 39 studies has been presented in [13]. The initial conclusion was discouraging – only 5 studies have reported advantages of using agents on learning, while in only 1 study a positive impact of pedagogical agents on the motivation has been recorded. However, after further analysis it was noted that only 15 studies featured a control group (i.e. without an agent), while only 4 out of these 15 applied motivational measures. Therefore, the proposal is for researchers to focus on examining the circumstances (e.g. the environment, domains, levels of design, etc.) under which the use of agents yields in an improved learning outcome.

One of the important factors of the effects of pedagogical agents outlined in [13] is their graphical representation. It was observed that the use of a pedagogical agent can have negative effects on the learning outcome, if learners dislike the agent's visual appearance. Similarly, in [12] visual clues are defined as important factors people rely on in order to form expectations for guidance and interaction.

A successful usage of an animated pedagogical agent was reported in [28]. The agent, a lifelike character with gesture support, was incorporated into an existing intelligent tutoring system *SQL-Tutor* for learning *SQL*. A study was then carried out, showing that learners who have been using the agent found the *SQL-Tutor* system to be "more enjoyable and helpful." When compared to our proposed pedagogical agents, the agent used with *SQL-Tutor* is relatively simple, and was employed just as a more pleasant way of presenting the learning material.

Obviously, there is a lot of ongoing research in the field of agent-based e-Learning systems. Although existing systems do include sophisticated metadata harvesting approaches, they do not seem to incorporate agents in both the metadata harvesting, and the course recommendation levels. This is the goal of our proposed architecture.

3 Architecture of the Existing Tutoring System

The architecture of the e-learning/tutoring system which represents the starting point for our agent-oriented approach is an extension of an existing web-based Java tutoring system *Mag* [16] that has been developed at our Department. *Mag* is system designed to help learners in studying programming languages during different courses [31]. It is an interactive system that allows learners to use teaching material prepared for programming languages and to test the acquired knowledge within appropriate courses. *Mag* is a multifunctional educational system that fulfills three primary goals [18]:

- Provide a tutoring system for learners in a platform-independent manner
- Provide teachers with useful reports that identify the strengths and weaknesses of the learner's learning process
- Provides a rapid development tool for creating basic elements of tutoring systems: new learning objects, units, tutorials, and tests

In spite of the fact that this system is designed and implemented as a general tutoring system for different programming languages, the first completely developed and tested version was used only for the introductory Java programming course.

Different techniques must be implemented to adapt content delivery to individual learners in accordance to their learning characteristics, preferences, styles, and goals. In order to support adaptive learning and personalization of the content delivery, the system administrators must constantly measure the learner's knowledge and progress, build learner model, and redirect the course as needed. The first version of *Mag* was further extended with an introduction of two general categories of personalization:

- *Content adaptation* – presenting the content in different ways, according to the domain model and information obtained from the learner model.
- *Link adaptation* – the system modifies the appearance and/or availability of every link that appears in a course web page, in order to show to the learner whether the link leads to interesting new information, to new information the learner is not yet ready for, or to a page that provides no new knowledge.

Open standards, like XML, RDF and OWL [20, 24] needed to be used in order to allow the specification of ontologies to standardize and formalize meaning and to

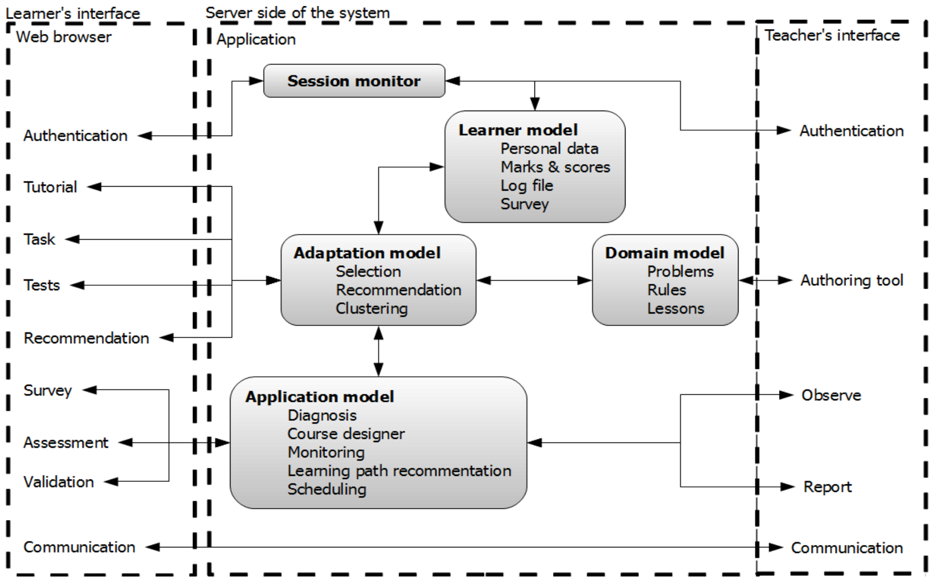

Fig. 1. Web-Based Learning Architecture

enable the reuse and interoperability. Fig. 1 shows the adapted architecture of the first version of *Mag* [31], which was developed on the basis of experiences with similar web-based learning systems [6, 20, 25], as well as ontology-supported adaptive web-based education systems [7, 9].

The core of the system includes *adaptation model*, *learner model*, *application model*, and *domain model*. The domain model represents storage for all essential concepts, tutorials, and tests in the domain. The whole course is divided into units which are all consisted of several lessons. Each lesson consists of three basic parts: tutorials, programs/examples connected to tutorials, and tests (an unlimited number of examples and tests can be attached). At the end of each lesson a post-test is conducted. A test contains several multiple-choice questions and code completion tasks that learners have to solve and present the level of acquired knowledge. *Provoking* and *Zestful* agents have to play essential role in this process. The application model applies different strategies/techniques to ensure efficient tailoring of the learning content and personalized tasks to individual learners. It supports the given pedagogical strategy.

The adaptation model follows the instructional directions specified by the application model and creates navigation sequence of resources recommended for the particular learner. Therefore the idea is to incorporate *Provoking* and *Zestful* agents in the adaptation model (more details are presented in next section). These two components are separated in order to provide an easier addition of new content clusters and adaptation of functionalities.

Each learner model is a collection of both static (personal data, specific course objectives, etc.) and dynamic (marks, scores, time spent on specific lesson, etc.) data about the learner, as well as a representation of learner's performances and learning history. Within the session monitor component, the system gradually builds the learner model during each session, in order to keep track of the learner's actions and his/her progress, detect and correct errors and possibly redirect the session as needed. The adaptation model is also responsible for building and updating characteristics of the learner model and for personalization of the application to the learner. It processes the changes in the learner's behavior (e.g. learner's activities) and provides an adaptation of visible aspects of the system accordingly. Its main tasks also include the storage and management of course data, various ways of presenting courses to learners, provision of reports and test results etc.

Educational ontologies for different purposes must be included, i.e. for presenting a domain (domain ontologies), for building the learner model (learner model ontologies), or for presenting activities in the system (task ontologies) [25]. A repository of ontologies must be built in order to achieve easier knowledge sharing and reuse, more effective learner modeling, and easier extension of the system.

4 *MagMAS* – An Agent-Oriented e-Learning Architecture

In this section we will present main ideas and functionalities of the new agent-oriented e-learning architecture named *MagMAS*, which is an upgraded version of the existing web-based Java tutoring system *Mag* [16].

In the course of further improvements of the original *Mag*, three different levels of personalization (based on levels of increasing abstraction and sophistication) that must be included in the *Mag* system [19] have been suggested in [9, 26]: *Self-Described Personalization*, *Segmented Personalization*, and *Cognitive-Based Personalization*.

Research presented in this paper is concentrated on the *Segmented Personalization* style of learning, with the following characteristics: learners will be grouped into smaller, identifiable and manageable clusters, based on their common attributes (e.g. class and age), preferences, and survey results. Parts of the instructions are then tailored to these groups, and are applied in the same or similar way to all members within a single group. Learning material will also be clustered by its purpose, based on the benefits it delivers to learners. In spite of the fact that the *Mag* system supports three types of tasks/questions [16] – *Multiple-choice of syntax check*, *Multiple-choice of execution results*, and *Code completion* – the focus of the research in this paper will be on the last type.

Within the *Code completion* type of questions, a problem is presented in form of a skeleton program with parts of the code missing. The learner is expected to enter the appropriate code snippet according to the program specification. Code completion tasks are used to check the learner's programming skills: if he/she has difficulties with a particular kind of questions or tasks, the system will increase their number in the next session in order to provide the learner with additional opportunities for improving the skills in mention.

The contribution of this paper is outlined in Fig. 2. It shows how application and domain models of the original *Mag* system were updated to include *Provoking* and *Zestful* pedagogical agents.

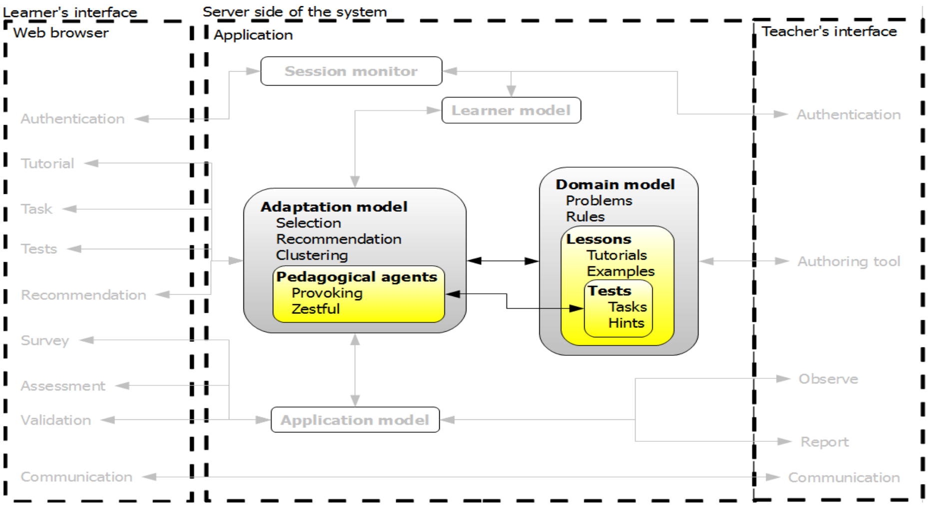

Fig. 2. Architecture of the proposed *MagMAS* agent-based e-learning system

As already mentioned, to each lesson an arbitrary number of code completion tasks is attached. At the end of the lesson, the learner is required to conduct a post-test offered by the system. It includes mainly code completion tasks that evaluate the acquired programming knowledge and skills. Newly introduced *Provoking* and *Zestful* agents play an essential role in this process. They try to motivate the learner to correctly apply the acquired programming knowledge that was presented to him/her during the appropriate tutorial, and also illustrated by several accompanying examples.

After a completed lesson, the set of tasks to be accomplished by the learner will be chosen intelligently, based on the stored learner model, but also on the learner's immediate reactions to agents' proposals. For each programming task, a numerous *hints* are prepared (by teacher, in this version of system) and attached to code completion tasks in the domain model. Hints are prepared in two forms: the first form includes *useful* hints which will be used by *Zestful* agent, while the second form includes *provoking/somehow wrong* hints which will be used by *Provoking* agent.

Both *Zestful* and *Provoking* agents have the same goal – to increase the learner's quality of learning – but approach to this task differently. The *Zestful* agent offers hints that, in the usual methodology of teaching programming languages, represent useful directions for problem solving as propositions of appropriate solutions to the given problem. The *Provoking* agent, on the other hand, tries to steer the process of learning and problem solving in a bad direction by offering wrong parts of the code. That is, it offers false hints and suggests bad solutions to the given problem. The basic rationale behind this approach is to encourage learners not to follow the tutor's instructions blindly, but rather to employ critical thinking and, in the end, they themselves decide on the proper solution to the problem.

In the rest of the section we will shortly present an example of how our agents act in order to direct the learner. The task is to complete a Java program for calculating the first 10 members of the Fibonacci sequence. The problem is presented in a form of skeleton program with a specific area for entering the code snippet. The teacher has prepared several positive and provoking hints, which the agents use to stimulate the learner to reach the correct solution using the `for` statement. Some possible hints/appropriate sentences agents will use during conversation are:

Zestful Agent

1. `for (int i = ?; i < 10; i++){}` – "What should be the starting index? Remember that the first element of the Fibonacci sequence has the index 0, while the expression for calculating other elements is $f_i = f_{i-1} + f_{i-2}$"
2. `for (int i = 0; i <= ?; i++){}` – "What should be the ending index? Although you need 10 numbers, remember that the index of the first element is 0."
3. `for (int i = 0; i < 10; ?){}` – "Should you use `++i` or `i++` to modify the value of `i`? Remember that this modification is always executed *at the end* of the `for` loop."

Provoking Agent

1. `for (int i = ?; i < 10; i++){}` – "What should be the starting index? Hint: the first element of the Fibonacci sequence is often denoted as f_0"
2. `for (int i = 0; i <= ?; i++){}` – "What should be the ending index? Hint: look at the initialization of the array `f` – how many elements does it have?"
3. `for (int i = 0; i < 10; ?){}` – "Should you use `++i` or `i++` to modify the value of `i`? Remember that `++i` first increases the value of `i`, and then uses the new value in an expression."

5 Conclusions and Future Work

During the last couple of years we have been conducting development and implementation of several different learning tools and architectures, starting from traditional approaches [16, 23, 32] and towards the incorporation of recent approaches like recommender systems, personalized content delivery [19], usage of agents [15]. Our first attempt resulted in incorporating harvesting agents that facilitate process of obtaining new/additional learning material for existing course material. In this paper we went a step ahead as our primary goal was to include different kinds of pedagogical agents in the environment for learning programming languages. Introduced pedagogical (*Zestful* and *Provoking*) agents actively participate in learning processes, provoking and motivating learners to learn more effectively.

Of course, these initial ideas have to be further improved and practically implemented and evaluated. Additional efforts have to be put into obtaining more sophisticated useful and provoking hints, nevertheless they are prepared in advance by teacher or harvested from different learning repositories.

On the other hand there are some additional rooms for improvements. For example *Moodle* [21] system has been used within the majority of computer courses at our Department. The learners have been accustomed to using *Moodle* as the fundamental tool for learning activities. The client front-end of the system could be therefore designed as a *Moodle* plug-in. In this way, we will be able to seamlessly introduce the system to learners, i.e. in a, for them, familiar learning environment.

Finally some further improvements of the system could be directed in the domain of code visualization and animation. Both kinds of agents introduced in *MagMAS* could be enhanced by this functionality, having in mind tools like *Jeliot 3*.

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E-Learning 3.0: Anyone, Anywhere, Anytime, and *AI*

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The concept of e-Learning 2.0 has become well established and widely accepted. Just like how e-Learning 2.0 replaced its predecessor, we are again on the verge of a transformation. Both previous generations of e-Learning (1.0 and 2.0) closely parody the prevalent technologies available in their kin Web versions (1.0 and 2.0, respectively). In order to acquire a better perspective to assess what technologies will be available in the Web 3.0 and therefore e-Learning 3.0, we take a historical glance at the previous generations of e-Learning and the Web. We then survey some existing predictions for e-Learning 3.0 and finally provide our own. Previous surveys tend to identify educational needs for e-Learning, and then discuss what technologies are required to satisfy these needs. Educational needs are an important factor, but the required technologies may not reach fruition. Gauging past trends we take the reverse approach by first identifying technologies that are likely to be brought forth by the Web 3.0, and only then looking at how these technologies could be utilized in the learning domain. In particular, we pin-point Artificial Intelligence (more specifically Machine Learning and Data Mining) as a major driving force behind the Web 3.0. We therefore examine the influence that AI might exert on the development of e-Learning 3.0.

1 Introduction

In 2005, Stephen Downes [8] published a seminal article describing the next stage in the development of e-Learning, namely e-Learning 2.0. He noted that "e-Learning as we know it has been around for ten years or so. During that time, it has emerged from being a radical idea – the effectiveness of which was yet to be proven – to something that is widely regarded as mainstream." The shift to e-Learning 2.0 was due to the emergence of Web 2.0 and the resulting emphasis on social learning and use of social software such as blogs, wikis, podcasts and virtual worlds [24,32,9].

Just like the original concept of e-Learning, e-Learning 2.0 has become a mature and widely accepted paradigm, and like its predecessor before it, is now due for change. If the past is any indicator of the future, then the emergence of e-Learning 3.0 will also be strongly influenced by the technologies that will bring forth the Web 3.0. The concept of Web 3.0 is still in its infancy, but we are starting to see a number of early indicators that Artificial Intelligence (AI) will become an integral part of the Web 3.0.

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The Web 2.0 has enabled large scale user-generated content production. However, large parts of this data are simply stored away and are rarely, if ever, utilized by others (e.g. 97% of users never look beyond the top three search results [26], so millions of carefully crafted documents are never even looked at). Clearly this situation needs to be remedied, we believe that one of the main objectives of the Web 3.0 would be to enable utilization of this data, and AI will be a perfect tool for accomplishing this.

The paper is organized as follows. First, we briefly outline the influence that web technologies have had on the evolution of e-Learning (Section 2). We then survey the views of other researchers about what e-Learning 3.0 might be like (Section 2.3). Finally we outline new developments in AI and their potential influence on the evolution of e-Learning 3.0 (Section 3).

2 Evolution of e-Learning

E-learning has been evolving alongside the World Wide Web. As new web technologies become available, they find their way into the education domain, which by applying these new technologies makes it possible to both utilize new learning methods, and to enhance the use of the existing ones. Simply put, new web technologies enable the application of learning theories to eLearning. If we can understand this trend, then we can better understand the future of e-Learning. The best way to understand this trend, is to first look at it historically, by taking a quick look at where it has been (Section 2.1, Section 2.2). Then we can better assess existing predictions about where it is heading (Section 2.3), and make our own predictions as well (Section 3).

2.1 E-Learning 1.0

Web 1.0 made content available online. This was a very significant development since it allowed (at least in principle) for easy access to view (or read) information. However, this "access" is often seen as the staple functionality available with the Web 1.0, which is why it is often referred to as the "read-only Web" [27]. E-Learning 1.0 quickly adapted this new technology. The motto "anytime, anywhere and anybody" emphasized characteristics of e-Learning 1.0 – providing easy and convenient access to educational contents [9]. Therefore, e-Learning 1.0 mostly focused on creating and administering content for viewing online. To ensure high quality and usefulness of created "read-only" materials, the concept of a "learning object" was developed. Learning objects could be thought of as Lego blocks that allow for sequencing and organizing bits of content into courses, and to package them for delivery as though they were books or training manuals [8]. In turn, to support the utilization of learning objects the concept of a learning management system (LMS) was introduced. The learning management system takes learning content and organizes it in a standard way, such as a course divided into modules and lessons, supported with quizzes, tests and discussions, and integrated into university's information system [8]. These frameworks allowed not only to provide access to educational materials but also to log and analyze their usage. This in turn, allowed for an application of a number of learning theories and methods, including instructivism, behaviorism, and cognitivism, each briefly summarized below.

Instructivism focuses on transferring content from teacher to learner [31]. Utilizing the web for content distribution provides an alternative channel to lectures and textbooks. This theory requires the student to passively accept information and knowledge as presented by the instructor, which made it a particularly good fit for rather passive LMS of the Web (and e-Learning) 1.0.

Behaviorism treats learning as a "black box" process, i.e. only the inputs and corresponding outputs are observable quantitatively, and the inner workings of the learning process are assumed to be unknown. It is based on the principle of stimulus-response, and learning is viewed as an acquisition of new behavior through either classical conditioning, where the behavior becomes a reflex response to stimulus as in the case of Pavlov's Dogs, or operant conditioning, where there is reinforcement of the behavior by a reward or punishment [19]. Behaviorism emphasizes performance rather than the reasons that the learner performs a certain way [6]. The interactive capabilities of LMS 1.0 systems were primarily based on the behaviorism. LMS logs were used to observe: "input" through the access logs of learning materials, "output" through the advancement and performance measures, as well as system's attempts at conditioning. Once this data is analyzed the necessary adjustments could be made as to condition the learning process more efficiently.

Cognitivists were not satisfied with treating learning as a black-box process, and by analyzing learning logs tried to gain better understanding of the inner workings of the mind during the learning process [19] . The obtained knowledge was then incorporated into LMS as to take into consideration what has became known about the processes of learning, such as thinking, memory, knowing, and problem-solving.

2.2 E-Learning 2.0

In addition to the ability of reading contents online (provided by Web 1.0), Web 2.0 introduced a capability to write (or save content) and is therefore commonly referred to as the "read-write web" [8,27]. The capability to write content allowed for the transformation of the web from a passive provider of information to a social platform that allowed people to interact and collaborate with each other by expressing their thoughts and opinions online. Utilizing these new capabilities allowed e-Learning 2.0 to incorporate the social aspects of learning theories [4,20].

Constructivism views learning as a process of knowledge construction rather than absorption [11,6]. It is often associated with pedagogic approaches that promote active learning or learning by doing [19]. The use of Web 2.0 technologies allowed incorporation into LMS 2.0 the capability to allow students not only to passively read educational materials, but also to express opinions and to socialize [19]. This functionality made it possible to include ambiguous situations and open-ended questions which further promoted extensive dialogues among students [19,31]. Overall, this allowed for the embedding into learning environments the cornerstones of constructivist learning: context, construction, and collaboration [14,31].

Social Constructionism focuses on the artifacts that are created through the social interactions of a group, unlike social constructivism which focuses on an individual's learning that takes place because of their interactions in a group [32]. This motivated the incorporation of wikis and social networking services (SNS) into LMS 2.0, which enabled both the collaborative construction of artifacts and the corresponding examination and analysis of created artifacts [31].

2.3 E-Learning 3.0: Survey of Predictions

The predictions of the future of e-Learning vary due to the differences in opinions of what the Web 3.0 will be like, and which technologies will best suit the needs in the learning domain.

[30] considers that the Web 3.0 will be the "Read/Write/Collaborate" web. E-Learning 3.0 will have at least four key drivers: distributed computing, extended smart mobile technology, collaborative intelligent filtering, 3D visualization and interaction. Distributed computing in combination with smart mobile technology will enable learners to come closer to "anytime anyplace" learning and will provide intelligent solutions to web searching, document management and organization of content. It will also lead to an increase in self-organized learning, driven by easier access to the tools and services that enable us to recursively personalize our learning. Collaborative intelligent filtering performed by intelligent agents will enable users to work smarter and more collaboratively. 3D visualization and interaction will promote rich learning, by making a whole range of tasks easier including fine motor-skill interaction, exploration of virtual spaces and manipulation of virtual objects.

[12] considers that e-Learning 3.0 will be both "collaborative" and "intelligent". Intelligent agents will "facilitate the human thinking greatly". Collaboration will be further improved by tools like Twitter due to a number of its "communicative conceptual characteristics"; a place to share and consume information, a new real-time search engine, a service for Web users, a platform of debate, a tool for listening and analyzing, a perfect traffic generator, an excellent means to meet new people and create new connections, and talk about what you are doing right now.

[21] suggests that in e-Learning 3.0, meaning will be socially constructed and contextually reinvented, and teaching will be done in a co-constructivist manner. The focus of learning will shift from "what to learn" to "how to learn". The technology will play a central role, however it will do so in the background and become invisible. Technology will connect knowledge, support knowledge brokering, and enable translation of knowledge to beneficial applications.

[25] considers that e-Learning concept of "anytime, anywhere and anybody" will be complemented by "anyhow", i.e. it should be accessible on all types of devices. Virtual 3D worlds such as SecondLife are expected to become a common feature of the 3D web, facilitated by the availability of 3D visualization devices.

As a result, e-Learning 3.0 will be able to reach a wider range and variety of persons being available on different kinds of platforms/systems, through different tools, where users will have the possibility to personalize their learning and have an easier access to comprehensive information. This situation may turn e-Learning into a cross-social learning methodology since it will be possible to be applied in all contexts, making collaboration easier. To enable this view of e-Learning 3.0 [25] considers that LMS systems need to be capable of representing information through metadata, granting semantics to all contents in it, giving them meaning.

[7] considers that machine-understandable educational material will be the basis for machines that automatically use and interpret information for the benefit of authors and educators, making e-Learning 3.0 platforms more adaptable and responsive to each individual learner.

A number of researchers express concerns about the issues that will arise with the advent of e-Learning 3.0. [3] warns that the evolution of e-Learning management systems significantly enhances ethical dilemmas, and advocate for the adoption of an extension of the "Three Ps" model of pedagogy to become the "P3E" model: personalization, participation, productivity, lecturer's ethics, learner's ethics, and organizational ethics. [17,12] are concerned that e-Learning will be impacted by some of the challenges of the Semantic Web including vastness, vagueness, uncertainty, inconsistency, and deceit. [2] expresses concerns about the privacy and loss of control, as university integrates into its infrastructure services that are located in a variety of countries, with different privacy laws and principles.

3 E-Learning 3.0: Intelligent Learning

The existing forecasts about where e-Learning 3.0 is heading tend to focus on educational aspects (Section 2.3), and only briefly mention technical aspects. We take a different approach; since from past transformations (e-Learning 1.0 and e-Learning 2.0) we saw its close relationship with the available technologies of the current generation of the World Wide Web. The challenge then is to correctly identify which technologies will be brought forth by the Web 3.0 (Section 3.1). We then hypothesize how these technologies may be utilized in e-Learning 3.0 (Section 3.2).

3.1 Artificial Intelligence

Since the inception of Artificial Intelligence (AI) there has been a lot of hopes riding on it. While AI technologies have succeeded in many areas, in other areas AI has dramatically fallen bellow expectations and resulting in so-called AI winters (characterized by severely reduced funding and interest) during the 1970's and then again in the late 1980's. Most of AI's success so far has been primarily in 'restricted' domains where rules, settings and objectives are well defined, e.g. chess. In more open-ended domains such as education, the success of AI has been limited. This limitation primarily comes from the fact that open-ended domains are inherently more complex and therefore an AI system needs to contain a lot of parameters, which in turn require a lot of data for estimation and as a result require significant amounts of computational power.

We think that this time around AI will be able to succeed and to match a lot of expectations. Crucial components needed for the AI to succeed in more general open-ended domains starting to fall in place. There is a vast amount of data of available, importantly a lot of this data is "open" to a wide audience, i.e. not hidden behind the corporate or institutional walls (Big Data, Section 3.1). No matter how vast the dataset is it tends to provide a limited view on the problem. New technologies are allowing to establish links between these datasets as to obtain a more complete picture (Linked Data, Section 3.1). The significant infrastructure needed to store and intelligently process this data is now becoming easily accessible and affordable (Cloud Computing, Section 3.1) The new scientific framework is becoming available for supporting AI in the process of scientific discovery (Data-driven Science, Section 3.1).

Big Data. Recently, vast datasets are becoming openly available due to increase in user generated data brought forth technologies provided by Web 2.0. The type of data that is being generated also differs, larger portions of it are user generated such as blogs, tweets, and wikis. To emphasize the importance of the role that data is expected to play, Tim Berners-Lee has suggested that the next generation of Web should be referred to as "Data Web" [16]. Currently web data is severely underutilized, e.g. 97% of users never look beyond the top three search results [26], so other millions of carefully crafted documents are never even looked at. Web data contains a precious resource – intelligence and is therefore often referred to as "Web Intelligence" [33]. This intelligence needs to be extracted and utilized, and AI is a perfect tool for accomplishing this objective. We consider that the role of Web 2.0 was to enable data production, and the role of Web 3.0 will be to enable utilization of this data.

Linked Data. Web 2.0 Data exhibits different characteristics, it is no longer stored in a central well structured databases, but is in a free-form, fragmented and is spread across the internet. One of the objectives of the next generation web was defined as to create "a web of data that can be processed directly and indirectly by machines"[16]. Semantic Web is often considered a popular choice for accomplishing this task [16]. However, we along with many others e.g. [18] believe that semantic linking is overly ambitious and is yet hard to achieve on the wide and general scale due to inherent ambiguity of natural language. However, this does not mean that the data could not be linked and utilized. In order to widen the linking objectives the concept of "Linked Data" has been recently developed [10]. There has been a number of success of using AI to produce the needed links that even captures some of the semantics e.g. folksonomy [13].

Cloud Computing. Processing and analyzing large quantities of data requires significant computational resources as well as frameworks to make these resources easily accessible. A variety of competitively priced cloud computing services are becoming available, e.g. Amazon's AWS, Google's App Engine, Microsoft's Azure to name a few. In addition a number of supporting frameworks has been developed that made the power of computational clouds easily accessible, e.g. a widely adopted Hadoop/MapReduce, and a more specialized ones such as Mahout, Hive, Pig, Oozie, and Rhipe.

Data-Driven Science. Large data sets (Section 3.1) can potentially provide a much deeper understanding of both nature and society [1]. As a result, social scientists are getting to the point in many areas at which enough information exists to understand and address major previously intractable problems [15]. As a result, science is becoming data-driven at a scale previously unimagined and is fundamentally transforming the scientific process and is driving new innovations in science [22].

The traditional scientific process has followed a top-down approach of starting with a hypothesis, collecting the needed data, and finally evaluating the hypothesis. Data collection has traditionally been a very expensive and time consuming process. Therefore starting collecting data without having a hypothesis in mind was a very risky endeavor. Recently large number of datasets have become available for little or no cost, in addition collecting your own data has become very inexpensive (e.g. [28] have assembled a dataset of 20 million tweets on various aspects of learning for under $10). Having vast amount of data available, allowed to make scientific process a bottom-up approach, i.e. by first gathering data, and then performing analysis as to discover hypotheses hidden within the data.

Data-driven science is starting to gain a foothold in the education, as indicated by the rapid development and increasing applications in the new areas of educational data mining (EDM) [5] and learning analytics [29].

3.2 Potential AI Utilization by Learning Methods

The traditional approach to constructing e-Learning systems has been a time consuming process requiring an explicit implementation of all the assumptions and rules. Adapting AI in e-Learning may allow us to concentrate more on modeling rather than a tedious implementation of all the rules. Maintenance and adaptation cost will also be reduced, since by using the data-driven approach, the model is able to adapt to the new users and contents, as well as potential changes. However, due to the open-ended nature of learning, applying AI is not always straightforward. In the following paragraphs we outline some possibilities.

Out of all learning theories, application of AI to behaviorism is one of the most straightforward ones. This is because behaviorism treats learning as a "black box" process, i.e. only the inputs and corresponding outputs are observable quantitatively, and the inner workings of the learning process are assumed to be unknown [19]. Behaviorism emphasizes performance rather than the reasons that the learner performs a certain way [6]. This paradigm fits perfectly with AI, as a main goal of AI is to model the dependency between inputs and outputs. Once the model is obtained the inputs needed for the desired response could be obtained by applying methods based on stochastic optimization or control theory.

Cognitivisim in a way similar to behaviorism takes an objective approach by assuming that knowledge and learning tasks can be identified and performance can be measured, and the objective of education is to analyze and influence thought processes [31]. Given these similarities, AI methods could be applied to cognitivism in manner that is similar to behaviorism, but in addition, the explicit assumptions of cognitivism on how we store and manipulate informations need to be incorporated which could be achieved by utilizing existing cognitive models.

Unlike behaviorism, many of the learning theories aim at understanding the inner workings of the learning process; therefore applying black-box models is not suitable. However there are a number of white-box machine learning methods whose inner workings could be easily examined, analyzed, verified and extended, e.g. graphical models such as decision trees and bayesian networks, or rule based methods such as inductive logic or association rule learning.

Social aspects of learning could be thoroughly studied thanks to the data available from e-Learning and Web 2.0 tools. Moreover since collaborative tools are often used in an informal, self-driven manner, it allows to better understand collaborative behaviors outside of confines of classrooms and formal educational institutions; which previously was difficult if not impossible to do. There is a multitude of methods which could be applied to better understand collaborative behaviors. Network analysis could be used for examining structural dynamics of collaboration; natural language processing along with network flow models could be used to better understand knowledge diffusion.

Constructivism considers that learning and teaching is an open-ended process, unlike objective methods such as behaviorism and cognitivism [31]. Open-ended and vague nature of constructivism makes it difficult to analyze. Since there are no clear objectives, traditional supervised learning methods are not applicable. However, unsupervised learning methods do not require an explicit objective and therefore are applicable in these settings. By using unsupervised methods it is possible to find and analyze patterns that may allow to further enrich constructivst view of learning.

Having e-Learning systems that are AI and data-driven, by no means precludes from utilizing and including existing pedagogical knowledge. Quite the opposite, existing knowledge can and should be incorporated into e-Learning systems. However, its influence on systems decision and its interdependency with others parts of the model should be estimated and verified based the data, rather than try setting these parameters via "educated" guessing. A possible way of incorporating existing knowledge is by providing data on features that are considered important in the learning process (e.g. difficulty level of learning materials, student's learning type, etc.). If the data on the feature is already available it could be simply fed into the AI system; if not, feature mapping too can be learned from the data.

4 Conclusion

The Web 2.0 has enabled the generation of a substantial amount of data, both by users and about users. While this data holds substantial value, it is often severely under-utilized, by simply being stored away or even worse – discarded. We believe that the Web 3.0 will help users to sift and sort this mass of information by utilizing AI. In the domain of e-Learning, AI will likely be used not only for assisting learners, but also for gaining a deeper understanding of the learning process.

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A Web Content Accessibility Evaluation Process for Learning Objects in the Context of a Virtual Learning Environment

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Abstract. A wide variety of web content editors that are included on virtual learning environments, help teachers to create learning objects as web pages to support their teaching processes, those editors add some accessibility features to the generated web content . However in most of the cases, the generated web content is not always according to all Web Content Accessibility Guidelines (WCAG 2.0). As a result, teachers and students with disabilities could not properly use the web content in their learning or teaching process. In this paper, we introduce a plug-in for the TinyMCE web content editor to support the web content accessibility manual evaluation process by applying the Case Based Reasoning technique. It is useful, when teachers use the TinyMCE editor upon the ATutor virtual learning environment, because teachers can identify web accessibility failures that can be improved by using recommendations provided by human evaluators.

Keywords: virtual learning environment, learning objects, web content accessibility, accessibility evaluation, case based reasoning.

1 Introduction

Web content accessibility evaluation is a process whereby experts, developers or teachers should ensure that their web contents have at least the minimum level of web accessibility required by any user (with or without disabilities) in special when there is an interaction in a Virtual Learning Environment (VLE). One of the most important features in a VLE is the web accessibility. This feature allows teachers and students to use contents without any accessibility barrier. According to Dunn [1], when web technologies are used in an appropriate way and there is an understanding of user requirements, the learning objects presented on a VLE, can, at least, be made accessible to students with some type of disability.

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The widespread use of VLEs through the web requires accessible web contents to improve the access and use of learning objects by teachers and students with disabilities. Each time, teachers use more tools, like web content editors, to generate those contents. However, teachers are not always familiarized with web accessibility. To tackle this situation, the experience from experts can be used in the web content accessibility evaluation process.

In this work, we have considered some elements to introduce a new approach in the web content accessibility evaluation process especially when learning objects are created in the context of a VLE. Those elements are:

- Web content accessibility guidelines: In some countries the governments and educational institutions have a concern to improve the accessibility in web environments. But as an international recommendation we can use the guidelines of World Wide Web Consortium (W3C) known as Web Content Accessibility Guidelines (WCAG 2.0).
- VLE: virtual space where teachers create their learning objects and students interact as a complement to their traditional learning process. In this work we use ATutor as the VLE.
- Web content editor: in ATutor the default web content editor is TinyMCE.
- Learning Objects: in this work we consider as learning objects the web pages created by means of the TinyMCE web content editor upon the ATutor VLE.
- Users: there are two users, teachers and experts. Teachers create de learning objects and may be tagged as beginners in their knowledge about web accessibility; and experts evaluate the web accessibility in the learning objects.
- CBR: the recommendations from experts in the web content accessibility evaluation process help teachers to improve the accessibility of web pages. To support the generation of those recommendations we use the Case Based Reasoning (CBR) technique.

One of the most important questions we need to answer in order to provide an additional support in web accessibility evaluation (considering as scenario the interaction between users and a VLE) is: How can CBR technique support the web content accessibility evaluation process for learning objects in a VLE? To answer the research question, in this paper a new approach in the web content accessibility evaluation process is introduced.

This document is structured as follows: section 2, we introduce a background of web accessibility and the CBR technique; in section 3, we describe the main components of the introduced approach in a plug-in called Web Content Accessibility Plug-in (WCAP) and its implication on the ALTER-NATIVA project; finally in section 4 conclusions and future work are stated.

2 Background

2.1 Web Accessibility Guidelines

To understand the web content accessibility evaluation process it is important to have a reference about the guidelines proposed by the World Wide Web Consortium (W3C) [2] for this purpose. The Web Content Accessibility Guidelines (WCAG) is a recommendation of W3C and its latest version is the WCAG 2.0 [3] which was published at 2008. WCAG 2.0 is organized in four principles: perceivable, operable, understandable and robust. Principles are, in turn, divided in 12 guidelines and for each guideline was defined some success criterions [4]. In Fig. 1, it is given representative organization diagram for principles in WCAG 2.0. In addition to above organization of WCAG 2.0, each success criterion has one of the three levels of conformance proposed by W3C too. These levels are: A, AA and AAA, being A the lowest level [5].

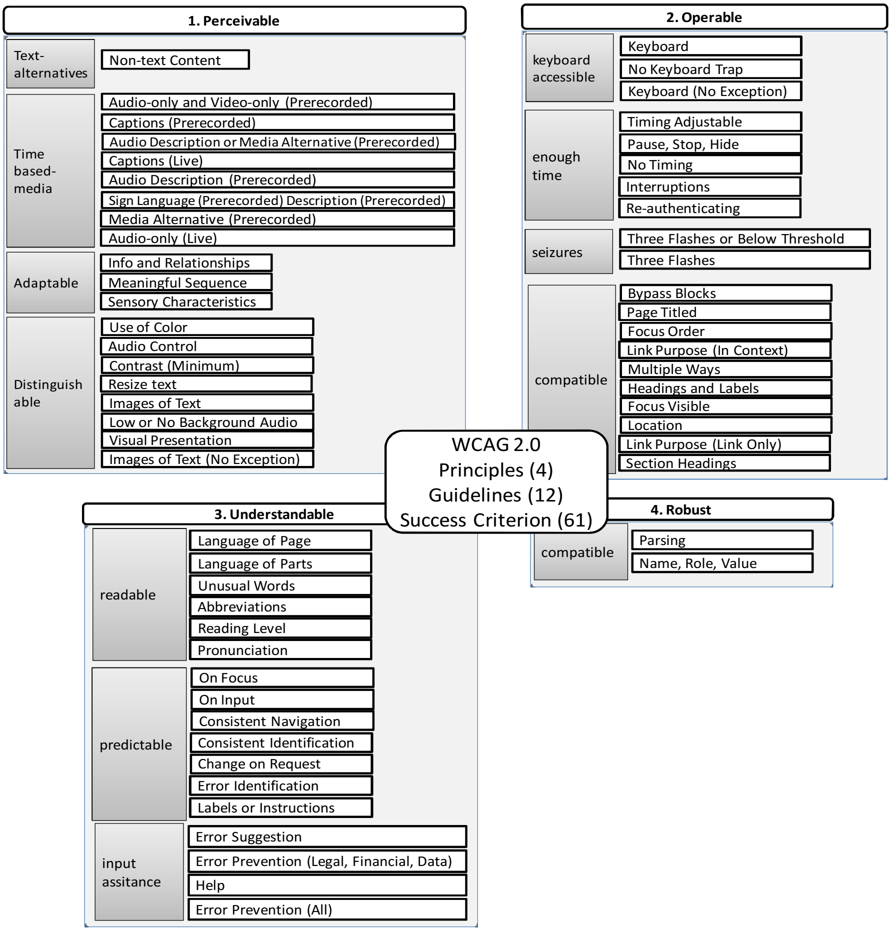

Fig. 1. Principles organization in WCAG 2.0

2.2 Web Accessibility Evaluation Process

According to the WAI (Web Accessibility Initiative) [6], a web content accessibility evaluation process can be defined as the process in which experts (with different expertise level) verify and determine if a web site meets standards and guidelines. As examples of this process, there are some case studies that show how is applied this web accessibility evaluation process. For instance, according to the study made by Alonso, Fuertes, González and Martínez [7], a set of web page are analyzed by people whose are learning about WCAG 2.0 (beginners) and Branjnik, Yesilada and Harper [8] present an study where the web accessibility of a set of web pages is evaluated by "expert" people in WCAG 2.0. In both examples, there is an agreement, a web content accessibility evaluation process has to ways of evaluation, a manual evaluation and automatic evaluation.

In the manual evaluation, experts use different strategies to evaluate the web content accessibility. Whereas that, the automatic evaluation is supported by software that analyzes the internal markup on the web pages and gets reports according to some characteristic selected by user. Following this description, on one side we can conclude that both of them process can be used in parallel way, because in a manual evaluation experts can use automatic evaluation tools in order to identify and get a solution to new failures on success criterion, on the other side an important stamen is mentioned in [7], the support material and different evaluation tools need to provide some kind of help to human evaluators in order to obtain consistent results in the future. In [8] is analyzed the expertise effect assuming that there is different expertise levels of different evaluators. Then in the evaluation process, [8] define that is required that experts know and understand about:

- How people with some kind of disability use the web environments?
- What kind of assistive technologies need to use the user to navigate through the web contents?
- Which are the limitations of those technologies?
- How they interact with other technologies?

As mentioned above, manual evaluation process requires the support of some automatic evaluation tools. These kinds of tools get us different possibilities when we like to generate a report evaluation of a specific web page. For example, in some of them we can select which version of WCAG we like to work, which type of structure (CSS, HTML, and so on) we like to evaluate.

2.3 Automatic Evaluation Tools for WCAG 2.0

There are a set of automatic validators for web content accessibility evaluation that works under WCAG 2.0 recommendation. In the Table I, are listed and analyzed some of them. The comparative attributes are referred to: is the validator an online service?; is it an standalone application?; is it open source?, does allow it a demonstration?; and does allow it file upload to test local web pages?.

Table 1. Comparative of Automatic validation tools for WCAG 2.0

Validator	Comparative attributes					
	Online	***Standalone***	***Free***	***Open Source***	***Demo***	***File Upload***
AChecker	X		X	X		X
TAW	X		X		X	X
eXaminator	X		X			
TotalValida tor tool		X	X			X
SortSite	X	X			X	X

By means of above analysis we identified that is possible to work with the AChecker validator [9] because this service is available online, is free and open source, besides it can be integrated within some VLE.

Once we have introduced the web accessibility concepts, in the next section a background of case based reasoning (CBR) is presented.

2.4 Case Based Reasoning (CBR)

As is known in the CBR technique new problems represent new cases to be solved by means of case retrieval from previously correctly solved similar problems [10] [11] [12]. Moreover, this technique uses the past experience (solving cases) to feed a set of cases. In this work, we choose CBR technique because it allows us to match the experience from experts who know about accessibility in web contents (using the success criteria of WCAG 2.0) with the design of educational web content. For instance, when a teacher uses the TinyMCE web content editor, he/she would need a help to know how to do web pages more accessible. In this sense, the CBR technique is useful to provide a set of recommendations based on the identified web accessibility failures in the evaluation process.

CBR technique is developed by means of a cycle which is known as four R or R4 [13] because the process (that is involved on it) can be represented as a cycle of four stages and each first letter in the name of the stage is R: Retrieve, Reuse, Review and Retain.

3 WCAP – Web Content Accessibility Plug-In

This section explains the plug-in developed and integrated in the TinyMCE editor in order to support the web content accessibility evaluation process when teacher are creating and editing learning object as web pages. Besides, this section explains, each step of the CBR cycle involved in the web accessibility evaluation process.

3.1 CBR Cycle on Web Content Accessibility Evaluation

In Fig 2 is presented the R4 cycle applied to the web content accessibility evaluation process described for this work. It is given a new problem (failure with some success criterion according to WCAG 2.0) at first stage or retrieve stage; a similar case or a set of similar cases are retrieved from the library case which store all case solved (second stage: Reuse); Then when a similar solution is retrieved some adaptation could be needed in order to solve the new case (third stage: Review). Once the solution is given, a new case and its solution are stored in the library case as a learned case in the retain stage. Finally the system store the case completely solved (fourth stage: Retain).

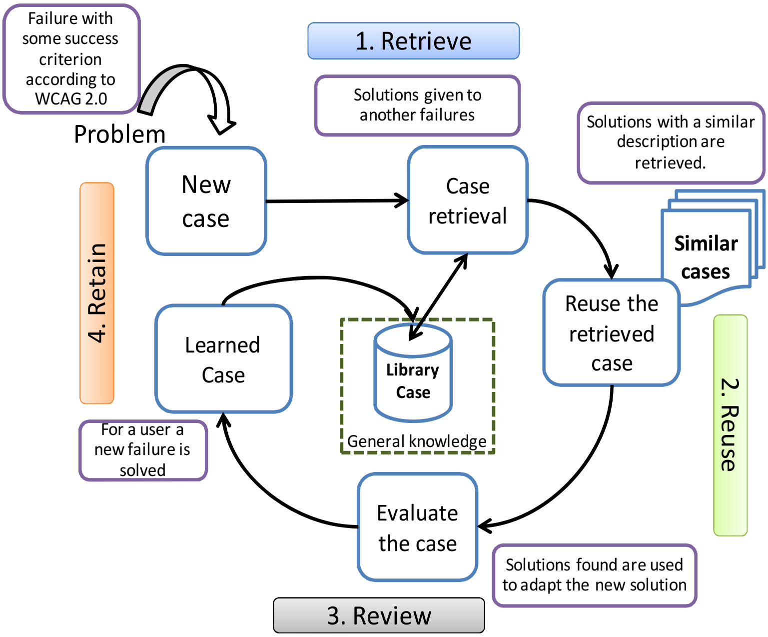

Fig. 2. R4 Cycle in web content accessibility evaluation

3.2 WCAP and ALTER-NATIVA Project

WCAP is presented as a plug-in which will support the task of teachers in the web content accessibility evaluation process when they using TinyMCE editor. This plug-in is developed under work context of ALTER-NATIVA [14] project. ALTER-NATIVA is a European project and its main goal is to define curricular references with technological support for higher education in the areas of language, mathematics and science, for attending people in context of disability (such as blind people, deaf people and indigenous people). Taking into account the disabilities covered by the project, there is a need to create accessible learning objects, so that all people, with different needs and preferences, can use the generated content for their learning process. WCAP will be tested in the validation stage of ALTER-NATIVA project.

As a schematic representation of the process depicted in Fig. 3 shows how the workflow diagram is performed when the teacher and the expert interact with WCAP. Notice that some steps have an indication of which stage of CBR cycle is corresponding with.

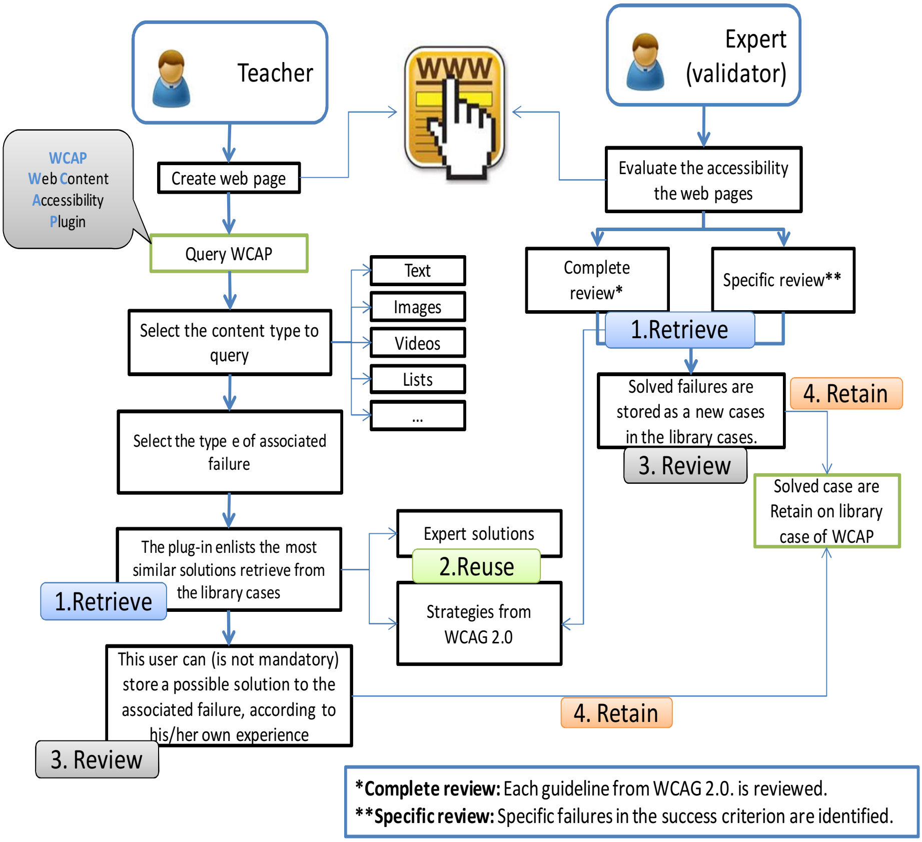

Fig. 3. WCAP Workflow

The main steps in the process are:

- Teacher creates new learning objects as web pages by using a web content editor integrated in a VLE.
- The expert reviews the list of web pages in the system and then selects some page to be evaluated. Next the expert chooses between a complete review of the web page or a specific review.
- After that, expert or teacher can select an element with some failure according WCAG 2.0 and at this point is presented the form of a new case.

- Once the expert or teacher sends the query that allows evaluating the new case, by means of WCAP (Fig. 4) the most similar cases are retrieved. This similarity is calculated by mean of the attributes presented in each case.
- A set of the most similarity solutions according to the current case are suggested to the expert or teacher who decides if use some of these suggestions to elaborate the new solution to that case
- When the solution to the current case is stored as a learned case in the library cases, it will be available to solve other new problems.
- The teacher uses advertise of the web content accessibility manual evaluation process as a recommendation to improve the accessibility on their learning objects (in this case web page).
-

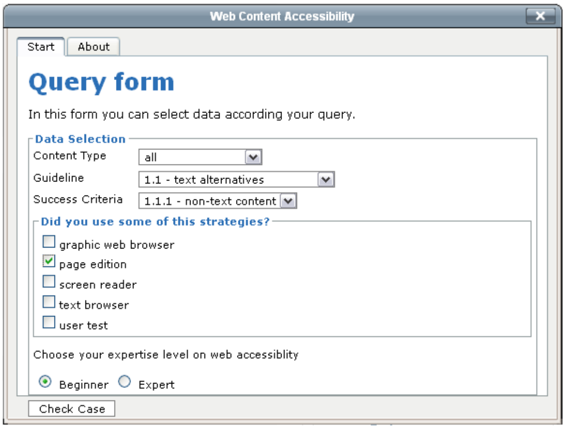

Fig. 4. WCAP query form screenshot

3.3 Implementation Notes

To develop the WCAP plug-in integrating the CBR technique we use the jCOLIBRI [15] framework. This framework was developed by the GAIA [16] group from the Universidad Complutense de Madrid. A class in the framework is implemented by using three main methods: PreCycle, Cycle and PostCycle. In the PreCycle method, the component and its connection to the library case is configured, in the Cycle method, each stage of the CBR cycle is performed and in the PostCycle method connections are closed.

Taking into account the CBR cycle, to retrieve the most similar cases in the retrieval stage, jCOLIBRI uses different methods and the most important retrieval methods is the Nearest Neighbour or NNretrieval. In this method a similarity between new cases and stored cases is computed to retrieve the best recommendation in web accessibility for teachers.

To integrate the WCAP plug-in in the TinyMCE editor, we developed two modules:

- The first module was modeled as a dynamic web application, which uses the jCOLIBRI framework. This application is connected with a library case (in a Postresql [17] database) where the expert`s experience about the failures in web content accessibility is stored. This module also supports the core services of the CBR-based component.
- The second module is the plug-in developed in Javascript language, in which teachers can search for solutions about their web accessibility doubts, mainly when they need to know how to solve an accessibility problem in the web content they are editing.

Both of these modules were connected using the DWR (Direct Web Remoting) [18], a bridge to communicate the Javascript interface of the plug-in with the CBR-based component.

4 Conclusions and Future Work

The plug-in WCAP is not introduced as a new web accessibility evaluation method; it is an additional support to the manual approach of web accessibility evaluation. In addition, the architecture could be implemented in a wide variety of areas such as software development industry (in order to improve the process of accessibility evaluation in software products), educative context (in order to manage the evaluation process of learning objects during the implementation process by teachers), organizations (which support companies in the process of making their web pages accessible). This wokr is an effort towards the inclusive and accessible web for all so that people with any disability such as visual impairment, deafness or cognitive disabilities can access to all web content.

CBR technique provides an important support that allows us to integrate the people's expertise about accessibility in web content evaluation with the success criterion of WCAG 2.0. By means of CBR the architecture combines solutions regarded web accessibility issues providing a better support in the evaluation process including recommendations from other experts.

As future work, we are planning to use and improve the plug-in according to the results obtained after the test stage of ALTER-NATIVA European project.

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Virtual Laboratory for the Study of Kinematics in Engineering Faculties

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Abstract. In engineering faculties, kinematics is studied during the first year, providing the basic knowledge for understanding, modeling and designing mechanical systems. The traditional method of teaching kinematics uses drawings and mathematical equations to explain the motion of rigid bodies forming various mechanisms. From the experience of the authors, due to this approach students often tend to regard kinematics as excessively abstract, having difficulties in understanding the correspondence between analytical expressions and the actual behavior of mechanisms. The Virtual Laboratory of Kinematics (VLK) is an attempt to overcome these difficulties, by allowing students to visualize and interactively modify the motion and configuration of basic mechanisms. VLK consists of a package of software applications, which has been tested in theoretical mechanics classes during the past few years. The favorable feedback received from students encouraged the authors to improve it gradually and, recently, to completely re-write it, also implementing additional features and capabilities.

Keywords: virtual laboratory, mechanics, simulation, mechanism.

1 Introduction

Generally taught in the first year in engineering faculties, kinematics is part of the fundamental course of theoretical mechanics. The knowledge acquired in this course provides the basics for the study, in the following years, of technical disciplines addressing the design of mechanisms and, in general, of various mechanical devices.

The traditional way of teaching kinematics consists in using schematic drawings and mathematical formulas to explain the motion of points or of rigid bodies. The application sessions consist, in the same approach, in demonstrations made by instructors in the laboratory, based on the use of mechanical models. This teaching method has inherent shortcomings because of its relatively limited capacity of illustrating the correspondence between the analytical expressions taught at the course and the actual phenomena. At the same time, the mechanical models used for demonstration are unable to exemplify some of the key notions taught at the course, for instance the trajectories, velocities or accelerations of certain points. Moreover, their

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configurations and characteristics are generally difficult to adjust, so that the possibility of varying the problem input and parameters is limited.

The use of e-learning technologies and software can provide a modern, more efficient way, of teaching kinematics, by the virtualization of mechanical models and laboratory demonstrations. During the past two decades, with the increasing use of personal computers, the development of virtual laboratories as e-learning instruments has gained momentum in various fields, from technology to natural sciences or mathematics and for different levels of instruction [9], [10], [13]. Applications designed for teaching engineering sciences in universities represent a distinct category. Today, many universities use in-house software dedicated to such purposes [2], [4], [6-8]. This software provides low-cost, highly customized solutions for the teaching process, having the advantage, in contrast with commercial products, of being easily adaptable and extendable according to local curricular requirements.

During the past few years, the authors of the present paper have experimented different methods of improving the teaching of kinematics, and of theoretical mechanics, in general. The Virtual Laboratory of Kinematics (VLK) is one of the most recent results of these efforts, consisting of a package of software applications dedicated to the modern and efficient teaching of the discipline. Created by using modern software development platforms, namely Visual C++ [5] and OpenGL [12], these applications display real mechanisms and allow the user to interactively customize the sizes of the parts, the parameters of the motion and the graphical representations. VLK incorporates the experience acquired by the authors in the use of earlier applications developed by them for the study of different chapters of theoretical mechanics [3].

2 Description of the Virtual Laboratory of Kinematics

2.1 General

The Virtual Laboratory of Kinematics (VLK) includes, at present, four software applications, designed to illustrate animatedly various kinematical characteristics of mechanisms containing rigid bodies, in translation, rotation and plane motion, respectively [1], [11].

Each application starts with a default set of values, but the user can define, optionally, his own input data. By checking or unchecking various checkboxes, the user can also choose the characteristics that are represented.

The applications display the motions of the mechanisms, with the instantaneous values of the coordinates, as well as the velocity and acceleration components, for the relevant points of the considered mechanical systems.

The graphic style and layout of the applications was optimized, taking into account the following requirements:

- maximum clarity and simplicity of representation, for easy understanding and focusing on the important features;
- minimal use of hardware resources, so that students working on lower performance computers should not be disadvantaged;

– maximum contrast and visibility, for visually impaired students;
– large display, adapted for use with a projector.

All applications provide the possibility of zooming in and out the display, in order to obtain detailed and overall views of the mechanisms. This feature is particularly useful for displaying entirely the generated trajectories and centrodes.

2.2 The "Cardan" Application

The application studies Cardan's problem, i.e. the motion of a bar with one end constrained to move on a horizontal straight line and the other end constrained to move on a vertical one. An application of this type of mechanism can be found in steam engines.

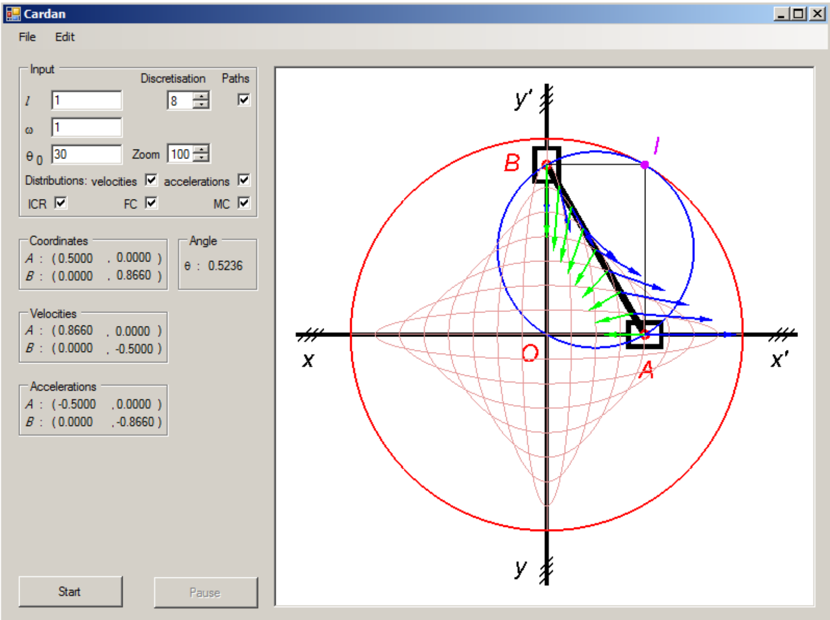

Fig. 1. The "Cardan" application: trajectories, velocities, accelerations, instantaneous center of rotation, fixed centrode, movable centrode

The application illustrates the main characteristics of the plane motion of a rigid body (Fig. 1): trajectories, velocity and acceleration distributions, instantaneous center of rotation (ICR), fixed centrode (FC) and movable centrode (MC).

The student can define the following data: length of the bar, l, angular velocity, ω, initial angle between the bar and the vertical direction, θ_0, and a bar discretization parameter (used to represent the trajectories, as well as the velocity and acceleration fields).

The program is based on the formulas that define the coordinates of the end of the bar, expressed with respect to the Cartesian reference system in Figure 1 (with the horizontal axis xx' and the vertical axis yy'),

$$\begin{cases} x_A = l\sin\theta \\ y_A = 0, \end{cases} \qquad \begin{cases} x_B = 0 \\ y_B = l\cos\theta, \end{cases} \tag{1}$$

where

$$\theta = \omega t + \theta_0 . \tag{2}$$

The instantaneous center of rotation, I, is a point of zero velocity, situated on the rigid body that is in plane motion (bar AB) or on an extension of this body. With respect to the fixed reference frame, the point I describes a curve called fixed centrode (the large circle in Fig. 1), while with respect to the reference frame linked to the body it describes another curve, called movable centrode (the small circle in the same figure).

2.3 The "Parallelogram" Application

The program studies the motion of a parallelogram mechanism, which consists of three bars. Two of the bars (having the same length), are connected by hinges to the fixed element, while the third one (with the length equal to the distance between the fixed hinges) is connected by hinges to the first two. The first two bars have rotation motions, while the third one has a translation motion. An application of this type of mechanism can be found in front end loaders.

The program illustrates the main characteristics of the rotation motion and translation motion, respectively, of a rigid body (Fig. 2): trajectories, as well as the velocity and acceleration distributions.

The student can define the following data: length of the rotating bars, $a = OA$, length of the translating bar, $b = AB$, angular velocity, ω, initial angle between the rotating bars and the horizontal direction, θ_0, and two bar discretization parameters.

The program is based on the formulas defining the coordinates of the movable hinges, expressed with respect to a Cartesian reference system chosen with the origin in the fixed hinge, O,

$$\begin{cases} x_A = a\cos\theta \\ y_A = a\sin\theta, \end{cases} \qquad \begin{cases} x_B = a\cos\theta + b \\ y_B = a\sin\theta, \end{cases} \tag{3}$$

where the angle θ, made by the rotating bars with the horizontal direction, is expressed by relation (2).

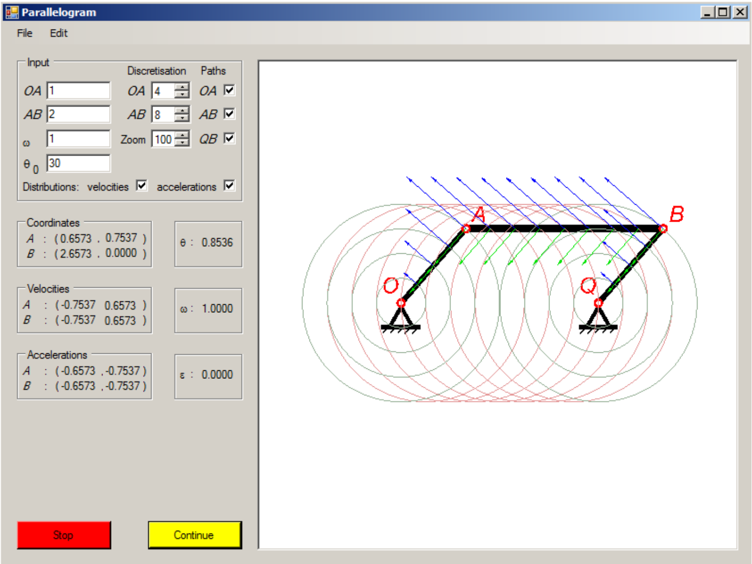

Fig. 2. The “Parallelogram” application: trajectories, velocity and acceleration distributions

2.4 The “FourBar” Application

The program studies the motion of a plane four-bar mechanism. The system consists of two bars connected by hinges to the fixed element, a third bar connected by hinges to the first two and a fourth bar (not represented by the program), connecting the fixed hinges. Unlike the parallelogram mechanism, the lengths of the bars are arbitrary. The first two bars have rotation motions, while the third one has a plane motion. Applications of this type of mechanism can be found in various industrial machineries, such as robots.

The program illustrates the main characteristics of the rotation motion and plane motion, respectively, of a rigid body, i.e. trajectories (Fig. 3), velocity and acceleration distributions (Fig. 4), instantaneous center of rotation (ICR), fixed centrode (FC) and movable centrode (MC) (Fig. 5). The method of velocity plane and the method of acceleration plane, used for the kinematical analysis of the system, are also represented in Figure 4.

The student can define the following data: lengths of the bars, $a = OA$, $b = AB$, $c = QB$, $d = OQ$, angular velocity of the bar OA, ω, initial angle of the same bar with the horizontal direction, θ_0, and three bar discretization parameters.

Using a Cartesian reference frame with the origin in the fixed hinge, O, the coordinates of point A are the same as for the parallelogram mechanism (3), while the coordinates of B can be determined from the equations

$$\begin{cases} (x_B - x_A)^2 + (y_B - y_A)^2 = b^2 \\ (x_B - d)^2 + {y_B}^2 = c^2. \end{cases} \tag{4}$$

The two centrodes of the bar AB are complex curves, each with two branches, determined numerically, unlike the case of "Cardan" application, where they are circles.

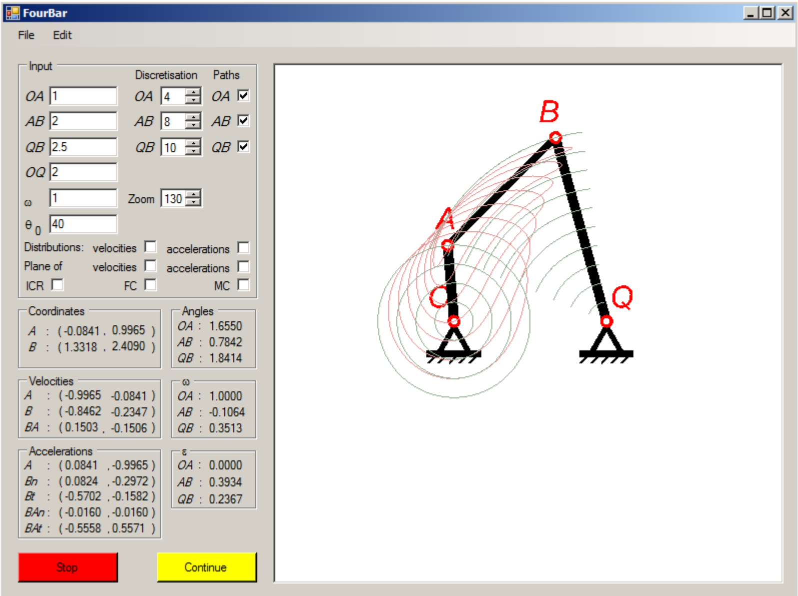

Fig. 3. The "FourBar" application: trajectories

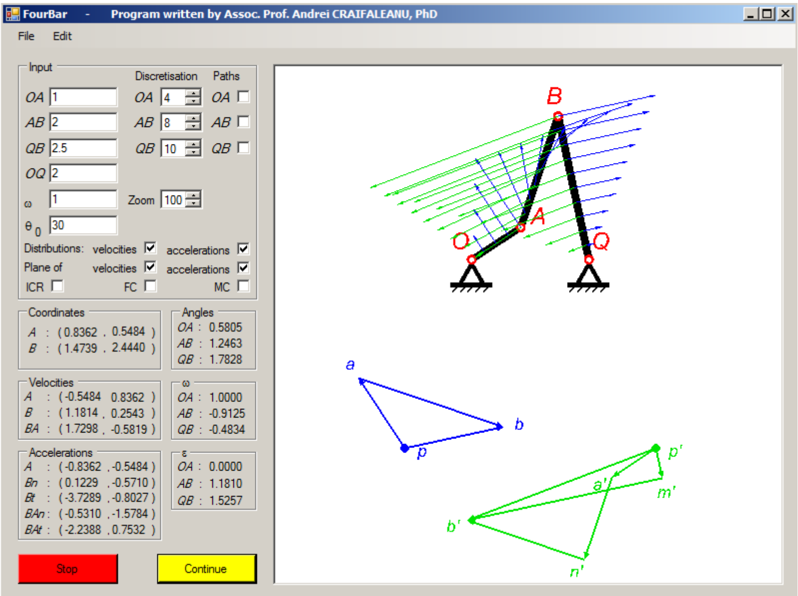

Fig. 4. The "FourBar" application: velocity and acceleration distributions, plane of velocity, plane of acceleration

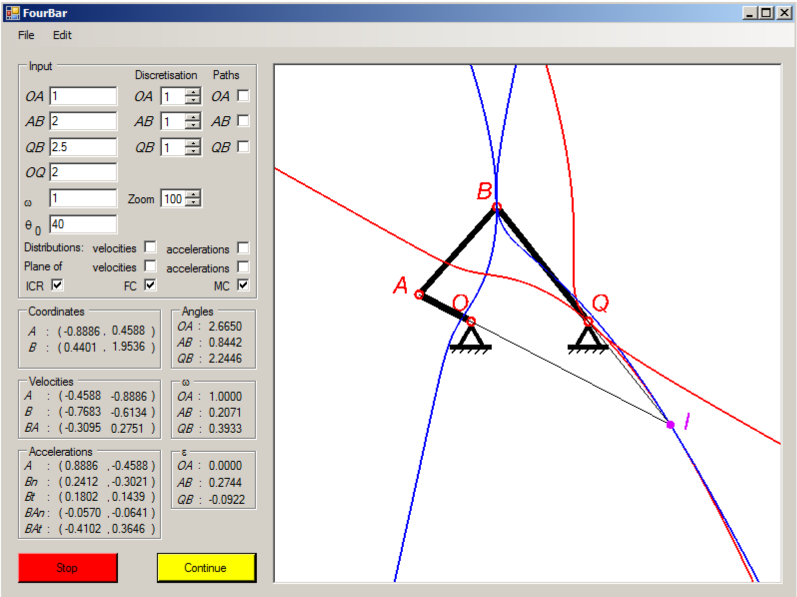

Fig. 5. The “FourBar” application: instantaneous center of rotation, fixed centrode, movable centrode

2.5 The “SliderCrank” Application

The program studies the motion of a slider crank mechanism (without or with offset), which consists of two bars, one of them connected by a hinge to the fixed element and the other connected by hinges to the first bar and to a slider. The first bar has a rotation motion, while the second bar has a plane motion. This type of mechanism, which converts the translation motion into rotation, is currently used in piston heat engines.

The program illustrates the main characteristics of the rotation motion and of the plane motion of a rigid body, i.e. trajectories, velocity and acceleration distributions, the method of velocity plane, the method of acceleration plane (Fig. 6), instantaneous center of rotation (ICR), fixed centrode (FC) and movable centrode (MC).

The student can define the following data: bar lengths, $a = OA$, $b = AB$, offset (distance between hinge O and the fixed direction xx'), e, angular velocity of the bar OA, ω, initial angle of the same bar with the horizontal direction, θ_0, and two bar discretization parameters.

Using a Cartesian reference frame with the origin in the fixed hinge O, the coordinates of point A have, again, the expressions written for the parallelogram mechanism (3), while the coordinates of B are determined from the equations

$$\begin{cases} x_B = a\cos\theta + \sqrt{b^2 - (a\sin\theta - e)^2} \\ y_B = e. \end{cases} \tag{5}$$

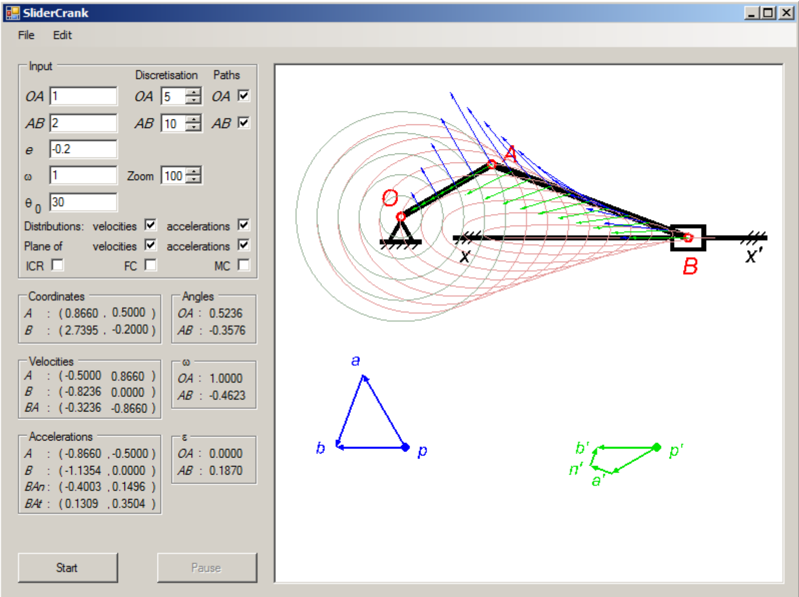

Fig. 6. The “SliderCrank” application: trajectories, velocity and acceleration distributions, plane of velocity, plane of acceleration

3 Use of VLK in Application Sessions

3.1 Steps of the Application Session

VLK was used in kinematics application sessions at the University “Politehnica” of Bucharest. The steps of the application session are described below. The corresponding course chapters are used as prerequisites.

1. Brief reminding of applicable notions and equations, performed by the instructor.
2. The instructor presents problem-specific aspects, in preparation of the practical demonstration.
3. The instructor explains the use of the software application (component of VLK).
4. The students fill in the input data, launch the animation and observe the motion of the mechanism, as well as the real-time evolution of parameters, trajectories and graphic representations.
5. By changing successively each input parameter, the students observe the modification of the mechanism behavior and of the graphical output (trajectories, centrodes etc.).

The instructors assist the students in performing the last two steps and explain the changes observed on the screen. They also highlight the practical applications of the concerned mechanism, e.g. in various types of industrial machinery, and answer the questions asked by the students.

3.2 Observed Outcomes

The response of the students to the use of VLK in application sessions was extremely positive, with an evident progress in their active participation in the class. Due to the interactive features of the software, the sessions became more dynamic and attracted increased attendance. Students expressed favorable opinions about the new teaching method, some of them also suggesting GUI improvements or the development of VLK by including new applications.

From the point of view of the impact on the teaching activity, the use of VLK facilitates substantially the explanation of the mechanism motion and of the influence of various parameters on its behavior. Since most of the engineering students have a particular interest in mechanisms, as a field of their future profession, the illustration and the highlighting of the practical applications respond to their expectations.

One of the main factors that contribute to the success of kinematics teaching based on VLK is the fact that it puts together both the theoretical aspects of the problem (i.e. the equations that define the motion of the mechanism) and the practical aspects (i.e. its visualization and interactive control), creating, thus, a suggestive correspondence between the analytical expressions and the actual behavior of the mechanism.

4 Conclusions

The Virtual Laboratory for the study of Kinematics (VLK) consists of a package of graphical interactive software applications, developed to facilitate the understanding of the key notions of kinematics by students in engineering faculties. The applications provide a set of simple mechanisms, for which the user can customize appearance, size, motion parameters and displayed characteristics.

The applications structure is developed such as to illustrate the key aspects taught at the course, by providing an intuitive demonstration of the motion of the studied mechanisms, combined with various animated representations, such as velocity and acceleration distributions, fixed and movable centrodes etc.

The graphical representations, as well as the layout of the applications screens, are optimized for maximum clarity, accessibility and visibility, in order to provide the best quality of information dissemination to all students.

The authors benefited, in the development of VLK, by the experience acquired with some earlier applications created by them for the study of different chapters of theoretical mechanics. The favorable feedback received from the students encouraged the authors to gradually improve these applications, by adding new features and, recently, by completely re-writing them, adding new mechanisms and upgrading their graphical capabilities and overall performance.

Based on the scalable concept of VLK, future development is planned, consisting in gradually adding new applications for various kinematic mechanisms.

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Effect of Multiplayer Interactive Violent Video Games on Players' Explicit and Implicit Aggression

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Abstract. While violent video games are of great concern to the public for their potential impact of inducing aggression, recent changes in the dynamics of gaming has rendered study of such phenomena quite challenging. The impact of interpersonal factors on players' aggression has not yet to be fully understood. The present experiment was designed to test explicit and implicit aggression caused by multiplayer interactive violent games. 56 male participants were randomly assigned to three groups (four-player group, double-player group and solo-play group). Extrinsic Affective Simon Task (EAST) and words evaluation task (WET) were used to test implicit and explicit aggressive cognition respectively. Competitive Reaction Time Task (CRT) was for measuring explicit aggressive behavior. Results showed: (1) Participants with low-trait aggression were more aggressive in implicit aggressive cognition when playing in four-player group than in other two groups. (2) Explicit aggressive cognition was affected by both interactive modes and trait aggression without interaction. The solo-play group was more explicitly aggressive than the four-player group. High-trait aggression group was more aggressive than low-trait group. (3) Participants' aggressive behavior decreased as the number of players increased. Factors that affect violent video games' impact on players' aggression were discussed.

Keywords: Violent Video Games, Multiplayer Interaction, Explicit Aggression, Implicit Aggression, Trait Aggression.

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1 Introduction

1.1 Violent Video Games in People's Daily Life

Video games are widespread with the popularization of the Internet. According to the report of user's consumption in game market(2010), sales of online games in mainland China reached RMB 25.62 billion, an increase of 39.4% compared with the year 2008 [1]. Another accounting report(2012)showed that by the end of 2011, users of online games in China had surpassed 324 million [2].

Applications of rapidly developed computer-based technology make video games quite different from those PC designed games. Seeking commercial benefits, game developers design more interesting and more realistic video games to attract players through Virtual Reality Technology (VRT). More role-play modes are employed in video games to increase players' engagement and identity in game roles. Besides, open ended stories in online games increase the likelihood of players' addiction. At present, Massively Multiplayer Online Role Playing Games (MMORPG) becomes a trend of online games. Bringing high level enjoyment and immersion, multiplayer interaction has become essential in game design [3].

Of more concern, violent content is also designed in video games to attract players. In mainland China, supervision systems of video games are not sound, resulting in a flood of violent games without classification sold in markets. The authors in this study conducted a survey on video game habits in mainland China from 2009 to 2011, which showed among the most often-played three video games for college students, 84.4% of the games consisted of violence and 30.2% were extremely violent. For middle school students, 92.5% of their favorite games were violent.

1.2 Impact of Violent Games on Aggression

Early in the 1960s, psychologists found children learned aggressive behavior through imitating violent behavior on television [4]. Compared with other media, violent video gamestend to have a greater impact on players' aggression. With players' highly participation and interaction [5], video games reinforce players' aggressive behavior more directly and immediately [6]. Besides, lifelike violent content is more likely to form players' identification with violent characters in games [7]. Early surveys showed adolescents' aggressive behavior in schools was positively related to their frequency of playing violent video games [8]. Recently, many experiments have tested the causal relationship,indicatingthat playing violent games for a short time increased aggressive cognition, affect and behavior, physiological arousal, and decreased pro-social behavior [9-11]. Latest meta-analysis has reached conclusion that violent video games undoubtedly serve as risky causal factor of aggression [12].

1.3 Affecting Factors of Aggression: Focus on Multiplayer Interaction

Online games have popularized throughout the world. Rather than human-computer interaction in console games, online games are characterized by immediate multiplayer interaction. Online game players usually form groups or virtual communities, fight together as combat teams or fight against each other. Worries arousethat once multiplayer interaction is brought into violent games, aggressive behavior in the game world is connected to real life.

According to General Aggression Model (GAM) [13], when an individual is exposed to violent environment, personal and situational factors as input variables arouse a present internal state (i.e. aggressive cognition, aggressive affect and physiological arousal), consequently leading to thoughtful or impulsive aggressive behavior after appraisal and decision process. Most studies focus on the effect of physical situations (i.e. bloody graphic, game realism, game characters, playing perspective etc.) [14-17]. However, as a potential situational factorinducingplayers' aggression, multiplayer interaction was rarely studied.

Theoretically, multiplayer interaction in online violent games may affect players' aggression in following aspects: first, unlike console games, aggressive behavior in games is reinforced by social reinforcer as well as material reward. Second, as an easier transfer of learning aggressive behavior in games, multiplayer interaction relates the virtual world to real life more closely. Third, through playing roles and interacting with others in games, players tend to identify with the violent roles or gangs [18], thus increase aggression.

Empirical studies also demonstrated the difference between playing multiplayer interactive games and human-computer interactive games. It was found players experienced higher presence, immersion and enjoyment when playing with a real person than a computer [19]. Participant would show different physiological arousal when he was informed that he is playing with a human rather than a computer [20]. William and Clippinger (2002) found, relative to computer opponent, participants reported less hostility after playing with human opponent in non-violent games,implying that human opponent might arouse participants' awareness of social evaluations [21]. However, another studyindicated that participants had more aggressive thoughts after playing a violent game with human opponent than computer opponent [22].

When multiplayer interaction especially cooperation taken into account, the effect of violent games on aggression becomes confusing. On the one hand, realistic violent games increased higher aggressive affect and physiological arousal than non-realistic violent games [17]. Thus, players tend to increase higher aggression than solo-play violent games [19-20]. On the other hand, other studies indicated playing shooting games cooperatively with others resulted in less aggressive cognition [23]. Cooperation in games led to players' higher perspective taking and empathy [24].

Based on the above analysis, for one thing, multiplayer interactive violent games may lead to less explicit aggression under the influence of awareness of others withsocial evaluations. For another thing, it may lead to higher implicit aggression due to a more realistic violent content as well as higher involvement and physiological arousal. Therefore, the study aimed to test the effect of multiplayer interactive violent games on players' explicit and implicit aggression in comparison with solo-play games. As participants with hightrait aggression are more likely to be affected by violent games [9], trait aggression was examined as well.

We hypothesized that, as the number of player increases, (1) implicit aggressive cognition increases; (2) explicit aggressive cognition decreases; (3) explicit aggressive behavior decreases; (4) participants' aggression after game-playing is also affected by trait aggression. In general, multiplayer interactive violent games induce lower explicit aggression but higher implicit aggression.

2 Method

2.1 Participants

Participants were 56 male undergraduates at a large university in China, aged from 18 to 25 (*Mean*=21.07, *SD*=1.693). To avoid frustration (possibly aroused due to lack of game skills) which may result in aggression, all participants were required to have an experience of playing "Counter Strikes" (CS) (the game used in the experiment) for more than half a year. All participants provided their written informed consent for participating. Procedures were approved by the local institutional review board.

Participants completed a Game Addiction Scale [25], a Aggression Questionnaire (AQ) [26], and a questionnaire on game habits. The average self-report time of playing video games during the past 6 months was 0.86 hour/day (*SD*=0.679). The whole group was divided into high and low trait aggression groups by the median of AQ scores and randomly assigned to three between-subject groups (i.e. four-player/double-player/solo-play group). No difference was found on the total and subscales scores of AQ (Table 1) among the three assigned groups, all $F_{(2, 53)}<1.5$, all $p>0.10$.

Table 1. Group Assignment and AQ Scores *M (SD)*

		N	Total AQ	PA	VA	Anger	Hostility
Single	High T	10	89.6 (8.02)	29.3(4.35)	15.9(2.38)	23.3(6.41)	21.1(3.70)
	Low T	10	65.0 (7.18)	22.1(4.10)	14.2(4.05)	14.9(3.14)	13.9(3.60)
	Total	20	77.3(14.63)	25.7(5.56)	15.1(3.35)	19.1(6.55)	17.5(5.12)
Double	High T	8	88.0(7.97)	28.2(6.47)	19.4(3.11)	22.3(3.15)	18.3(5.37)
	Low T	8	70.3(5.92)	24.8(4.33)	12.3(2.38)	16.9(3.66)	16.4(1.51)
	Total	16	79.2(11.38)	26.5(5.60)	15.8(4.55)	19.6(4.30)	17.3(3.93)
Four	High T	10	88.2(8.39)	27.9(4.52)	17.3(3.16)	21.3(4.32)	22.0(3.77)
	Low T	10	68.9(7.51)	20.9(5.30)	13.4(2.22)	17.9(2.13)	16.6(5.62)
	Total	20	78.5(12.59)	24.4(6.00)	15.4(3.33)	19.6(3.76)	19.3(5.41)

Note: PA=Physical Aggression, VA= Verbal Aggression， High T= High Trait, Low T=Low Trait.

2.2 Experiment Design

A 3 (interactive modes: four-player cooperation, double-player cooperation, solo-play) ×2 (trait aggression: high, low) between-subject design was adopted to test participants' implicit aggressive cognition, explicit aggressive cognition and aggressive behavior after playing different interactive modes of violent games.

2.3 Materials

Game Selection

The first personal shooting game "Counter-Strike" (CS) was selected for its popularity and easy operation. It can be played either as a console game or an Internet game. The number of players and opponents can be set to accomplish three interactive modes with similar graphics and process. In the experiment,all participants played as cops to fight against terrorists controlled by computer. The numbers of cops and terrorists were set the same. The game was set at a low degree of difficulty toavoid frustration. According to Video Game Rating Sheet [27], games played in the three interactive modes were evaluated equally in aspects of enjoyment, difficulty, frustration, action speed, violent content and violent graphics, all $F(2, 53)<1.5$, all $p>0.10$.

Extrinsic Affective Simon Task

Extrinsic Affective Simon Task (EAST) was used to measure implicit aggressive cognition [28]. 10 attribute stimuli and 10 target stimuli (Chinese words) were selected with their use frequencies controlled (Table 2).

Table 2. Words Used In EAST

Target stimuli	A	Violate	Revenge	Smash	Lash	Batter
	NA	Smile	Gentle	Considerate	Affection	Embrace
Attribute stimuli	P	Delightful	Pretty	Joyful	Blissful	Lucky
	N	Painful	Disgusting	Corrupt	Foolish	Miserable

Note: A=Aggressive Words, NA=Non-aggressive Words, P=Positive Words, N=Negative Words.

Three blocks were included in the EAST. First, participants classified attribute stimuli (i.e., positive and negative words), which were colored white, by pressingeither a good key or a bad key according to valence of the words for 20 trials. Then, they classified the target stimuli (i.e., aggression and non-aggression words), which were colored blue or green, by pressing keys according to their colors for 20 trials. In the third block, with a mix of white and colored words presented for 120 trials, participants were instructed to press keys according to not only valence when words were white but also color when words were blue or green.Participants' reaction time and accuracy of the first response were recorded by E-prime.

Words Evaluation Task

Words Evaluation Task (WET) was used to measure explicit aggressive cognition. The WET was a7-point Likert-type scale to evaluate positivity and negativity of words (table 2). The words were displayed in a random order. More positive evaluations for aggressive words imply higher explicit aggression cognition.

Competitive Reaction Time Task

Competitive Reaction Time Task (CRT) is a valid measure of aggressive behavior [29]. Participants were told they were competing against another participant of faster responses. “Winner” could choose intensities of noise from level 1 (80 dB) to level 4 (110 dB)to punish “loser”. In fact the opponent didn’t exist, and the noise was set by the computer randomly in 48 trials. The intensity selections of each participant were recorded to measure his aggressive behavior.

2.4 Procedure

Participants were randomly divided into three different interactive-mode groups. Participants in the interactive modes didn’t know each other and played in separate rooms contacting through the Internet.

Participants practiced playing games for several minutes before experimental task and then were instructed to play in one of the three modes for 20 minutes. The four-player and double-player groups were instructed to play cooperatively. They were told their game scores would be summed up and compared with other groups. The winning group would receive an extra reward, while the losing group would be penalized. The solo-play group was told that their scores would be compared with other individuals for reward or penalty. After the 20 minutes of game play, participants fulfilled the EAST. Next, participants played games for another 10 minutes in order to enhance the treatment, followed by the WET. Then participants fulfilled the CRT following the instruction that they would play another game with another participant in the laboratory. Afterwards participants filled in the “Video Game Rating Sheet” and were briefly interviewed about the motivation of punishment selection during the CRT. Explanation of the experiment was debriefed to participants at the end.

3 Results

3.1 Preliminary Analysis

Four participants were excluded for game addiction according to “Game Addiction Scale” (GAS) to exclude a potential disturbing factor for the results. 52 participants’ data entered further analysis. Differences on AQ among the three different interactive-mode groups were not significant, all $F(2, 48)<1$, all $p>0.10$.

3.2 Implicit Aggressive Cognition

In EAST, trials of colored target words were analyzed. Reaction times less than 300 ms or more than 3000 ms were re-coded as 300 ms and 3000 ms respectively. One participant’s EAST data was excluded due to his low accuracy (3 S.D. away from mean). 51 participants’ data entered further analysis. The average accuracy of the remaining participants was 94%. We calculated the EAST scores d for aggressive and non-aggressive words respectively by deducting the mean log-transformed reaction time with positive responses from that with negative responses. Differences between ds and zero were examined(Table 3).

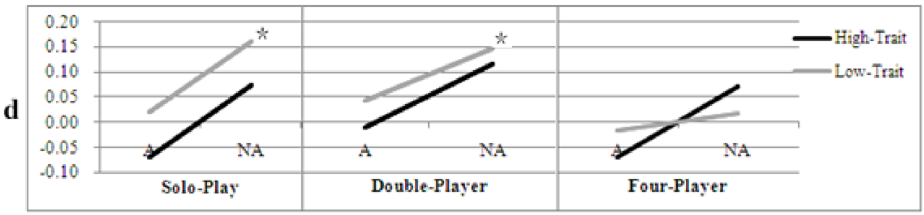
Initially, the effect of interactive modes on players' implicit aggressive cognition was examined. For aggressive words, ds of participants from the three groups was not significantly different from zero, indicating the participants in three interactive modes evaluated aggressive words as not negative. For non-aggressive words, ds of solo-play and double-player groups were significantly larger than zero, *p*=0.004, and 0.014 respectively, indicating the two groups evaluated non-aggressive words as positive. However, d of four-player group was not significantly different from zero, indicating evaluating non-aggressive words as not positive, implying higher aggression in implicit cognition than the other two groups.

Further analysis was conducted to test high/low-trait aggression groups in the three interactive modes respectively. As shown in figure 1, high-trait group from three interactive modes evaluated aggressive words as not negative and evaluated non-aggressive words as not positive, implying aggression in implicit cognition. Low-trait groups in the three interactive modes evaluated aggressive words as not negative. However, for the non-aggressive words, low-trait participants in solo-play and double-player modes evaluated non-aggressive words as positive; while in four-player mode, participants evaluated non-aggressive words as not positive, implying that low-trait participants had higher implicit aggressive cognition in the multiplayer mode.

Table 3. Log-transformed RT for Aggressive and Non-aggressive Words of Six Groups

		N	Words	PR	NR	*d*	*T*
Solo-play	High-trait	9	A	6.67 (0.22)	6.60 (0.21)	-0.07	1.04
			NA	6.59 (0.20)	6.67 (0.11)	0.07	-1.63
	Low-trait	10	A	6.77(0.26)	6.79(0.24)	0.02	-0.44
			NA	6.70 (0.19)	6.86(0.25)	0.16	-2.90*
Double-player	High-trait	8	A	6.76(0.20)	6.75(0.21)	-0.01	0.16
			NA	6.72(0.18)	6.83(0.22)	0.11	-1.53
	Low-trait	8	A	6.65(0.23)	6.69(0.23)	0.04	-1.19
			NA	6.60(0.21)	6.75(0.24)	0.15	-2.37*
Four-player	High-trait	6	A	6.67 (0.22)	6.60(0.21)	-0.07	1.06
			NA	6.59(0.20)	6.67(0.11)	0.07	-1.35
	Low-trait	10	A	6.79(0.28)	6.78(0.28)	-0.02	0.28
			NA	6.71(0.32)	6.72(0.31)	0.02	-0.24

Note: A=Aggressive Words, NA=Non-aggressive Words, PR=Positive Response, NR=Negative Response.



Note: * =0.05 sig. compared with 0

Fig. 1. d for Aggressive and Non-aggressive Words of Different Groups

3.3 Explicit Aggressive Cognition

The words evaluation of four groups from six groups is shown in Table 4. A 3 (interactive modes) × 2 (words) mixed ANOVA was conducted. The main effect of words was significant, $F(1, 49) = 142.28$, $p<0.001$. The main effect of interactive modes bordered on significance, $F(2, 49) = 2.65$, $p=0.081$. The interaction of words and interactive modes was significant, $F(2, 49) = 3.43$, $p=0.04$.Further simple effect analysis was carried out. For non-aggressive words, the effect of interactive modes was not significant, $F(2, 49) = 1.188$, $p=0.313$. However, for aggressive words, the effect of the interactive modes was significant, $F(2, 49) = 3.556$, $p=0.036$, indicating the three groups evaluated aggressive words differently (i.e., they showed different explicit aggressive cognition). According to the post hoc test of Bonferroni, four-player group evaluated aggressive words more negatively than the solo-play group.

It got more interesting when considering trait aggression as covariant.Besides the significant effect of interactive modes ($F(2, 48) = 3.989$, $p=0.025$), the effect of trait aggression was also significant, $F(1, 48) = 6.293$, $p=0.016$. High-trait groups were more aggressive than low-trait groups in explicit cognition. There was no interaction between the two factors.The results indicated that explicit aggressive cognition was affected by both interactive modes in games and trait aggression without interaction.

Table 4. Words Evaluation From Six Groups *M(SD)*

		n	Target words		Control words	
			A	NA	N	P
Solo-play	High-trait	9	2.56(0.654)	5.71(0.470)	1.98(0.430)	6.31(0.470)
	Low-trait	10	2.02(0.656)	5.98(0.569)	2.16(0.735)	6.20(0.833)
	Total	19	2.27(0.694)	5.85(0.569)	2.07(0.601)	6.25(0.670)
Double-player	High-trait	8	2.05(0.487)	6.18(0.483)	2.05(0.334)	6.55(0.298)
	Low-trait	8	1.93(0.413)	5.75(0.805)	1.88(0.320)	6.30(0.586)
	Total	16	1.99(0.441)	5.96(0.678)	1.96(0.328)	6.43(0.467)
Four-player	High-trait	7	1.94(0.472)	6.16(0.580)	1.86(0.574)	6.69 (0.414)
	Low-trait	10	1.66(0.499)	6.16(0.580)	2.00(0.490)	6.44(0.337)
	Total	17	1.78(0.494)	6.17(0.593)	1.94(0.514)	6.54(0.379)

Note: A=Aggressive Words, NA=Non-aggressive Words, P=Positive Words, N=Negative Words.

3.4 Explicit Aggressive Behavior

The mean punishment intensityin CRT was calculated. Participants' aggressive behavior decreased as the number of players increased, M (SD) = 2.24 (0.94), 1.95 (0.87), and 1.82 (0.76) for solo-play, double-player, and four-player groups respectively. No main effect of interactive modes was found in the 3×2 ANOVA, $F(2, 46) = 1.225$, $p=0.449$, indicating participants in different interactive modes shared an equal level of aggressive behavior. The main effect of trait aggression was not significant, $F(1,46)=0.657$, $p=0.502$. No interaction existed, $F(2, 46) = 0.931$, $p=0.401$.

4 Discussion

4.1 Effect of Interactive Modes on Implicit Aggressive Cognition

Results indicated the three groups displayed different affect to aggressive and non-aggressive words. Solo-play and double-player groups sensedaggressive words as more negative than non-aggressive words, while four-player group sensedboth aggressive and non-aggressive words as equally not positive, indicating higher implicit aggressive cognition. The hypothesis was partly confirmed.

Group size might function as a situational factor leading higher levels of aggressive cognition. Expecting to interact with an unfriendly group increases hostile expectations (aggressive cognition) and the presence of others increases arousal [30]. Additionally, senses of belonging to an online game group also affect game behavior. A survey showed individuals with high allegiance to online allies behaved more immorally than those belonging to no groups [31]. Fighting for benefits of in-group, individuals tend to make moral justification and dehumanize victim and consequently reconstruct cognitive structure to accept aggression [13]. Generally, fighting in groups, even cooperatively, would temporally change the structure of players' aggressive cognition, with higher implicit aggressive cognition.

4.2 Effect of Interactive Modes on Explicit Aggressive Cognition

Explicit aggressive cognition differed among groups. Four-player group showed less aggressive cognition than the solo-play group, partly confirming the hypothesis.

In multiplayer interactive games, players experienced higher presence and immersion through interaction with other players [19]. In other words, they perceived the game as real-life society with social interactions. According to Social Facilitation theories, presence of others arouses individual's self-awareness to adjust hisbehavior to social customs [32-33]. Multiplayer interaction made participants evaluate aggressive words more negatively to meet social norm through arousing players' awareness of social situations. In addition, players in online games pay attention to other players rather than physical stimulus [34]. Compared with interactive groups who cared more about cooperation with others, the solo-play groupconcentrated more on their own aggressive actions with reinforcement, thus tended to evaluate aggressive words more positively.

4.3 Effect of Interactive Modes on Explicit Aggressive Behavior

No significant difference of aggressive behavior was found among the three groups, indicating different interaction modes in the violent game might not be sufficient to stimulate different aggressive behavior. According to reinforcement theory of social learning, whether to conduct the learned aggressive behavior depends on environment factors, such as reinforcement and social competition [35]. GAM also emphasizes aggressive behavior will be conducted after appraisal [13]. Results of explicit aggressive cognition implied games with multiplayer situation might arouse participants' higher awareness of social appraisal, which might inhibit participants' aggressive behavior. However, facing competitive situations in the CRT, participants had limited access to cognitive resource, which might lead to impulsive aggressive behavior. In addition, a brief interview after experiment indicated some Chinese participants and tended to give low punishment in seeking for win-win result. Therefore, to some participants, competitive situations in the CRT and that in real life differed greatly, which confused the result as well as undermined the external validity of this experiment.

4.4 Effect of Trait Aggression

High-trait group was more aggressive than low-trait group. The resultwas consistent with Anderson's study (2000) and the prediction of GAM that players' aggressive personality and the situational factors co-determine aggressive behavior.According to GAM, it's easier and faster for players with high-trait aggression to startup aggression-related clues and aggressive behavior scripts.

It was interesting that implicit aggressive cognition was affected by trait aggression and interactive modes in games with interaction. On the whole, participants with high-trait aggression were more aggressive in implicit aggressive cognition than those with low-trait aggression. However, the conclusion was not applicable for four-player group. As the number of interactive players increased to four, participants with low-trait aggression displayed an equal level of implicit aggressive cognition compared to those with high-trait aggression. These results indicated players with low-trait aggression were more sensitive to multiplayer interactive violent games.

5 Conclusion and Suggestions

In conclusion, as the number of player increases, multiplayer interactive violent games induce lower explicit aggression but higher implicit aggression.Base on previous results, we suggest the following:

(1) Implicit aggressive cognition was affected by interactive modes and trait aggression with interaction. Participants with low-trait aggression had more implicit aggressive cognition when playing in four-player group than in other two groups.

(2) Explicit aggressive cognition was affected by interactive modes and trait aggression without interaction. Compared with four-player group, solo-play group evaluated aggressive words as more positive, implying higher explicit aggression. High-trait aggression group was more aggressive than low-trait group.

(3) Participants' aggressive behavior decreased as the number of players increased without statistically significant difference.

With the popularization of online games, future studies should take into account multiplayer interaction in games from a social and interpersonal perspective, providing an in-depth understanding of this phenomenon and elaborating on suggestions for future prevention and intervention.

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Towards a Quality Model for Open Courseware and Open Educational Resources

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Abstract. Seeing the world's knowledge as a public asset that can be accessed, shared, used and reused, etc. mediated by technology, especially ICT, is a potent idea and it may have an influential impact on educational processes within our society. A decade of development of initiatives that offer open courseware and open educational resources has passed, and all the related projects have contributed to the provision of open university-level digital educational materials. For the time being, there is no articulated set of quality criteria to be used for development, use, modification, evaluation, and comparison of such resources, though, there is concern about this subject. We introduce here a set of criteria for Quality Assurance of open courseware and open educational resources, from a social and constructivist perspective, as a first step towards construction of a quality model. They have been grouped in four categories related with content, instructional design, technology and courseware evaluation.

Keywords: open courseware, open educational resources, quality assurance, quality criteria, quality model.

1 Introduction

Within the last decade, the world's knowledge has been, and it is still seen, more and more, as a public asset that can be accessed, shared, used and reused, mediated by technology, especially ICT, and this powerful idea may have an influential impact on teaching and learning within our society. During this decade, a pleiad of initiatives that offer open courseware and open educational resources has emerged, resulting in worldwide related projects that have been providing open university-level digital educational materials. All these projects meet a huge demand for high quality educational resources that anyone may access from anywhere at any time via the Internet.

The most remarkable such initiative is, of course, MIT OpenCourseWare Initiative with the available instructional resources related to 2000 courses, and with the associated 250 universities and organizations that provide their course materials freely and openly for more than 13,000 courses in 20 languages [1-3]. MIT OCW has also triggered the development of The OCW Consortium, which supports the construction of OCW projects around the world, and which offers access to more than 6000 courses from 64 sources in 12 languages [4]. Another comprehensive repository is OER Commons with more than 31,000 instructional materials, which are very diverse from

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textbooks, audio or video lectures, and readings, to lesson plans, assessments, syllabi, etc. or even games [5]. The Connexions project is also relevant both by its size (more than 20000 reusable modules combined into more than 1200 collections), and even more important by its approach to support high reusability and easy remixing of the content [6]. Other open educational resources initiatives like Carnegie Mellon University's Open Learning Initiative are interesting because they intend, beside providing open courseware, to serve as platforms that increase our understanding about human learning, aspiring to contribute to the development of better learning environments by using that understanding [7]. Other promising OER/OCW initiatives are Webcast.Berkeley, Universia, Open University, Open.Michigan, and so on [8-11].

Another approach is taken by The Free Education Initiative of The Saylor Foundation, which is driven by the idea of "building" a free online university without walls or any other boundaries of conventional higher education systems [12]. Currently, there are available course materials for over 200 courses from the slated 241 courses, which are necessary for majoring in 13 areas of study. The available educational materials may be used in various ways, though The Saylor Foundation invites its learners to use them aiming to simulate the traditional four-year higher education experience, i. e., to select a major, to fulfill its requirements, and to complete the General Education Program. Recently, The Foundation has started another challenging initiative The Open Textbook Challenge, which aims to offer learners a cost-free alternative to traditional textbooks. Thus, The OTC stimulates authors to write or re-license textbooks as CC-BY by offering a $20,000 award for each textbook released this way. Another approach that is growing fast lately, which is somehow in between the two presented previously here, is Coursera, a Web portal that distributes interactive courses in humanities, social sciences, physical sciences and engineering that benefit from the constant support of the instructors and peers from a global learning community [13].

In this paper we propose a set of quality criteria that could serve as general guidelines for development, use, modification, evaluation, and comparison of open educational resources and open courseware, from a social and constructivist perspective. The structure of the paper is as follows: the second section offers o short motivation for research, the third one includes the criteria for Quality Assurance (QA) of open courseware and open educational resources, the forth includes the related work and the last one consists of some conclusions and future work ideas.

2 Motivation for Research

Despite that more than 10 years have passed since the launch of the MIT OCW program, a thorough search of the literature has revealed there is no articulated set of quality criteria or quality model to be used for construction, evaluation and comparison of OCW initiatives. Though, there is concern about this subject, and there are some projects aiming to develop such set [14, 15, 16]. However, no concrete results are available yet, so the users, being them learners, teachers, faculty etc., have no guidance in their quest for choosing the most suitable educational resources that match closely their educational needs at some point in time.

On the contrary, establishing quality criteria, benchmarks or metrics for evaluation of traditional online courses has been a constant preoccupation both for developers and users, on the one hand, and the educational institutions that provide such programs, on the other hand. Several programs or institutions have approached this subject and their efforts have resulted in standards for quality of online courses and learning, along with scoring systems to be used for their straightforward evaluation. These efforts have benefited from the work of teams of experts with various backgrounds (course development, instructional design, professional development, research, education, and administration) in education, both classical and online, who have been representing educational organizations that share an interest in online education and that are keen to offer to their students high quality online courses. Their work has been based on systematic literature review corroborated with specific surveys taken by significant actors in the online educational process [17-20].

Of course, we have to consider that while taking an online course in a blended learning environment or in a pure online learning program is a requirement for obtaining some formal recognition, like a degree, The OCW movement has started with the premise that OCW will not stand for a formal education, and it will not be granting university degrees or certificates. However, taking into consideration the magnitude of the progress of open courseware initiatives and their impact on users worldwide, it becomes crucial to provide the users, persons or institutions, with a valuable set of quality criteria, which can be used to assess the quality of open courseware and open educational resources. These criteria may be further used to develop a scoring system, aiming at helping users to establish the appropriateness of a particular open educational resource for their specific educational needs at some point in time.

3 Criteria for Quality Assurance of OER and OCW

In this section, we introduce a set of criteria for evaluation of the quality of open educational resources and open courseware. This works builds on the results of previous author's works on the matter of open resources for education, which have analyzed thoroughly the main open courseware initiatives around the world, and that have identified both the strengths and the weaknesses of their offer [1, 2, 21-25]. The QA criteria correspond to the quality characteristics of *quality in use*, *internal and external product quality* according to ISO/IEC 25000 SQuaRE standard, and they cover the next user needs: effectiveness, efficiency, satisfaction, reliability, security, context coverage, learnability, and accessibility. These quality criteria may be used for quality assessment of either small learning units or an entire courseware. They have been grouped in four categories related with *content, instructional design, technology* and *courseware evaluation*. A detailed presentation follows further on.

Content Related. In this category we have criteria that reflect whether the resource provides the online learners with multiple ways of engaging with their learning experiences, promoting their mastery of the content. They evaluate the usefulness of each educational resource, being it a small learning unit or an entire courseware. First, we think at easiness of using the resource, reflected by *readability* and *uniformity of language, terminology, and notations*.

When evaluating open courseware, users are first interested in the *availability of the course syllabus*, so they become aware since the very beginning of the content scope and sequence. At the same time, users might be equally concerned with the *comprehensiveness of the lecture notes*, i.e. whether the course content and assignments demonstrate sufficient wideness, deepness and rigor to reach the standards being addressed. *Modularity of the course content* is another issue to be approached in the first steps of the initiation of the learning process, as modular course components are units of content that may be distributed and accessed independently, giving each user both the *possibility to select the most suitable learning unit* at a particular time and the *opportunity to choose the most appropriate learning path* that matches user's needs and abilities, and which can be approached *top-down, bottom-up or as a combined approach*. *Availability of assignments* (with or without solutions), being them exercises, projects, and activities, is important as well, as they are content items that enhance the primary content presentation. These assignments may ask students to work independently or as a group, the latter especially when using open courseware for blended instruction.

When looking at a particular learning resource, other than an entire courseware, which can be a small learning unit, a course module, a lesson etc., users are particularly interested in various characteristics of the resource: *accuracy, reasonableness, self-containedness, context, relevance, availability of multimedia inserts*, and *correlation of the resource with the course in its entirety*.

Instructional Design Related. First, from the instructional design point of view, we have to consider the educational resource *goal and learning objectives*, which are expected to be clearly stated and measurable, as the learner's level of knowledge mastery and practical abilities is ought to be measured against both the main goal and each and every learning objective. The educational materials provide for multiple opportunities for learners to be actively engaged in the learning process, having meaningful and authentic learning experiences during undertaking various *appropriate instructional activities*: problem- or project-based learning, e-simulations, learning games, webcasts, scavenger hunts, guided analysis, guided research, discovery learning, collaborative learning groups, case studies etc. *Learning outcomes* state the learner's achievements after performing a learning activity, i. e. what learners will know and/or will be able to do as a result of such an activity, in terms of knowledge, skills, and attitudes. Related with them is the *availability of the evaluation and auto-evaluation means* (with or without solutions). The teacher users may be also interested in the *learning theory* (behaviorist, cognitivist, constructivist, humanist and motivational etc.) and in the *instructional design model* (ADDIE, ARCS, ASSURE etc.) that have been used to develop that particular educational resource.

Moreover, experiences that seed the stimuli for *reflective learning* will always add to the overall quality of the open educational resource or courseware. Under the reflection perspective, the desired outcome of education becomes the construction of coherent functional knowledge structures adaptable to further lifelong learning. Reflection here has two meanings. One would be the process by which an experience, in the form of thought, feeling or action is brought into consideration (while is happening or subsequently) and the other refers to the creation of meaning and conceptualization from experience and to the potentiality to look at things from another perspective (critical reflection) [26-29].

Technology Related. Both open educational resources and open courseware are expected to benefit fully from ICT technologies, to have user-friendly interfaces, to comply with standards for *interoperability*, and to provide for appropriate access for learners with special needs (*accessibility*). *Extensibility* of each educational resource, from a technological point of view, refers to easiness of adding content, activities and assessment, aiming at expanding learning opportunities. A high quality *user interface* is expected to provide for consistent and straightforward navigation throughout the resource, along with making available rich multimedia inserts, in various formats, and to match various learners' needs. A clear specification of the *requirements* with respect to the supporting technology at user's end (both hardware and software), along with the *prerequisite skills* to use that technology are useful to help learners understand how they are supposed to use that resource to benefit fully from its content. A high quality open educational resource is expected to work smoothly on a variety of platforms in use around the world (*multi-platform*). Having a true engaged learning relies on learner's opportunity to interact with the content and with other learners, which is not possible without the right *supporting tools*. *Security* of the confidential information regarding the learners is also an important issue to consider when evaluating quality of open educational resources and open courseware, despite the apparent anonymity in the online world.

Courseware Evaluation. Despite the initial claim of just offering high quality educational materials to learners worldwide, with no other intention the support the learners during their learning journey, all major open courseware initiatives have started to be more involved with their learners. In this new context, there is a stringent need to evaluate the courseware regularly for effectiveness, using various assessment strategies, and to use the findings as a base for future improvement.

Each prospective learner would most probably first be interested in the *courseware overview*, which includes information about the *content scope and sequence*, *the intended audience, the grade level, the periodicity of updating the content, the author's credentials and the source credibility, its availability in multiple-languages, instructor facilitation or some kind of semi-automated support, suitableness for self-study and/or classroom-based study, the time requirements, the grading policy*, along with *instructions about using* that courseware and its components, in order to establish the most suitable learning paths. *Prerequisite knowledge* and *required competencies* are also useful for learners at the beginning of the learning process related to a particular educational resource. *Matching the course schedule*, if any, with learner's own pace is also desirable.

Another issue to be approached since the very beginning regards the *repository or institutional policies* with which the learner is expected to comply with respect to the use of resources, with licensing and copyright issues, with multi-cultural education, with privacy etc. To have open educational resources and open courseware that are *free of bias and advertising* is also desirable for these resources. Another quality criterion is concerned with the option to provide, or aiming to provide, a formal degree or a certificate of completion (*degree or certificate*). *Participatory culture and Web 2.0* aspects are also important being them related to the possibility to contribute to the resources or to collaborate with fellow teachers/learners/developers etc. Other key aspects to be evaluated and improved constantly are concerned with *user interface*, *appropriate design and presentation* of the educational content to the users.

4 Related Work

Related work is rather scarce with just a few works approaching, in very broad lines, the subject of quality of open courseware and open educational resources in the context of evaluating the impact of these paradigms in education nowadays. All these works emphasize on the importance of the quality of OERs/OCW and on the need for continuous quality evaluation and assurance, but none of them include some guidelines or criteria for quality evaluation of OERs and open courseware [22-25, 30]. The policies to be used for Quality Assurance (QA) fall in three classes [21-22, 25]:

- QA activities are undertaken, prior to publication on the site, by the institution that offers open courseware or OERs, both as formal peer review process and as informal reviewing. Though, these processes are not open to the users;
- QA activities are performed by external peer reviewers on the institution's request, as external peer reviewing is one of the most powerful mechanisms to ensure quality in academia;
- individual users have the opportunity to review free educational resources, and to decide, on whatever arguments they want, whether the resource is useful, high-quality, or good in any way. This can be achieved by using star ratings, by adding evaluative comments, by describing in which way the resource has been used, or by displaying the number of the downloads for each particular resource. This approach is based on the argument that quality is not an intrinsic part of an instructional resource, but contextual, as a particular resource may be excellent for one user in a certain context, and, poor for another user in a different context [14];

Some authors consider that quality of open courseware and OERs is guaranteed by the reputation of their institution of origin, which is always interested to attract prospective students with the quality of its instructional offer, and to keep up with their prestige [21, 24-25]. Moreover, teachers and institutions seem to pay more attention to the QA process knowing that their instructional materials will be published as open content, and the whole world will be their audience [22, 24]. Thus, the QA awareness of each author is high and, consequently, quality of open educational resources is also high, especially for those derived from regular closed courses [22].

Quality assurance is seen as a built-in part of the development process, first by having pre-publication quality checks. However, there is concern about futile evaluation in the case of resources that have already been checked from a pedagogical point of view, because they have been developed by teachers, or by multi-disciplinary teams that have been funded by public grants. The huge burden of pre-publication quality checks is pointed out as well in the literature [25].

A particular issue approached in the literature is relevance, as part of the concept of quality, as usually a user search for open instructional resources results in too many results, so it is difficult and time-consuming to select the most relevant resources that have the highest quality. Techniques and technologies that give users the opportunity to narrow their searches are expected to alleviate this particular problem [21].

5 Conclusions and Future Work

This paper introduces a set of quality criteria that may be used to evaluate and pursue quality of open courseware and open educational resources, and that may constitute the foundation of a quality model for such resources. This initial set of QA criteria needs to be significantly improved. First, compliance with the existing quality standards (such as ISO/IEC 25000 SQuaRE standard) is most wanted. Besides compliance, a scoring or rubric system that will help evaluate in a quantifiable manner both open courseware and open educational resources is foreseen. Furthermore, the assessment procedure needs to be established on more non-subjective grounds, in order to facilitate quality assessment performed by other users and evaluators. Other future work ideas envisage using these quality criteria to assess some particular open courseware, and learning, based on this experience, how to develop further the initial set of quality criteria.

The higher goal of the foreseen future work is construction of a quality evaluation framework for open courseware and OERs, which may help users to use, modify, evaluate, and compare such educational resources, while pursuing their educational goals. Moreover, developers may also use that framework to tailor their work.

Quality models and QA frameworks are very necessary for the time being, and, in our opinion, they may contribute significantly to the sustainability of the paradigm of open sharing of educational resources, as a key step to the development and evolution of open educational models. These models may finally lead to development of a *global reflective educational infrastructure*, which will provide for achievement of people's learning needs, both individually and collaboratively, supporting them and their communities on their lifelong and life-wide journeys for social construction of knowledge throughout their life.

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Developing Online Collaborative Games for e-Learning Environments

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Abstract. Based on our experience, we believe that games, competition and teamwork offer a pleasant and active way of learning. This is much more efficient when the learner has a smile on his face, when he is astonished and curious about next levels and finds the game sufficiently challenging and fun to try again. Our application proposal has the purpose of implementing an e-Learning platform for improving the teaching and learning process in somewhat abstract domains, such as computer architecture or object oriented programming, with the help of games. These games are time-dependent and are able to support collaboration between groups. To this date there are two learning games implemented: a crossword puzzle and a collaborative jigsaw puzzle, the last one supporting multiplayer mode for up to 16 simultaneous players, being simple, fast, fun and reliable. Our application allows geographically distributed students to concurrently and collaboratively play the same game.

Keywords: e-Learning system, collaborative tool, online games.

1 Introduction

The explosion of communication devices and pervasive computing systems in everyday life due to technological development in ICT, led for the young generation to the acquisition of skills in using computers, laptops, tablets, cell phones, Internet or social networks without too much effort and generally outside the classroom. In this context, the tendency of so called “digital” or “online generation” is not having the patience to follow a course, read a book (even electronic) but rather "play or practice instead of learning theory". A very important challenge in the teaching process is to keep students motivated throughout the course, and to help prepare outside the class hours. Learning through play, the desire to win, forcing him to pay attention to rules, to retain them, motivates him to stay focused on the studied topic. Competition and teamwork are also motivational for students.

There is one thing that teachers and learners have to agree upon: learning is boring, because of age and mentality differences [14]. Adults show commitment and disposition to learn, being aware of the need to be prepared throughout life (long life learning concept). Youngsters, however, want to acquire knowledge and technical

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skills without too much effort. In education, as well as corporate facilities, trainings are not always seen as fun. All of this can be changed if games are implemented in the learning process. The learner's attention is kept awake by allowing him to interact with a virtual environment where he can test his skills, is allowed to restart the game at any time and, most important of all, is allowed to make mistakes (unlike real-life situations where mistakes are not desirable). Games are usually highly intuitive, user-centered; they have entered our social lives and support massive amounts of concurrent players (such as World of Warcraft, or, more recently, Minecraft).

Our application proposal has the purpose of implementing an e-Learning platform – Education Management Tool (EDM) – for improving the teaching and learning process in somewhat abstract domains, such as computer architecture, object oriented programming, operating systems, algorithms and data structures, with the help of games. These games are time-dependent and are able to support collaboration between groups. To this date there are two learning games implemented: a crossword puzzle and a collaborative jigsaw puzzle, the last one supporting multiplayer mode for up to 16 simultaneous players, being simple, fast, fun and reliable. The implemented application allows geographically distributed students to concurrently and collaboratively play the same game. Additionally, our work accomplishes many learning preferences of digital / online generation: parallel processing and multitasking, pictures processing, interacting/networking simultaneously with many others, acquiring quickly multimedia information, making the learning process funny [16]. The proposed puzzles are not used alone in teaching and evaluating the mentioned computer science subjects, they are periodically used in a mixture with classical teaching, practising with hand-on exercises and also evaluation.

Our approach mainly insists on how the professor could create his own game related to a computer science topic in the context of our previously introduced e-Learning platform (EDM tool [5]). The jigsaw puzzle is very appropriate for algorithms, computer architecture, microprocessor's organization and design because we use and refer to many pictures with (logical) schemes, instruction / data flow diagrams, memory hierarchy in the teaching process. Whatever is the engineering topic, in learning process the visual memory (visual learning style) is very important because, as an old Chinese proverb said, "a picture is worth a thousand words meaning". Also, we thought that a crossword puzzle is properly used to test student's knowledge in a funnier and more competitive manner. We have chosen examples from algorithms and other computer science fields because we teach these topics but our application allows that the didactic materials to be further extended, so that they cover other scientific fields too.

The organization of the rest of this paper is as follows. In section 2 we shortly review the Related Work in the field of educational software and mainly of game-based learning. Section 3 describes some of the latest developments of our application insisting on the games software design, concept and objectives and the user interface. In section 4 we present the system requirements. Based on a short interactive animated example, we explain the game's functionality. Finally, section 5 suggests directions for future work and concludes the paper.

2 Related Work

Transforming by gamification the learning process into "flow" [12] – as enjoyable and valuable for students as possible – can produce high benefits in some educational areas. This approach is successfully used worldwide in teaching music through the Kodály method [13] which reviews and reinforces concepts by games, pictures, movements, songs and exercises. A game that revolutionized the gaming and learning communities is Minecraft. It is a simple game with simple rules, but can be extended so that it gets very complex. It is very similar to a role-playing (RPG) game, where the user can actually change the environment by adding/removing building blocks. Besides the fact that it is fun to use, this game has great educational potential. For example, students can be asked to research a historic event and then recreate it in the game, or build a roller coaster and do experiments on velocity and acceleration [1].

In [2] the authors stated out that in-class games have a positive impact on students, they are more engaged in the learning process and thus they also perform better in exams. In [3] the authors present their experience on how can puzzles and games used to teach and reinforce Computer Science concepts, since many topics of this field are well suited for coverage in such games. They show that instructional crossword puzzles and the Jeopardy!-style games are good methods to create in-class experiences that support learning terminology and basic concepts. In [4] the authors examined the use of puzzles and puzzle-like problems in teaching design and analysis of algorithms like brute-force search, divide-and-conquer, greedy, dynamic programming, backtracking, etc. As a difference, our puzzles are integrated into our own e-learning system, the EDM tool [5]. New puzzles can be easily generated through EDM.

In our previous paper [5], we presented an interactive flash application of the well-known Towers of Hanoi puzzle (with three rods), proposed by Edouard Lucas in 1883, which can be solved through the Divide and Conquer programming technique. We also implemented the generalized version of the Hanoi problem, also called Reve's puzzle, with four or more rods [6]. We used the Frame-Stewart algorithm to solve the generalized Hanoi problem, with four rods. Our proposed interactive Towers of Hanoi puzzle can be run in user mode or in simulation mode. In [7] we integrated into EDM Tool some interactive third party lessons focused on graph algorithms (Breadth-First Search, Depth-First Search, Dijkstra, etc.), on binary tree operations (insertion, deletion, traversal, search, etc.) and also on digital logic circuits.

Using simulators for teaching Computer Science is another widely used method. Besides their importance proved in the computer architecture research field, simulators have lately been extensively employed as a valuable pedagogical tool as they enable students to understand the theoretical concepts better and to visualize how microarchitectural components work and interact [8]. In [9] and [10] we proposed some interactive graphical simulators to teach Branch Prediction and Simultaneous Multithreading Architectures. Such simulators play a key role in translating all complex processing mechanisms in relevant and easy to understand information.

International e-Learning platforms such as Moodle are already very popular, available free of charge as open-source projects. Moodle stands for Modular Object-Oriented Dynamic Learning Environment and is currently the most popular of the free e-Learning systems. It is provided without fee under the General Public License (GNU) available for any university to implement. It can be implemented on any broadly available operating system (Linux, Windows, Mac OS, etc.) and runs mainly under MySQL, though it can use any ODBC connection to other providers such as Oracle, IBM DB2, Sybase, Access, etc. [11]. It is a very complex system, managing anything from courses and lessons to exams and grades. It is a highly flexible system, but sometimes it may be hard to understand and/or use. In contrast, Education Management Tool is a targeted package that is easy to use and to understand (there is no training needed for understanding any concept in EDM), but still is powerful enough to suit the basic needs of the learner and teacher.

Other learning systems are Blackboard and WebCT, but both of them are expensive, sometimes too expensive for some universities to implement. Education Management Tool has the clear advantage of being free of charge.

3 Games Software Design: Concept and Objectives

3.1 Education Management Tool

Education Management Tool (EDM) is an e-Learning platform designed to help students in universities to access learning materials posted by the teachers, to complete online tests and obtaining immediate feedback, as well as retrieve information about results for their exams. It has the advantage of being free, accessible from anywhere and from any type of computing system device, not being restricted to the laboratory. It can manage an entire university: specializations, subjects, administrators, professors and students (see Figure 1). It is a complex tool which is easy to use, with three possible user types: Administrator, Professor and Student.

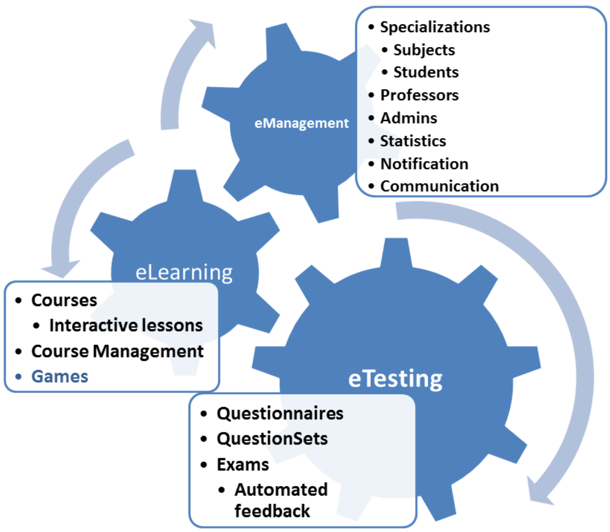

Fig. 1. EDM Tool Structure

Consisting of three modules, EDM is designed to meet the basic requirements of an e-Learning environment: learning, testing and management. The learning component consists of courses, developed by teachers in a manner similar to Google Docs, which are easily accessible by students. The courses may contain images and flash movies. The testing module consists of exams, customized and posted by the teacher. EDM provides a simple and intuitive exam management system that fits any workflow, supporting exam schedule, timed exams and highly editable quizzes. The management part offers the teacher the ability to manage grades and presence at courses together with a communication system for delivering messages to persons / groups.

Both of the games presented in this paper are implemented in Silverlight (a product from Microsoft similar to Adobe Flash) and are tightly integrated into the main application. From the Professor account, they are created and set up, and accessed afterwards from the Student account. A demo account has been set up within the system for anyone who is willing to try the new features of the system. It can be accessed at the web page http://edmtool.gotdns.com/, using the log in credentials (username/password) ism/ism. The games can be accessed by clicking on the left menu on the item "Games", then choosing from one of the two games available and finally joining a room. Because our application is in continuous development, we have not uploaded it yet on a professional server and keep it on the author's laptop, which may cause to not be accessible at any time.

3.2 Crossword Puzzle

During the lessons, the learners are taught to be able to understand and explain certain terms, but in real-life situations, they will have to recognize certain patterns and apply the required methods to solve them. Nowadays, in the age of information, when we don't have to carry around enormous amounts of knowledge, but to know how to find it using search engines (Google, Bing, Yahoo, etc.) or computational engines (Wolfram Alpha), our mind starts to behave differently. As a result, the learner can benefit more if faced with a game that allows him to guess / anticipate a certain term when he is presented with a definition or a situation where it is being used.

The rules for this game are simple: guess all words on the horizontal axis and you will get a combined word on the vertical one. When you correctly guess all terms, the game ends and your time is registered. The total time you have spent solving the crossword puzzle will be shown and compared to what other users have achieved, showing you a score leaderboard with the best times.

On the technical part, this game was easy to implement. After the game has been loaded and the terms and definitions are retrieved from the remote server, everything works on the client (the browser). When the game ends, another communication to the server is initiated, for storing the time achievement and showing the leaderboard.

Each professor is allowed to create a virtually unlimited number of crossword puzzles for the students. The creation of one is simple and intuitive, consisting of two basic steps: main term and associated terms. The main term must be a word which will be formed automatically upon completion of the puzzle. Then, the professor must enter for each character another term, along with its description, which will be guessed by the student. When entering this information, the professor must respect some limitations. Each term (main or associated) must have a character number in the range of 2-13. It must consist only of lowercase characters, from the Latin alphabet (without spaces or other special characters). In the order of the occurrence of characters in the main term, each associated term (in the order of creation) must contain at least one corresponding character.

The user enters the game, performs a request on the server to retrieve the terms, along with their descriptions, and then displays them to the user. Next, the user repeatedly guesses the term for the provided description; if the term is incorrect, the system responds with an invalid answer message, and the procedure of entering a term is started from the beginning. If the word is true, the answer is marked as correct, and the term input procedure starts from the beginning, unless all terms have been already guessed. If this situation occurs, the game ends, the elapsed time is recorded, sent back to the server and some statistics are shown, including the current player's position, competing with the times of other players.

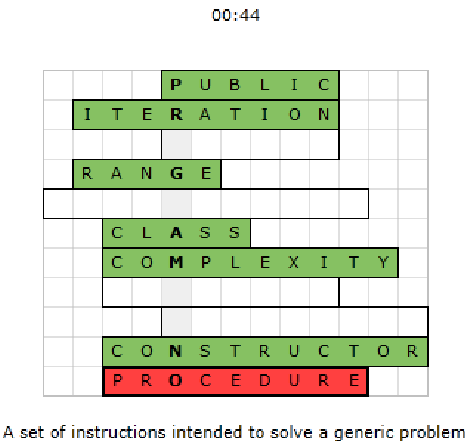

Fig. 2. Playing *Crossword Puzzle*

3.3 Picture Puzzle

The inspiration for this game came from the fact that certain subjects must be learned in text mode, while others must be mapped mentally into an image, requiring proper usage of the visual memory. The application trains the student to reconstruct an image or a schema requiring his knowledge, similarly to a jigsaw puzzle. Unlike a jigsaw puzzle, this application does not give any feedback if two tiles have been joined correctly, until the whole image has been reconstructed, making him think twice when trying to put together the pieces of the puzzle.

Picture Puzzle can be played in multiplayer mode; up to 16 players can join the game simultaneously and collaborate to form the completed image. A remote server takes care of the synchronization and the communication between the simultaneously connected clients. Each action that a player performs on the puzzle is reflected almost instantaneously on the other clients that are connected to the same room. This is done via http by using a long polling method technique of initiating callbacks to the other clients. In addition, recovery methods are implemented to be able to reconnect if the internet connection fails or the server crashes.

The implementation was a bit more complicated, but provided a better usage of the communication skills from the learner side. The paradigm of this game is the fact that the server must notify all connected clients that the game's state has changed (one of the users has moved a tile from one position to another). The server, as its name says, serves data to the client, and in the normal case, the client performs a request, and the server responds to that request. Therefore, the communication must be done via two sockets, one from the client to the server (as in the normal case) and one from the server to the client. Desktop applications are allowed to do that, but browsers, because of security reasons, allow only client-server connections. For callbacks to be still possible, a long-polling method is implemented that simulates server-client communication. The client initiates a request and listens for the response from the server, but the server does not respond until it decides it should do that. Although it is not one of the best methods, Facebook and Google Docs have demonstrated that it can be achieved, so that we started doing it as well. This approach has led to a completely different style of server-side and client-side programming, which was in itself a challenge. For example, two different clients should not use the same tile at the same time, so that we were forced to implement an exclusive check-out system for tile selection. This has been implemented on the client side as well as the server side in the following manner: when another client selected a tile, the server was notified, and checked if no other user has already selected the tile. Afterwards, all other clients were notified of that particular tile selection in order to keep a list of selected tiles from themselves, therefore disallowing selection of tiles that have been selected by other users. This approach also covers the case when two users select the same tile at the same time. Both of them are allowed from the client application to select the tile, but the server makes sure these types of requests are handled sequentially, and only one is allowed to select, while the other client action is dismissed.

From the technology point of view, we used WCF (Windows Communication Foundation – http://msdn.microsoft.com/en-us/netframework/aa663324) at the beginning, but it proved to be unstable, crashed a lot, was hard to implement and to debug. It carried around too much overhead; sometimes it was sending twice the actual data for no obvious reason. SignalR, an open-source library (http://signalr.net/), proved to be much more stable, easier to configure, and did not carry around too much overhead by using lightweight JSON (http://www.json.org/) encoded entities.

In EDM Tool, the games are created from the Professor account, and can be accessed by any student using the system. Upon creation, the following parameters must be set: a title, a description, one of the three levels of difficulty (Easy, Medium, Hard) and the image that should be completed by the students. Once this information arrives on the server, any client can connect and play the game collaboratively. When the game is over, a leaderboard is presented to each user, and the game is reinitialized, so that other users can join a new game.

Unlike Crossword Puzzle, where the user does not communicate with the server during game time, Picture Puzzle exchanges information with the server, sometimes even several times per second. Each action from the current user must be transported to the other connected players in a fast and reliable manner. For example, when the user joins the game, the server notifies everyone and sends the player information to all clients. The same procedure is applied when the user selects a tile (it must be blocked for all other players), when the tile is dropped or when a player leaves the game. An interesting challenge was having a common, synchronized timer for all players. In Crossword Puzzle, that was simple, because only one user had to see the timer. In this case, the timer must be initialized when the first user enters the game room and, for each client that connects afterwards, the elapsed time is sent to him. From the moment the timer info is received, the client increases the time counter on its own, because no further synchronization is needed. Another alternative was possible: instead of sending the elapsed time, a more accurate measure could have been to send a timestamp containing the date and time when the game started. But because people can possibly access the game from different time zones or have their clock set up incorrectly, this approach could have led to incorrect display of the elapsed time. Although much better, the current approach is still not the best option, because delays of a few seconds can also lead to inaccurate elapsed time measure, but these differences are acceptable. The best option would have been to measure the average time it takes for the server to respond, and then add that value to the received elapsed time.

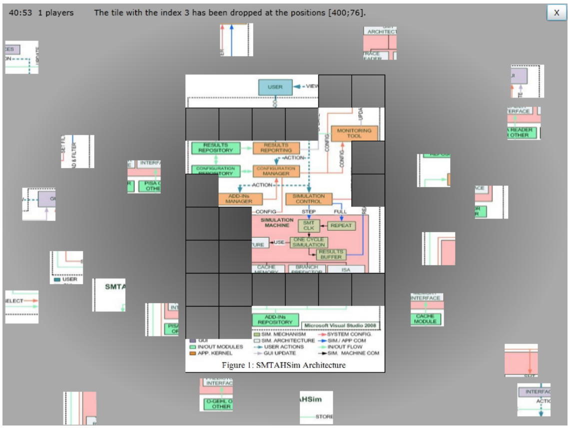

Fig. 3. Playing Picture Puzzle

4 The System Requirements

Because it is a client-server application, the system requirements have to be split up in two parts: server and client.

The server requires the operating system Windows Server 2008 to be installed, together with Microsoft Sql Server 2008 R2 as the database provider. Internet Information Services 7.5 at least has to be installed for the server-side assemblies to be deployed and for the proper execution of the code in those assemblies, .NET Framework 4.0 or a later version is necessary. From the hardware point of view, we recommend a Dual Core processor with a frequency of at least 2 GHz, 4 GB of RAM and an Internet connection of at least 10 Mbps, for a fluid game experience for up to a few tens of players. Hardware requirements are pretty high, because on each client request, the server has to send data to all the connected players, unlike normal servers, which respond only to the connected client.

The client requirements are not as high as the server ones. From the software point of view, any browser that supports Silverlight and has version 5.0 installed will work (Internet Explorer, Google Chrome, Mozilla Firefox). The hardware requirements are also low, although there is some graphical processing done during the game, it will not require too much processing power from the machine.

5 Conclusions and Further Work

Nevertheless, the game ideas could be implemented in other basic tools and topics. From a pedagogical point of view, the proposed tool benefits the learning process, since it permits students to observe rather than learn through classical methods, discovering the fact that studying can be fun as well. Sometimes the information within lectures is not transferred completely to the students also because of the age and mentality differences. EDM Tool provides the much-needed bridge, to alleviate this misunderstanding and to encourage students to work with the concepts and ideas presented during courses. Students will use the experience with these games in later courses when more notions (about advanced processors, operating systems, etc.) are introduced. As far as concern the educational added value, in the crossword puzzle game we followed a common educational methodology in which students first tackle easy and small chapters based on few definitions, and then progressively continue to more complex ones with many and more difficult definitions and tasks.

No success story comes without problems. The system is far complete, as well as the games. Although the games run smooth and without major problems, we have experienced some issues connecting new players to the Picture Puzzle application. If the connect succeeds, the communication works without any problems, but in some cases, the messages sent from the client never reach the server for some reason.

As future work, we intend to determine the success of this game-based learning approach, through performing assessments using questionnaires (from EDM Tool). Thus, we want to quantify the learning degree of each student and the satisfaction degree if they are using games in the learning process. For now, we observed that the games have good acceptance among the students. In fact, they are using these proposed games to do their homework, obtaining encouraging results in class. In this sense, the instructors could see how student grades will improve with respect to the previous academic years. Besides the tests, we will consider a different approach inspired from machine learning. Thus, we think to improve our games using reward learning algorithms such as reinforcement learning (Q-learning or SARSA) [15]. Also, we want to add new features such as the option to save some "good but not finished configurations", resuming games from that point, etc. Another issue is security. Although our system does not manage bank accounts or sensitive information, it can be the target of malicious attacks. In the future, we will increase the security of our application by implementing data encryption and hashing where needed. For example, the students could easily figure out the answers for the Crossword Puzzle if they are curious enough to seek through the page source code.

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Supporting Knowledge Transfer and Mentoring in Companies by e-Learning and Cloud Computing

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Abstract. Small and medium sized companies (SMEs) assure economic growth in Europe but have difficulties in facing technological, economic and financial changes and have skill shortage. Mentoring together with e-learning and the use of cloud computing services can help SMEs to solve some difficulties like knowledge gaps and resources short-age. This article focuses on aspects of knowledge transfer, mentoring and cloud computing and presents examples worked or coordinated by the authors i.e. the European projects Net Knowing 2.0 (http://www.netknowing.com/) DIMENSAAI (www.dimensaai.eu) and SmartPA (www.smartpuba.eu).

Keywords: SME, mentoring, e-learning, communities, cloud computing.

1 Introduction

Small and medium sized companies contribute to more than half of European value-added by business and assure economic growth [1]. Many of them are small ones and have difficulties in facing technological, economic and financial changes and skill shortage. The knowledge and human resources of SMEs are very limited and they need help to develop approaches that promote knowledge transfer (KT) for filling knowledge gaps and learning approaches easy to use particularly based on new ICT.

Mentoring is a human research development approach and together with suitable learning methods [2] can be organized to address aspects like knowledge gaps and shortage skills [3]. Mentorships for staff can be applied for a number of reasons i.e. when new ones are hired or as a part of leadership development. An existing member of staff or an external one guides newcomers or less-experienced people in a task to develop professional skills, attitudes and competencies. Also people with special needs can be helped by mentoring to integrate into work life.

On the job (or workplace) mentoring [4,5] means a learning partnership between employees for sharing information, transfer of individual and institutional knowledge and insight to a particular occupation, profession, and organization. The most used form of learning is informal one. One problem is that this kind of mentoring is often only accessible to a few numbers of employees and its benefits are limited only to

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those few who fulfill the conditions to participate. We will present also formal or structured mentoring which takes mentoring to a next level and expands its advantages and corporate value beyond the mentor-mentee relation.

KT is considered as an aspect of knowledge management depending on actors, tools and tasks. Some SMEs have focused on KT and used it as an enabler for innovation capability, but many of the practiced approaches failed. SMEs priority is survival, leading to just-in-time activities; the benefits of KT to the business have to be very clear and measurableand have to be directly related to competencies and activities of the staff on the job.

Online communities oriented to learning and supporting mentoring process and KT have the potential to support/assist mentors/trainers in managing the assessment and feedback activities and facilitate active and passive participation of learners/mentees/protégées. Cloud computing is an on-demand service model for ICT based services based on virtualization and distributed technologies. It can be used for small and medium-size business and also for learning purposes. With cloud computing in education, powerful software and computing resources are offered where and when they are needed. It offers also possibilities for people with special learning needs: older students, people with disabilities, people seeking new job skills, migrants. For very specific needs of SMEs it offers help.

The cloud will automate much of the low-level, administrative services that accountants have provided to SME clients or public administrations offers to citizen for so long.

Accountants and service administrations currently have their own separate IT arrangements, which duplicate resources and push up costs. With cloud computing, they can benefit from an ecosystem where scalable resources and pay-per-use costs are shared in the cloud and from gaining knowledge and best practices from other agencies.

This article focuses on aspects of KT, mentoring and cloud computing. One of the examples is the project Net Knowing 2.0 [6] aiming to help SMEs to turn their daily work into a source of corporate learning for all their employees and to support KT by efficient use of online communities, learning and ICT and introducing a mentoring approach.

Another example is the ongoing European project DIMENSAAI [7] coordinated by IAT aimed to improve participation in training, job qualification and employment for seniors and people with disabilities by the use of a diversity and mentoring training model focusing on the working places in the companies from health and care sectors [8, 9].

The project SmartPA [10] intents to build cloud communities [11] to support accountants for SMEs and public administrations to use cloud and to train mentors in this context.

2 Knowledge Transfer, e-Learning and Communities

SMEs are very different, have specific organizational needs and characteristics and very often are bounded by the pressure of day-to-day management and tight resources. Referring to suitable learning methods for their staff, informal learning is the most used form of learning in SMEs and combined with e-learning methods has objectively many advantages for SMEs [12, 13]. Jay Cross is "a champion of informal learning and systems thinking" [14]. His philosophies on the power of informal learning and network have fundamentally changed the world of learning in organizations.

One approach which seems useful in the context of improving learning and cooperation within SMEs and with other experts is that of learning and KT oriented Communities [15] with members who share knowledge, ideas and interests and who act as mentors to each other. They offer new opportunities for KT and learning processes by using new forms of interaction between team work and loose contact between the actors [16] particularly when they are supported by web-based environments.

Social media can be used for supporting communities [17] and can take many different forms, including Internet forums, weblogs, social blogs, micro blogging, wikis, podcasts, photographs or pictures, video, rating and social bookmarking [18].

In communities, knowledge is created when people participate in solving a common problem and exchange the needed knowledge for the problem.

A community cloud could be built in which infrastructure is shared between several organizations from a specific community with common concerns (security, compliance, jurisdiction, etc.), whether managed internally or by a third-party and hosted internally or externally. The costs are spread over fewer users than a public cloud (but more than a private cloud), so only some of the cost savings potential of cloud computing are realized.

The community developed within the project Net Knowing 2.0, oriented to Web 2.0 [19] supporting also mentoring, uses social media tools [20]. The decision to use TikiWiki which support also social media applications [21] has been taken after an analysis of some open source tools.

Community clouds for accountants and for public administrations are planned within SmartPA.

3 Mentoring

Mentoring has been used in Europe for a long time. Mentoring involves not just guidance and suggestion, but also the development of autonomous skills, judgments, personal and professional master ship, expertise, trust and the development of self-confidence over the time. Mentoring is a process for the informal transmission of knowledge and social capital usually face-to-face and during a sustained period of time.

Mentoring on the job where the mentors are companies' employees has advantages because the companies' employees know the work processes, what knowledge is needed for their efficiency and which the companies' knowledge resources are. They are used to the working environment and can estimate the hazards and situations which could be challenges to mentees or their fellows at the workplace. A further advantage is the development of a situation of mutual trust between the colleagues, which later is the basis in the daily work. Experience and expertise is necessary in the mentoring as well as being moderately extraverted. In the relation with the mentee, motivation and responsively is required. The mentee needs to be ready for professional development, open to learn and accept feedback. Time and initiative are necessary too. The company can have benefits from mentoring by a quick introduction of the mentee into formal and informal company structures and demands, facilitating a deliberate, systematic and smooth transfer of technical or internal knowledge, opportunities to shape the workforce of the future in an international, deliberate way to meet company strategic goals and objectives, training of social competence of the mentee and the mentor.

Mentees have the opportunity to meet with a trusted person to enter into a work place quickly and to cope with initial problems to discuss and resolve emerging job problems of genuine nature and in relation to the individual needs, to learn setting realistic goals and achieving them, to acquire new skills and enhance their skills and thus their future career opportunities and prospects in the future through the KT from the mentor. Mentee could build relationships or interactions allowing them to secure, maintain and advance in the job choosing a way that corresponds to the work routines and social actions of other employees.

There is a broad range of mentoring relationships ranging from informal or spontaneous mentoring to highly structure and planned mentoring. In the following, we present two types of mentoring, informal and formal ones. Informal mentoring is created informally by special interest in the mentee by the mentor when i.e. the mentee has identified as potential employee. Formal mentoring is when the relationship is supported by the organization so that more participants can benefit.

Particularly formal mentoring and KT can be supported by online communities. A formal mentoring approach started in the project Net Knowing 2.0 in a small network of German SMEs. IAT and University of Craiova work now with providers of Cloud Computing Services taking into consideration a catalogue which has been developed within a workshop with representatives of these SMEs. In the project DIMENSAAI and SmartPA we will use both forms of mentoring.

4 Support of Mentoring in On-Line Communities via e-Learning and Cloud Computing

We consider that web-based training and cloud computing can improve not only SME staff competencies but also the KT processes within and across companies. SMEs could drastically reduce the costs pertaining to their LLL strategies and processes by adopting the cloud.An ICT-based approach, a web-based one allows mentors and mentees to learn on-line, to communicate and collaborate, and to transfer and share knowledge.

Such an approach has a number of benefits including provision of a 24 hour access of saved knowledge, for training material and communication, accessible anywhere with internet availability, provision of a platform even if face-to-face communication is not possible, learning assessment, feedback and monitoring of the mentor-mentee relationship.

In what concerns cloud computing services, SaaS (software as a service) and PaaS (platform as a service)result to be the most suited categories for SMEs since the supporting ICT instruments can be out-sourced and need no longer be managed in-house. PaaS is meant to accommodate the middleware and to improve the performance in using it. It may consist for example of a web-based e-learning development platform containing the web/application server, the integrated development environment, the associated database and all additional utilities for development and testing. PaaS offers SMEs the possibility of acquiring on-demand usage-time for different types of software services. This includes a wide range of applications: office tools, graphic utilities, data storage facilities, etc. SaaS is dynamically scalable, device independent, and most of the applications are collaborative, allowing thus multiple users to share documents and work on them concurrently. Adding social media services through SaaS can only enhance this collaboration.

The LMSs (Learning Management System) used by SMEs have traditionally been associated with management and operational issues such as data back-up, down-time during scheduled educational sessions, business continuation and disaster recovery planning, efficient alerting system, scalability and flexibility planning.From our experience with LMSs, we know that during peak time intervals, the platforms tend to perform slower. This is especially painful for those critical tests in which a user response time limit is enforced in the quizzes. Users will become frustrated if the system seemed to slow down their throughput by slowly posting the responses to the servers and getting new questions in. Such a situation is easily avoided if the LMS was hosted in the cloud. Problems such as bandwidth, hosting space and speed would be delegated to the CSP which is bound through service level agreements to ensure that even during peak hours, the quality of the service will hold.Furthermore, managed cloud services not only ensure the typical cloud services, but also add wrapped management services for customers. It is in fact a slow transition from the traditional hosting world to the cloud-based world. This concerns data back-ups, management at the OS level and also at application-level of the rented virtual servers, monitoring and technical guidance. With this approach it becomes easier to ensure that the LMS platform is running as expected. The CSP may be delegated with monitoring the built-in (or custom developed) performance tracking tools, the consistency of the LMS modules, and the alert system of the hosted LMS. Furthermore, the business continuation and disaster recovery planning of the LMS owner and users are facilitated by the CSP's own business continuity and disaster recovery plans.

Added to this, SMEs will surely be interested in the pay-per-use approach since the only moments in which they need to care about the LMS platform and the quality of the provided e-learning service are during the classes and during the test/quizzes associated to these classes. The costs associated with hosting in-house a learning platform are never to neglect. This is rarely the case with the majority of the European SMEs for their business plans and long-term budgeting.

SMEs agree that long-life learning is a critical process for the long-term success of their businesses. No longer is a firm concerned with the accessibility and scaling up of the learning environment since the cloud reduces the SMEs costs associate with hardware and communication infrastructure on one side, and provides transparently and (almost) in real-time as much hardware and communication infrastructure as needed by their business requirements. Both SMEs and learning content providers are able to save money through this approach as they don't have to hire dedicated ICT personnel, they don't have to worry about hosting and servers, there is no downtime for the business, and most importantly, they can focus on their core business that is e-learning, while leaving all the technical aspect to the cloud experts.For the subscription-based services, SMEs and e-learning providers benefit financially by moving the learning offer into a SaaS-like cloud service instead of buying a product (such as for example, the supporting software applications that need to be hosted and administered on the SMEs hardware/network). The same applies for the shared platform within the content-syndication model.Security risks associated with the sensitive e-learning content and the related access control will also be delegated to the cloud service provider.

The connected, transparent interface offered by a cloud system gives both far greater visibilities into the business, not just retrospectively but also into the future. It represents a powerful tool allowing the business owner, their accountant as well staff of administrations to engage in strategic planning around the business.

Face-to-face interaction and socialization processes consolidate the relations between members and group membership.

5 Example of Mentoring

The goal of mentoring staff from SMEs is to improve job performance by increasing employee's capability to manage their own performance emphasizing on trust, experience, and supervision, to facilitate performance and KT in the organization, to support retention and leadership development.

Within the Net Knowing 2.0 project workshops with SMEs have been organized in partner countries to discuss with representatives of SMEs some tactics for implementing a mentoring program in their companies. For a successful deployment of a mentoring program within the specific context of a SME environment some factors have to be considered like putting the specific working environment into context, researching the role played by the organizational culture or "climate" in the development, maintenance and success of the SME, determining knowledge gaps which can be reduced by a mentoring system and qualification needs of the staff. SME managers have to be convincing that a mentoring intervention has real benefits in this context being not bureaucratic. Before the mentoring process starts barriers to effective mentoring/coaching issues that need to be incorporated within the mentoring/coaching intervention have to be cleared. Figure2 presents a screenshot from the learning suite within Net Knowing 2.0 including a mentoring part. This will be adapted and translated in all partner languages and trained with SMEs from these countries by using a blended approach. The formal mentoring process started now in Germany in cooperation with cloud computer experts from the University of Craiova.

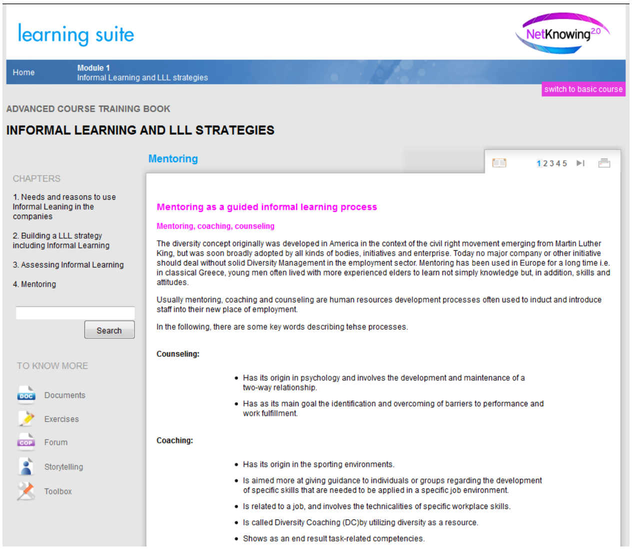

Fig. 1. Screenshot of the Net Knowing 2.0 learning suite [23]

Another European project is DIMENSIAAI: Diversity and Mentoring Approaches to Support Active Ageing and Integration [7].

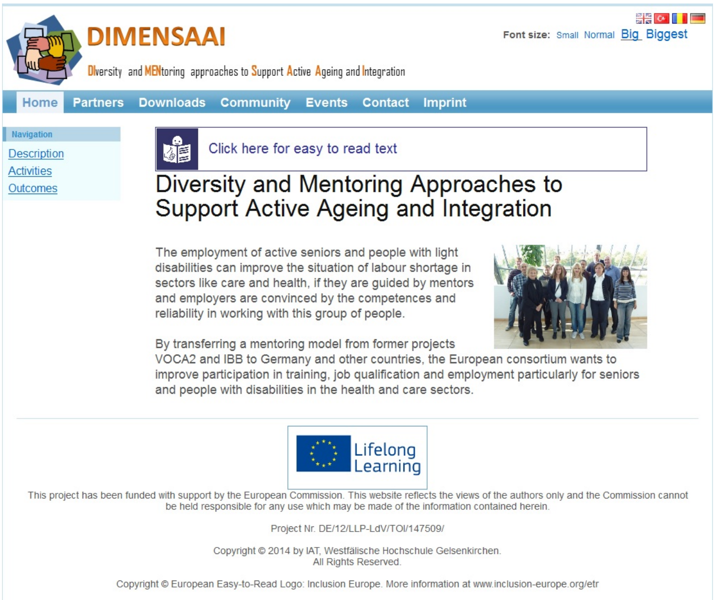

Fig. 2. Screenshot of the DIMENSAAI web-site [7]

By transferring a mentoring model from former European projects Voca2 and IBB, to Germany and other partners, the consortium intends to improve participation in training, job qualification and employment for two target groups: seniors (55+) and people with disabilities by the use of a diversity and mentoring training model focusing on the working places in the health and care sectors. A social network supported by an ICT platform for innovative online training, information exchange, collaboration will be developed within the project.

Within the project SmartPA mentors will be trained for accountants and staff from public administrations to use cloud services.

Fig. 3. Screenshot of the SmartPA web-site [10]

6 Conclusions

Mentoring can be an excellent tool for retention, progress and integration of staff in a company/organization if implement appropriately. It provides an efficient way for KT particularly supporting skill shortage and as the older generations start in their retirement. Cloud computing can be used for small and medium-size business, in administration tasks and also for learning purposes. Technology can never become an absolute substitute for face-to-face activity within SMEs. And many aspects can complicate the KM process in companies. Missing to most are motivation issues such as sharing mechanisms and user-friendly methods and tools to facilitate knowledge transfer. SMEs should be helped to develop an open and adaptable attitude to web-based and cloud computing tools and methods.

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Wiki Tools in Teaching English for Specific (Academic) Purposes – Improving Students' Participation

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Abstract. This study is based on an on-going investigation on the impact of Web 2.0 technologies, namely a wiki-based learning environment, part of a blended approach to teaching English for Specific (Academic) Purposes for EFL undergraduate students in a Romanian university. The research aims to determine whether there are statistically significant differences between the degrees of wiki participation recorded in the first semester of two consecutive academic years, starting from the assumption that modifications in the learning environment, namely the change of location for face-to-face meetings from class to computer lab setting and the introduction of more complex individual page templates may lead to increased wiki participation. Due to the project's multiple dimensions, out of which participation and response to the new online environment are particularly important, the results provide information necessary for further decisions regarding specific instructional design needs and wiki components, and changes affecting the teaching/learning process.

Keywords: English for Specific (Academic) Purposes, Web 2.0, Wiki, Blended Learning, Higher Education.

1 Introduction

The needs of present day learners are changing at an amazing speed under the pressure of global economic and societal transformations, accompanied by technological advance and Internet expansion. Paradigmatic shifts in education are being documented by theoretical and evidence-based research and, at all levels, policy makers and stakeholders have put increasingly more reflection and resources into providing better learning opportunities in new educational settings and creating novel and creative openings for teachers and students to experiment and put in action new approaches to teaching and learning.

In European higher education, the reviews on developments of ICTs and their inclusion as key factors in the building of a sustainable knowledge-based economy and on the use of social software (the so called "Learning 2.0") highlight the advantages and challenges of technology integration in universities and emphasise

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their capabilities to sustain education reform, support educational management and create what is called a "reflective practicum" with beneficial consequences on academic communities of interest and of practice [1], [2]. Large scale studies commissioned by European agencies on the impact of ICT and new media have also documented positive influences on foreign language learning and learners' participation and degree of involvement in higher education teaching/learning process [3], [4], [5].

While the general motivation for our research may be attributed to the impact of these developments on teaching, a more specific rationale is rooted in the local context. Consequently, a few brief considerations on the adoption of technology in Romanian higher education are needed to account for our choice.

After 2000-2001, and then after its accession to the European Union in 2007, Romania has taken important steps to follow the European strategy for development, with particular emphasis on higher education and the creation of infrastructure for the implementation and development of e-learning. According to some larger-scale quantitative studies regarding these developments, at present most universities seem to have the necessary infrastructure for implementing e-learning but use it mostly for administrative and course management [6], [7]. Issues related to stakeholders' readiness to transfer the learning process in an online environment still need documenting together with in-depth qualitative studies on technology use and its pedagogical implications. While larger scale institutional adoption of e-learning seems to be put on hold, trends highlight students' increasing use of the Internet for study and personal/professional purposes [8] and faculty are engaging increasingly in promoting Web 2.0 technologies, as showed by a fair amount of qualitative and small-scale research published in international and Romanian journals documenting experiences of learners (see, for instance, the latest contributions of Grosseck and Popescu [9], [10]).

In this context, we consider that our on-going project could be subsumed to the words of British educational researcher Paul Ramsden: "The aim of teaching is simple: is to make student learning possible" where learning consists of "changing the ways in which the learners understand, experience or conceptualise the world around them". According to Ramsden, the prerequisite of becoming a good teacher is to first understand students' experiences of learning [11]. Therefore, we believe that back in 2009, our decision to create a wiki-based online environment and gradually introduce it in a blended learning design was prompted mostly by the urgent need to reconsider *the multidimensional character of teaching and learning* against the background of 21st century education changes.

Wikis were originally devised to provide "an easy-to-use knowledge management system enabling effective and efficient online collaboration" and "simplify creating online content" without users' having advanced computer skills [12]. They started to be used for instructional purposes for their collaborative features, and potential to sustain the emerging educational paradigm shift from cognitive/behavioural to social constructivism [13].

Consequently, the process of building a new learning environment by integrating technology, particularly Web 2.0 tools, in teaching English for Specific (Academic) Purposes (ESAP) to undergraduate students was an essential step towards finding a variety of solutions for an enhanced teacher and student experience by means of which, among other things, we hoped to enable all parties involved to reflect more on the needs of 21st century education, engage in the learning process and, thus, become more empowered as to educational and professional choices.

The aim of the current study is to bring further evidence that, as part of a blended learning design, a wiki-based learning environment has a positive impact on students' learning dynamics, namely participation and response. The results will provide additional data for taking decisions regarding more specific instructional design needs and wiki components, as well as a basis for a more in-depth qualitative research of the changes affecting the language teaching/learning process.

2 Research Background

The wiki environment for the ESAP course for EFL undergraduates from the Faculty of Sociology and Social Work, Babeș-Bolyai University in Cluj-Napoca has been developed over three consecutive academic years (2009-2012). It was set up on the wiki hosting service Wikispaces due mostly to its user-friendly interface that renders it easy to manage and use by teacher and students alike. Additionally, the development of Web 2.0 tools and evidence of their successful use in language learning at tertiary level [14], [15] , as well as the need to cater for a growing variety of learning needs (ranging from general communication to professional, social and personal development), determined us to add the wiki platform as an alternative multidimensional and versatile learning space. At the time, wikis' potential for collaboration and organic growth made them attractive in relation to keeping pace with the accelerated change in teaching and learning. Maximisation of learning opportunities, fostering language awareness, promoting learning autonomy, reflective practice, participation of both teachers and students in curricular and syllabus decisions and choice of most adequate teaching/learning methods were only a few of the long term objectives.

A first study (2009-2010) was aimed at investigating the overall impact of the blended approach, in particular of the online learning environment on the students' capacity to process course information (displayed as individual learning units) by carrying out semester-long individual page edits consisting of sharing personal information and course assignments. Wiki design issues and low frequency of teacher feedback were considered to be responsible for the large number of students with low interest for individual study based on wiki resources. On the other hand, students' low attendance at face-to-face meetings and uneven online involvement, namely a slow start and increased frequency after mid semester and at the end of the semester, a typical behaviour due to assessment constraints, were also noticed. [16]. Similar findings were reported by Cole in 2010: "Students prioritize their time according to the greatest perceived benefit with the result that coursework deadlines for other modules and part-time work pressures are automatically awarded a higher priority" (Discussion) [17].

During the following academic year, observations of online and offline behaviour, review of technical issues and the lessons learned during the previous semester together with up-to-date research determined us to introduce several improvements and adaptations to the wiki structure, course organisation and content, all of which allowed us to set a new study (2010-2011) to verify our assumption that in order to learn a language efficiently in an online environment, students need not only basic computer and Internet skills but also a fairly good entry level of English (at least B1-B2 according to the Common European Framework for Reference - CEFR) and certain abilities to work in collaboration. The results of a student survey and statistical analysis of their answers for accuracy versus supposition confirmed that the wiki environment was adopted successfully by the group of students who had more advanced computer and Internet skills, a fairly good level of English and were adepts of collaborative learning. [18]

3 Current Research

Wiki Environment: Our choice went to what some authors call a "hybrid wiki," which seems to have been more successful in higher education [19] and has been generally associated with a system of incentives, rewards or other motivational enforcement that, according to Ebner et al., contradicts the original spirit of the application [20]. Its features include user and version tracking, permission for users and pages, teacher moderation and feedback for template-driven activities and embedded media. Thus, it displayed the functionalities of a content management system, namely teacher controlled course content pages (home page, course rationale, description, schedule, introduction and welcome pages, wiki related information and tutorials) and student-edited individual pages. The latter were designed with two purposes: firstly, to allow enough time for students to become proficient wiki users (during the first part of the semester) and then to offer them a space for *individual contributions* comprising personal elements (similar to social networking descriptions) and *English language learning related tasks* based on course units.

Hypothesis: The present study is targeted at wiki participation as defined by the two main functions of the wiki environment: accessing content (page views) and production of content (page edits). Our assumption was that during the first semester of the academic year 2011-2012 there would be an increase in wiki participation as compared with the first semester of the previous year (2010-2011) as a result of what we considered important modifications of the blend.

The first hypothesis is that change of location for face-to-face meetings from classroom to the computer lab may increase participation due to more time for hands on activities aimed at getting familiar with wiki environment and at developing independent study skills. In addition to this, activity started sooner than in the previous year due to the bulk accounts creation available on Wiki spaces plan for higher education. In this stage, students were also guided gradually through what was to become their semester-long assignment for 50% of the final grade, namely editing their individual pages.

A second hypothesis is that the introduction of a more complex page template, accompanied by detailed instructions as to form and content of the tasks, would generate enhanced response. Its elements were designed (1) to trigger self-expression by means of completing a personal profile (photograph, motto, "about me": maximum 200 words related to interests, hobbies, favourite books/music/movies accompanied by pictures, embedded media etc) and (2) to raise language awareness and take first steps towards taking control and get more reflective in (language) learning (English language profile: initial level, self-assessment, Learning needs/goals for the current year, My learning diary: weekly selection of assignments). .

Participants: For the purpose of our study, we selected the individual pages belonging to first year undergraduates studying social work. Based on a placement test administered during the first week of the semester, students were grouped according to language level (cf. CEFR) as follows: in 2010-2011, one group comprising 42 elementary and lower intermediate students (A2-B1) and another comprising 33 higher intermediate students (B2); in the academic year 2011-2012 three groups: elementary (A2) – 31 students, lower intermediate (B1) – 22 students and higher intermediate (B2) – 25 students. Each student was allocated an individual page for course related assignments. The selection of the participants was based on their more active involvement in class activities (higher attendance included) during the academic year 2010-2011. This means that our conclusions cannot be generalised for now. We hope that a future longitudinal study based on our work-in-progress may show a higher degree of accuracy.

Method: Data were collected with the help of wiki intrinsic statistics which allowed us to quantify students' interaction with the wiki by means of page views and edits statistics for the intervals October 2010- February 2011 and October 2011- February 2012, corresponding to the first semester of the two academic years. They were analysed in two stages: first, the dynamics of page views and edits was computed for the groups with different level of English within each academic year. Based on the results, a second analysis was performed to compare the activity of the A2-B1 students across the two academic years. In order to test the hypotheses, we used SPSS 13.0 and the nonparametric tests Mann-Whitney, Wilcoxon and Friedmann. The decision to apply them was based on the results of the Kolmogorov-Smirnov test.

4 Statistical Study

4.1 Dynamics of Page Views and Edits for Academic Year 2010-2011

The first step was to test for differences in edits/views between the two academic years. By computing the statistical indicators of centrality, we obtained the following results: in 2010-2011 the median value for edits was 4.29, and that for views was 52.32. In 2011-2012, the median value for edits was 5.136 and that for views was 68.03. Consequently, according to Kruskall-Wallis nonparametric test (χ^2 = 60.66,p=0.000) there are differences between:

1. the number of edits performed in the two years, namely in 2012, the median value of edits was higher than that recorded for the previous year;

2. the number of views recorded in the two years, namely the median value of views recorded in 2012 is higher than the mean values of edits for 2011.

We examined the data sets consisting of the views recorded for the pages of the two groups, namely B2 and A2-B1 from October 2010 through February 2011.

In order to assess their statistical significance, we applied the Kolmogorov-Smirnov test and then we checked if there are statistically significant differences within the B2, respectively A2-B1 groups in regards to the views for the studied months by applying the Friedman nonparametric test (χ^2 =50.31,p=0.000).

Following the application of Friedman test, the results showed statistically significant differences among the monthly data within the B2 group (χ^2 =64.92,p=0.000). The analysis continued with the Wilcoxon test and the results are: January-February(Z=-3.75,p=0.000); December-February (Z=-4.03,p=0.001); November-February (Z=-2.04,p=0.04); November-January (Z=-3.92,p=0.000); October-January (Z=-4.81,p=0.000); October-December(Z=-3.58, p=0.000); October-November (Z=-2.81,p=0.02).

Next, within the A2-B1 group the Friedman test (χ^2 =50.17, p=0.000) showed statistically significant differences among monthly views. The Wilcoxon test was then applied to differences between months and we obtained the following results: January-February (Z=-3.75,p=0.000); October-February (Z=-2.62;p=0.009); December-January (Z=-3.83,p=0.000); November-January (Z=-3.93,p=0.000); October-January (Z=-4.81,p=0.000); November-December(Z=-2.21,p=0.000); October-December (Z=-3.58,p=0.000); October-November(Z=-2.81, p=0.005).Finally, by applying the Mann-Whitney test, statistically significant differences were obtained for the two groups in December (U=620,p=0.04), namely the views median in B2 is higher than the views median in A2-B1 group. The tendency across the study was that the views median was higher in B2 (higher intermediate) group as compared to that computed for A2-B1(elementary-lower intermediate).

In the process of statistical analysis of the page edits, the first step was to compute the statistical indicators of centrality, dispersion and localization for 2010-2011. By applying the Friedman test to find out if there are statistically significant differences among the monthly data within the B2 group we obtained (χ^2 =64.89, p=0.000). The Wilcoxon test was then applied to check which are the statistically different months and we obtained the following results: January and February(Z=-4.79, p=0.000); February and December (Z=-3.21,p=0.001); November-February (Z=-2.01,p=0.04) October-December (Z=-4.17,p=0.000) January-November(Z=-3.71 p=0.000); November-October (Z=-2.42,p=0.001). Statistically significant increases of the medians for the studied months were registered. Next, within the A2-B1 group the Friedman test showed statistically significant differences among monthly edits (χ^2 =50.16, p=0.000). The Wilcoxon test was then applied to check which are the statistically different months and we obtained the following results: January-February (Z=-3.75,p=0.000); October-February (Z=-2.61,p=0.009); December-January (Z=-3.83,p=0.000); November-January (Z=-3.92,p=0.000); October-January (Z=-4.81, p=0.000); October-December (Z=-3.57,p=0.000); October-November (Z=-2.81,p=0.005).Finally, by applying the Mann-Whitney test, statistically significant differences were obtained for the two groups in December (U=490,p=0.04), namely the edits median in B2 is higher than the edits median in A2-B1. The tendency across the study was that the edits median was higher in B2 (higher intermediate) group as compared to that computed for A2-B1(elementary-lower intermediate). To conclude, *during the first semester of academic year 2010-2011, the group with a higher level of English performed the most intense activity.*

4.2 Dynamics of Page Views and Edits for Academic Year 2011-2012

In order to further check the above pattern, we examined the data sets consisting of the views recorded for the pages of the three groups, namely B2, A2 and B1 from October 2011 through February 2012. The statistical analysis carried out to determine the views and edits dynamics started with computing statistical indicators of centrality, dispersion and localization for edits and views. The application of the Kolmogorov-Smirnov test, followed by the Friedman nonparametric test showed that there are statistically significant differences between the medians of monthly views (χ^2 =67.92,p=0.000) within the A2 group.

Based on the Wilcoxon test, the following data were obtained: October and February (Z=-2.62,p=0.009); December-January (Z=-3.83,p=0.000); November-January (Z=-3.93,p=0.000); October-January (Z=-4.81,p=0.000); October-December (Z=-3.58,p=0.000); October-November (Z=-2.81,p=0.005). A similar analysis was performed for group B1 and significant differences per months were found (χ^2 =60.32,p=0.000). The Wilcoxon test generated the following results: January-February (Z=-2.14,p=0.03); December-February (Z=-2.81;p=0.005); October-February (Z=-2.42,p=0.02); December-January (Z=-3.003,p=0.003); November-December(Z=-2.28 p=0.001); October-December (Z=-3.22,p=0.001).

The analysis of group B2 showed significant differences between the median of the views/ month (χ^2 =59.43,p=0.000) and the Wilcoxon test showed the following results: January-February (Z=-2.89,p=0.02); December-February (Z=-4.03,p=0.000); November-February (Z=-2.85,p=0.004); October-February (Z=-2.03,p=0.4); December-February (Z=-3.97,p=0.000); November-January (Z=-4.35,p=0.000); November-December (Z=-2.9,p=0.004); October-December (Z=-4.37,p=0.000); October-November (Z=-4.25,p=0.000).

Finally, the Kruskal Wallis test was applied to check if there are differences between the three groups and the computations confirmed statistically significant results in the months of December(χ^2 =4.2, p=0.04)and November (χ^2 =12.004,p=0.001) between the three groups. The median of the views is higher within the A2(elementary) group, followed by B1(lower intermediate) and B2(higher intermediate).The Kruskal Wallis test was applied to check if there are differences between the three groups and the computations confirmed the following statistically significant results: between B1, A2 and B2: November (χ^2 =28.34,p=0.000). The median of the edits is higher within B1, followed by A2 and B2. This hierarchy is maintained across the study. In conclusion, *during the academic year 2011-2012, the students from the group with lower intermediate level performed the most intense activity.*

4.3 Comparative Study

The next step was to examine and compare the two data sets consisting of views and edits recorded for the pages of A2-B1 students in 2011 and 2012 to find out if the modifications introduced in the learning environment had an impact on the students with basic computer skills and lower level of English. Firstly, we assessed the statistical significance of the data set for views by applying the Kolmogorov-Smirnov test,

Table 1. Statistical indicators of centrality, dispersion and localization for 2011-2012: Views

Views A2-B1	Mean	Standard Deviation	Confidence Interval	Min	Max	Median
2011	45.91	84.89	34.37 ;57.47	0	673	12
2012	74.89	105.13	62.18;87.61	0	892	40

followed by the nonparametric Mann-Whitney test. The result of the Mann-Whitney test is ($U=168, p=0.000<0.05$), so there are differences between the two years in terms of a significant increase of the views.

Next, we considered the two data sets comprising the number of page edits recorded for of A2-B1 students in 2011 and 2012. We applied the Kolmogorov-Smirnov test, followed by the nonparametric Mann-Whitney test. The result of the Mann-Whitney test is ($U=223.5; p=0.000<0.05$). Again, the results indicate that there are differences between the two years, this time in terms of significant increase of the edits.

Table 2. Statistical indicators of centrality, dispersion and localization for 2011-2012: Edits

Edits A2-B1	Mean	Standard Deviation	Confidence Interval	Min	Max	Median
2011	3.56	7.48	2.58 ;4.58	0	49	0
2012	5.40	9.84	4.20 ;6.6	0	85	2

All in all, the application of the two nonparametric tests demonstrated that *the activity of students with elementary and pre-intermediate level of English was more intense in 2012 than in the previous year.*

4.4 Findings and Comments

The dynamics of page views and edits within each year shows that the group with higher level of English performed more intensely, with a peak activity in January 2011. In contrast, during 2011-2012 it was the group with lower intermediate level who participated more actively both in terms of views and of edits. During this year, B1 students performed at a relatively steady pace, while A2 students' activity fluctuated and B2 moved more abruptly. All in all, the activity reached a peak in January, with B2 registering the highest values in 2010-2011 and A2-B1 in 2010-2012.

The study of the page view/edits dynamics also confirmed the behaviour pattern (on and offline) noticed in the first study, namely the intensification of activity under the pressure of the imminent assessment constraints.

In terms of changes affecting the behaviour of students with elementary and pre-intermediate level of English, the findings of the comparison between the two academic years point to a more intense activity recorded in 2011-2012, which may be attributed to the change of location for face-to-face meetings from classroom to the computer lab and the introduction of a more complex page template for students' wiki-based individual assignments. Both these changes also involved an increased teacher presence for the initiation in and tutorials for wiki activities, which triggered an increased online student activity. Certainly, this result has yet to be confirmed by a content analysis of the pages to see if increased number of edits meant also a more confident usage of English for self-expression and assignments.

5 Conclusions

The decision to enhance the experience of teaching/learning ES(A)P by creating a media-enriched online environment and gradually implementing a blended learning design for our course was, in our opinion, an important step towards fulfilling one of our basic aims, namely to provide a variety of ways to make (language) learning possible. The results of our three consecutive research attempts have confirmed numerous other studies that acknowledge the potential and positive impact of web-enhanced teaching. Though small-scale and modest in scope, the present study may be considered as evidence that Web 2.0 tools can be used successfully in higher education, in particular for participation and response to a foreign language course. Yet, additional regular observation of classroom attendance and online activity patterns is needed to corroborate the results and improve on the initiation and early stages of wiki work.

Further on, our research will focus on more in-depth analyses of how the new learning environment can support a systematic and efficient acquisition of the foreign language and can foster the development of collaborative skills for undergraduate students. Consequently, we intend to conduct a content analysis on the various products of individual and collaborative work performed on the wiki platform and analyse and compare the interaction patterns (teacher-students, student-student) resulting from wiki participation in the two academic years.

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Ad-Hoc Business Process Management in Enterprises as Expert Communities

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Abstract. The article describes the features of business process management that concerns ad-hoc processes in enterprises as expert communities. The analysis of the possible implementation in corresponding Enterprise Content Management (ECM) system is shown. These results were obtained in the fourth stage of the complex project, which is carried in the frame of Government Grant with participation of NRU HSE and "IT" Corporation (Russia).

Keywords: enterprise content, ECM, ad-hoc, innovation, semi structured information, subject-oriented approach, business process management, S-BPM, communication network, contact net, networking.

1 Introduction

Modern business and government services are becoming more dynamic [5].It is fairly common that businesses need to manage unstructured processes (ad hoc) rather than well predefined business processes. The traditional approach of business process modeling and BPM are poorly suited for the optimization of ad-hoc processes. Ad hoc processes consist of a series of activities which cannot be predefined. In such processes, users must be able to decide what to do and when to do it, and also they must be able to assign work (activities) to other people, creating interactions among various users. For provision of operational flexibility it is necessary to support contingency and the interrelations among all the structural units, so that any innovation can be rapidly spread to all parts of the organization. Companies need to achieve agility when integrating the solution which can satisfy business requirements into the processes, in other words we can see clearly the necessity of SOA implementation relating to business globally. Therefore the main task in searching excellence in business practice is to improve *collaboration between people and agents of support*. So every human activity can be obtained from an organizational point of view in a sequence of informational transformations. It is one of the main ideas of presented study which can be implemented on a particular platform with predictable benefits.

2 Motivation, Aim and Research Questions

For the abovementioned reasons Enerprise Content Management Research and Development (ECM R&D) processes are one of the most- rapidly growing sectors of

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IT market, overcoming traditional corporate sector [1]. With a reference to AIIM report in the nearest future the actual factors for ECM modification and empowering will be cost reduction and efficiency growth in business processes, and in close conjunction such factors as compliance management and content chaos reduction are followed. But surprisingly, such serious part of enterprise activity as support of innovation activity is not mentioned in AIIM report, what is our motivation for completing this research.

The aim of this particular work is dedicated to study of definition of the requirements for developing ad-hoc processes support in a frame of ECM system, existed or planned for implementation. We formulate two research questions:

RQ1: what are the possibilities to support ad-hoc processes (that possibly could lead to innovations) in enterprises?

RQ2: how the model of such organization learning could look like?

3 Ad-Hoc Processes and Organizational Develpoment

As any process, ad-hoc processes are oriented on particular objective. They are built around the sharing of common information systems and corporate data sources, correspondence without direct staff assignments, blogs, conferences, internal social networks, etc, while their main tool is the correspondence and other communications (Q & A, call-center blogs, wiki's, online). Example - the corporate social networking company with expert competence centers, where knowledge can be accumulated, stored and distributed enterprise wide. Experts in such centers are linked by (via) cross-functional principle, thus elaborating solutions for complex interdisciplinary problems.

Properly speaking, having chosen an innovative way of development an enterprise has to create new structure for managing the specialist's crews, which are able to solve related problems and tasks. In such a case it is possible to seriously consider the importance of knowledge economics or innovative economics, and it could become an answer to the question 'when a country stands on a way of innovation development'. Short answer is simple – when we'll create corresponding conditions for:

Instant improving and management of internal processes and technologies.

Generation and development of new knowledge of process logic and existed technologies.

Specialists' motivation to cross-functional experience and knowledge exchange.

Certain step towards the exhibited tasks solution, beyond financial investment, is development and implementation of *innovation-oriented ECM platform*. That platform has to maintain and support ad-hoc process in all its existence. Consequently, requirements to this platform should depend on organization of innovation development and what methodology is prevailed in its realization, as well as a number of social meaningful factors.

4 The Role of Innovations in Modern ECM Platforms

The ultimate goal of innovations is to build a flexible architecture of a corporate enterprise [4]. That can ensure comprehensive functionality in order to support real-time business processes providing a fast reaction to ongoing environmental changes by selecting anappropriate business process optimization. Such an enterprise architecture should include description and allocation of the personnel roles a description of the processes (functions and behavior), as well as an introduction of the required technology used throughout the life cycle of an enterprise, thereby providing business agility. In this regard, many IT professionals understand the necessity of developing new approaches to designing and implementing IT systems. One can believe that the next generation being based on advanced architectural principles and advanced technological solutions will be really able to improve quality of social life.

Considering organizational systems, there are two aspects: the formal (a system of the roles assigned to people) and the informal (the actual performance of roles). Activities of a company which has implanted such principles of compliance management are built in accordance with a system of norms, rules, activities, relationships, regulations, etc., to ensure standards and controls. Another component is the control *subsystem*, which coordinates the activities of its members and administrates it. Thus, a continuous monitoring of standards and requirements such as information systems, risks assessment, connected with discrepancy of business allows priority determination of business processes and information systems modernization. For example, the use of ITIL 3 in any organization ensures that the requirements of ISO 9000, CobiT, SOX (Sarbanes–Oxley Act), and COSO are all met. Active compliance management is the most appropriate tool for this task designed specifically to improve organizational effectiveness. There is a problem related to information systems, as well as the processes themselves which are not flexible enough to be easily rebuilt regarding many, often hidden interprocess communications. As a result, the employee of the organization engaged in the process has to do extra work to verify the results due to numerous requirements.

5 Synergy between Natural and Artificial Environment

It is always obligatory to consider methodological aspects that support the innovation process [2]. Analysts of all the times tried to solve the problem of how to model the activity so it would reflect a desired level of abstraction and at the same time be as close to reality as possible. An answer here could be just one; we have clearly seen the clearance between a model and a reality and always take it to account in our considerations and assumptions. From the management point of view it is a challenge to find a synergy in combining artificial system as a model and natural system as a reality being controlled. In order to achieve a synergistic effect modeling of business processes must be considered in terms of describing natural-artificial systems. There are two approaches of modeling processes: Modeling “top-down” and "bottom-up".

Modeling “top-down” is the formation (forming/shaping) of business process models from integrated to detailed decomposition. Modeling of the system “top-down” on each level gives us the requirements for the next level of detailization in terms of business performance as an artificial system.

Modeling “bottom-up” is the formation of the integrated business processes by aggregating detailed processes or procedures. Modeling a system from the "bottom", we create a “natural” model of transmission processes, which are usually based on the principle of minimizing resource performer.

At present, many companies find themselves in a stalemate because they describe only processes with an artificial point of view by modeling the "top-down". They should, on the one hand, automate and standardize processes to reduce costs, improve efficiency and quality, but, on the other hand, be flexible to move on, respectively, considering the fast changing needs of consumers, markets, laws through the introduction of changes in corporate strategy at the operational level.Thus, the research urgency is caused by the problem of effective management of constantly developing and increasingly complex systems and people involved in their operation and development in terms of synergy between artificial and natural components.

6 Subject-Oriented Approach Fundamentials

Subject-oriented approach (S-BPM) is a new paradigm of business process modeling. This method allows to illuminate and incorporate the true participants of the business activity while modeling the processes and to adopt their understanding of their roles and responsibilities to the real productive system. So process flow involves the effective interaction of staff in accordance with their actual roles, which are defined by their duties. This approach allows to "include" activity of the employees participating in debugging and introduction of business processes, to use reflexivity for changes and to introduce models by the same people who carry out these business processes later [8]. Thus, employees are motivated by their individual contribution to the company. Subject-oriented modeling supports service oriented view on business and allows trial participants to determine the best process for achieving individual goals and key performance indicators.

The S-BPM refers to participants exhibiting their behavior pattern within a process as “subjects.” Each subject in the process is defined, modeled and documented by the description of its individual actions. Here “subject” is considered not only as a resource which is required to perform a specific action but as rational person who possesses intelligence, creativity and reflection [7].

In this article a new model represented a newer approach and can be described as a nonlinear iterative innovation process. In this model multiple interdependent intellectual resources at all process stages are involved; as well parallel, iterative and quickly modified process execution with reference to rapidly changing business requirements. Model of multiple intellectual resources takes into account the diversity of these intellectual resources and creates conditions for their creative networking.

The key issue of such model is ability to self-modification processes (ad-hoc) being inherent in the processes themselves. This approach allows you to modify the process in such a way that it complies with established requirements each time. But to achieve this result it is necessary to know everything about the process including the way it is implemented by specific performers, or its ‘natural behavior’. Building such a model using standard modeling, thereby led to increase of the decomposition and, however often is too difficult and impracticable.

7 Subject-Oriented Modelling of Workspaces

In the traditional modelling the ARIS methodology allows to execute modeling on three of five levels (stages) of life cycle of system development: *Requirement Definition level,* Design *Specification Level and Implementation level.* At the first stage models which define business requirements to the projected system are under (in the course of) construction. Design Specification Level models are transposition of business requirement to information technologies. Specifications level models derive from Requirement Definition Level models. At long last (finally), Implementation Level models describe concrete realization of system; they follow from Design Specification Level models.

The subject-oriented approach allows alternative scenario of the development. In relation to life cycle development these two models presented above are the requirement descriptions of a workflow control system. But, to turn simple models avoiding skills of programmers to the executed applications, it is necessary to fill models and elements (subjects, messages, conditions, transitions) with all necessary attributes and properties. The procedure will provide generation of the high-grade (full-rate) application, including connection to other information systems, electronic documents flows, automatic steps etc., and can be charged to corresponding expert. Thus, the same models in tool system Metasonic S-BPM Suite describe processes at all three levels.

The first model type is intended to describe the process of messages exchange between the subjects (this is quite enough); the second - subjects’ participation in the process which can be described by subjects states and transitions from one state to another [3].

The subject "Founder of Innovation" sends message "The application for the community creation” to subject "Agent" (this is not a man, but an element of an IT system). "Agent", who has staff profiles, sends two messages with his recommendations on potential investors of intellectual capital and their profiles to the "Founder of Innovation». Having examined the recommendations and profiles of candidates, the «Founder of Innovation" sends an invitation to potential investors and, after receiving consent, creates a new community for the innovation development. The formal establishment and registration of community is operated by an Agent. A potential investor becomes a participant in the innovation process. The development of the innovation begins after accumulation of the intellectual investments of the community (fig.1).

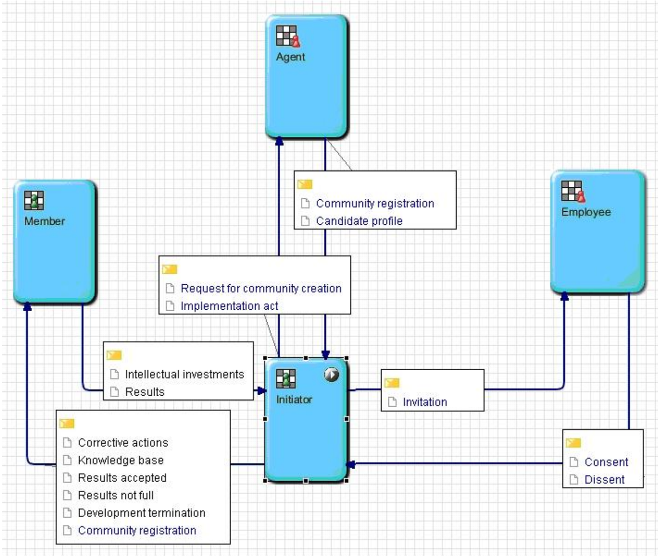

Fig. 1. Model of the innovation process

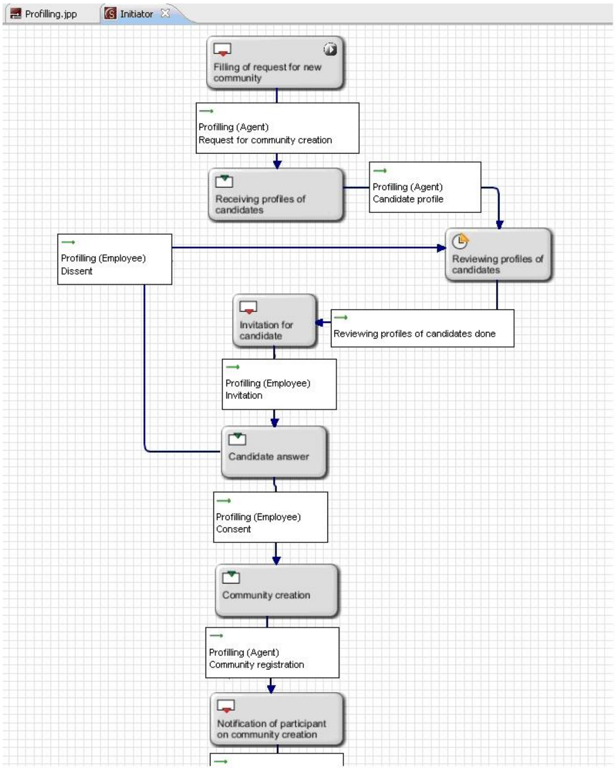

Fig. 2. Example of an innovation creation initiator in «the manager of the subject»

On fig. 2 activity description example of an innovation creation initiator (which has turned into the owner of the process) in «the manager of the subject» is shown. This model is detailed elaboration (decomposition) of the subject «the Initiator of creation of an innovation (the owner of process) », created in «the manager of process» (fig. 1). In this model difficult logic constructions and operators are missing, distinctive for notations of traditional modeling methodologies. All necessary decisions according to the logic of process performance are made by the subject who possesses certain degree of freedom within the limits of given process model [10].

After creating the models it is required to: start models in an interactive imitating mode (if necessary), coordinate them with colleagues and load them on the server. The application starts working at once; it is possible to initialize process copies. For innovative process each participant should have certain degree of freedom in decision-making. This freedom should be enough for stimulating creativity, reflection, and self-organization. If modification of a process is needed, it is brought into corresponding model which is immediately loaded on the server. It is possible to start the updated application at once (the changed copy of innovative process). All copies of innovative process (initial and changed) remain. Information environment remains also. It is necessary for gathering full information on each copy of the process, for accumulation and generalization of experience of innovative activity within the enterprise.

The described approach on platform S-BPM allows realization of operative connection as plural services of information access to unstructured information and various DBMS with access to data at the fields' level. Thus, access to unstructured information can be carried out via one query executed in several services simultaneously, for example, Yandex, Google, Exalead, Fast, at this moment connected to the system. Therefore, there is an auto-generation of system architecture of innovative process management which in more mature phases of self-realization could be corrected and analyzed by experts group, responsible for processes of innovative development.

It is worth noting that flexibility of an architectural skeleton in this case is the cardinal advantage, which allows reaching innovative results in the optimal way. Morally formulated in 1983 by academician V.A. Legasov [6] concept of *flexible production management* on a platform of universal informational highway (pipeline), is realized today in the form of services to the information corporate bus (ESB).

The above description gives the confidence to claim that high-grade innovative ECM system can be designed only from the subject-oriented point of view to innovative process management. This approach has advantages not only to innovative processes, but also to all processes which demand flexibility, simplicity and speed of modification. S-BPM implementation as a part of innovative ECM system gives enterprise the powerful tool for independent management of business processes and ECM system services.

8 New Role of Employees

The main idea of the subject-oriented approach is to consider the subjects of organization as the main participants in its description. It implies that employees quickly and cheaply can integrate their methods of performing the process into the overall scheme of a process, thus achieving self-organize and adapt the system to the external environment.The process users are always given real information about process runtimes, critical paths, and resource bottlenecks. That's why the employees are gaining new roles in organizational structure according to these new requirements:

- Employees should understand the basic goals of the business and participate in achieving them, keeping a balance between business requirements and their capabilities.
- Employees have to understand the responsibility and the consequences for business, caused by mistakes in the work, including the deterioration of customer loyalty, which directly depends on the company's competitiveness.
- Management of division should be predictable and transparent due to unification of its processes, activity based costing and responsibility delegating throughout specialists.
- It is necessary to measure the efficiency and reduce operating costs through reporting and measurement of qualitative and quantitative performance indicators in the process, thus creating KPI culture.
- It is necessary to modernize regularly the IT Infrastructure in conformity with changing requirements of business.
- It is necessary to justify and optimize IT costs.
- To meet some of these requirements, management of IT services has been allocated to a separate management process that was described in ITIL and legally enshrined in the Standard Systems IT Service Management ISO 20000.

9 Research Restrictions

The subject-oriented approach to innovative process is integrally combined with necessity of accounting the socially-psychological factors, which are connected with innovations development. The purpose of this article was not in adduction of detailed description of socially-psychological factors, for this reason we result only general reasons and recommendations.

First of all, creativity is a rare human feature. It means that it is worthwhile including in network innovative communities only those employees who want and can be engaged in innovations development. It is a special "elite" network and its participants (subjects) should acknowledge certain ideological principles. Each employee who wishes to be engaged in innovative process has to study and undertake certain common rules for all participants. In capacity of rules perfectly proved in business ideology of contacts network construction - Networking is offered [9].Secondly, for effective performance of innovative process it is necessary to consider psychological features of each subject and, accordingly, conducting additional researches.Finally, it is necessary to learn (to allocate) to flag among semi structured information that part which contains dramatic distortions, which were consciously or not brought by subjects. In oppose the application of semi-structured information for enterprise governance looks problematic.

In the process of innovative creativity the most essential risk factor is uncertainty and loses of information applicability. In order to solve formulated task continuous actualization of the investigated information and selection of relevant information is required. Hence, except control system of workflows connection with information services providing reliable, adequate access to the relevant information from unstructured sources, and coding services, preservation and access to the problem-structured information is necessary.

10 Conclusion (Summary)

While creating innovative ECM system it is indispensably to provide the support of nonlinear innovative process considering plurality of intellectual investments sources, interdependence and parallelism of development cycles of an innovation, constant orientation on demand, thus providing agility to holistic process. We answered RQ1 in sections 5, 6 and 8.

Modern requirements to innovative ECM system can be executed only with orientation on innovation subject support and the subject-oriented approach to innovative process management.It is necessary to consider the essential impact of socially-psychological factors on innovative process. The created model corresponding to RQ2 we presented in the section 7.

Generation of methodological basis of innovative activity in all phases of its development is the necessary condition for realization of government program transition to innovative economics. The speed of innovations is directly proportional to degree of intellectual resource integration as for separate enterprise, or group of the enterprises which have set such an ambitious task.

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Learning in the Smart City: A Virtual and Augmented Museum Devoted to Chaos Theory

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Abstract. This paper presents a virtual museum introducing the interactive VR and MEMS applications related to the learning of chaos and complexity theory. In this museum, the user can learn the history of the dynamical systems and how to build Chua's circuit, as well as realize artistic artifacts transforming attractors into sounds and music. This environment can be used in the city in order to create new ways of experiencing science, turning physical activities into virtual ones, an important step towards being able to have the museum in the smart city. Moreover, some applications have been developed to work on iPad and iPhone and can be used as a guide in the real exhibitions. A user-centred design strategy with 40 students has been carried out in order to implement the Virtual Museum of Chua's Attractors, aiming at widening the experience in the smart city and allowing a considerable public participation.

Keywords: learning, user-centred design, chaos and complexity, educational environments, virtual world.

1 Introduction

The advantages of integrating technologies in educational environments have been widely discussed in literature [1, 2, 3, 4]. Nowadays, Virtual Reality allows the creation of multimodal and multi-activities environments for science education [5, 6, 7], by which the user can have an active role exploring the contents and learning by doing or playing. Hence, the virtual space is not only a tool for representation, but also a tool for action and interaction, integrating constructivist theories as well. Many authors suggest that the interaction with virtual environments and immersive 3D scenes involves learning [8], but not all the environments imply education [9]. The users can learn and improve their skills because the interaction mechanisms strongly stimulate cognitive capacities such as eye-hand coordination and visual-spatial representations. Virtual environments could be used to present and disseminate many scientific topics. Moreover, auditory display techniques combined with immersive virtual environment could be used both to improve the comprehension of scientific

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phenomena by using 3D modeling and music, and to use science for artistic purposes [10, 11, 12, 13]. Many authors suggest that digital learning application can stimulate students' interest about complex scientific topics [14, 15]. Students' lack of interest into scientific topics originates from the difficulty to understand specific phenomena. However, the 3D visualization of scientific objects, associated with real-time interaction, and the simplification of the complex phenomena can involve students. Moreover, by providing various interactive hands-on paths, it is possible to engage them in an immersive learning environment on topics like physics and mathematics. Furthermore, since the pioneering experiments in hands-on approach of Museums such as La Villette (Paris) or The Exploratorium (San Francisco), a Virtual Museum has become a compelling metaphor by which it is possible to create high scaffolding educational environments. Moreover, a number of large-scale projects have been primarily dedicated to the archaeological site modelling or museum collection digitization (dea.brunel.ac.uk/project/murale/, www.archeoguide.it, www.cineca.it/sap/teatrcultherit.htm). Moreover, the European Network of Excellence EPOCH (www.epoch-net.org) is engaged in the standardizing processes for data capture, networking, and interoperability as primary strategies for linking information throughout the field. The aim of this paper is to present a Virtual Museum in which visual and auditory representations of three dimensional chaotic and complex objects show the simplicity of science learning. This tool has not been designed for advanced users and is an easy-to-use, easy-to learn, and stand-alone environment. In particular, this virtual environment can be used as an Edutainment laboratory in order to promote new ways of experiencing science, such as Chaos Theory, and turning physical activities into virtual ones. The aim is exploit the availability and quality of knowledge communication in the smart city, highlighting the growing importance of Information and Communication Technologies in learning contexts.

The paper has 5 sections: Section 2 introduces science dissemination and the use of new technologies. Section 3 presents the main scientific topics displayed in the Virtual Museum. Section 4 deals about the virtual environment with a detailed description of the interaction systems we have developed. Section 5 concludes the paper providing future directions of this work.

2 Science Dissemination and New Technologies

Since it is essential to involve young generations in scientific studies [16], a wide number of interactive exhibits are incorporated into virtual museums. Frequently museums present exhibitions developed in order to enhance the visitors' experience, as well as to facilitate new forms of participation in science. In fact, the lack of interest in key science topics and mathematics has been linked to the way they are taught from the earliest age. Therefore, greater emphasis needs to be placed on the development of more effective forms of learning method, and analytical skills as well as the improvement of techniques for stimulating intrinsic motivation for learning science. Many researches show that learning by non-traditional methods is a successful experience. Research in Psychology indicates that active learning (the physical construction of knowledge by using the hands in coordination with the eyes) could remarkably enhance students' learning efficiency [17, 18]. A rich interaction can offer participant feelings and, hence, benefit students' active learning, and promote teaching effects. An immersive environment allows a direct approach to science, influencing the formation of critical thought, the development of psychological and social relationship, scaffolding the learning process. The users are active subjects in the virtual environment and learn by performing different activities. On the side of the system development, the construction of the Virtual Museum of Chua's Attractors has been an interdisciplinary effort and many problems of attractors representation in graphics have been already solved [19], but a lot of work needs to be done. Due to the difficulty of chaos visualization, the quality of the interaction with dynamical systems that it is possible to realize and the development of compelling paths on complexity and chaos is still at the beginning. We want to exploit the cognitive advantages of learning by a virtual museum in an immersive audio-visual three-dimensional scene. The complexity of many physical phenomena can't be easily understood, this is even at the base of the chaos basilar mythological concept developed by the ancient Greeks. Contemporary science tried to understand the principles of chaos theory. In particular, Chua invented the first circuit able to visualize chaos. In the following 30 years of research on this topic, many studies have experimentally, mathematically and physically demonstrated chaos. This effort changed the way we perceive science and the scientific discoveries in society, developing larger and more complex visions of the phenomena. Basically the aim of research is to open a new access to science matter for everybody and not only for scientists. In this view, the Virtual Museum we have developed try to activate a new way of learning science, linking our everyday life to scientific improvements. The museum promotes also collaborative and social skills, based on shared learning and joint activities among students.

2.1 Chaos and Complexity

Chaos and Complexity theories are some of the most remarkable achievements of science in the 20th century. A complex system is a collection of many simple nonlinear units that operate in parallel and interact locally producing an emergent behavior.

A complex dynamical system evolves in the space of phases (the set of variables that define the state of the system) delineating a particular evolution. In Chaos Theory, we consider non-linear dynamical systems that evolve in an unpredictable behavior from initial conditions, even though their behavior is deterministic and well structured. Chaotic systems exhibit both complex behavior and stable dynamics in a well-defined region of space known as "attractor". Chaotic attractors themselves are markedly patterned, often having elegant, fixed geometric structures, despite the fact that the trajectories moving within them appear unpredictable. The geometric shapes of the chaotic attractors are the order underlying the apparent chaos. Chua's oscillator [20, 21] is a canonical system for research in chaos, since it can be realized in a real world setting as a simple electronic circuit. It is the simplest electronic circuit in which the presence of chaos has been proved mathematically. The circuit exhibits a rich variety of bifurcations and chaos and it has become a paradigm for chaos theory

[22, 23]. For these reasons Chua's Oscillator and its mathematical model can be used in many different tasks such as research on non-linear dynamics and chaos, chaos theory demonstration, and also for educational purposes and science dissemination [24, 25, 26, 27]. The Lorenz attractor generates only few classes of dynamics and their associated patterns. On the contrary, Chua's circuit, and all the systems based on the circuit, produces a broad variety of chaotic structures, of many different shapes and sizes [28]. Today more than one thousand attractors have been visualized. The variety and richness of the chaotic shapes produced by Chua's circuit and its generalizations inspired the idea of creating a Gallery to collect them. The Gallery shows the complexity and the beauty of the chaotic patterns and presents science through an artistic interpretation [29, 30]. Simulation of chaos produces not only a wide variety of three dimensional model of attractors but also rich collection of sounds and music.

3 Educational Virtual Museum

In order to realize a tool based on a user-centred design strategy, we have designed a pilot questionnaire aiming at gathering information for eliciting user requirements. Then, we have realized the final questionnaire, administrating it to a sample of 40 subjects. Data analysis has provided useful data for the implementation of the museum; finally, the positive usability results have shown the suitability of the adopted participatory strategy. Regarding the virtual museum software architecture, it is as simple as powerful. There are only three different layers: one for handling user interface, one for managing scenes, and one for 3D Audio and 3D Video render (called Render Engine Layer).

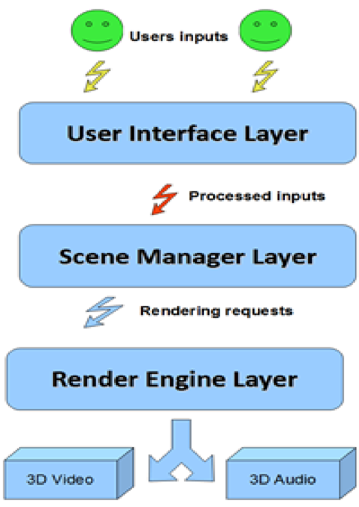

Fig. 1. Architecture

The user interface layer can receive and manage the inputs provided by different user controllers as Wii-mote, mouse and keyboard. Then the processed input signals are control by the scene manager that updates the user's avatar position and the point of view. The scene manager also sends requests to render engine for drawing the virtual 3D world and playing sounds and music from exposed objects. The main employed technologies (Fig. 1) comes from free and open source projects: users' inputs are managed and filtered by GlovePIE (http://carl.kenner.googlepages.com/glovepie_download) and then translated in a compatible way for the user interface layer. The Scene Manager and 3D video Render are guied by Irrlicht (http://irrlicht.sourceforge.net/). The 3D audio rendering are controlled by OpenAL (http://connect.creativelabs.com/openal/). 3D Objects, Musics and Sounds enjoyable in the virtual museum, are generated at run-time in a systematic way, or randomly. The Gallery of Chua attractors has become a virtual museum available both to researchers and to non-specialists. Within the museum, visitors can manipulate the chaotic shapes, change their parameter values, create new attractors and listen to music and sounds generated by their dynamics. In this way, users can discover new and unexpected dimensions of chaos, beyond anything they could previously imagine. Visitors to the museum are accompanied by an avatar that acts as a guide. It describes the general characteristics of Chua systems and their generalizations (including formal aspects) together with the characteristics of the specific system the visitor is looking at. The system allows visitors not just to admire the shapes but to manipulate them in a 3D environment, using special glasses for stereoscopic vision of the shapes and data gloves for interacting with the pattern in an unconventional way. This kind of immersive interaction with an artificial world provides visitors with an insight into the full complexity of chaos. The investigation of chaotic domain still requires much work. Nonetheless, there can be little doubt that the approaches and technologies we have developed provide new ways of exploring chaos, and expanding our scientific knowledge.

3.1 Interface

The main goal of the virtual Museum of Chaos is make use of science in a creative approach and arouse curiosity and interest of a wide auditory about chaotic phenomena. The virtual Museum tries to realize a concrete idea of edutainment tool that combines the educational and entertainment purposes. The setting consists of a single navigable area divided by panels showing pictures of attractors and chaotic evolution. The visitor can control his/her position by using the general map of museum, located on the right bottom site of the screen. The museum symbolically contains five sections, like five different typologies of artistic productions coming out from chaotic system simulations. An avatar functions as guide in the space exploration (Fig. 2). Moreover he can interact with three dimensional chaotic objects. Models of attractors in rotation are placed in central position and utter their characteristic sound. The first section is dedicated to the attractors produced by the Chua's Oscillator. The second section is dedicated to present visual representation of patterns generated by the system with dimensionless equations. Other sections display images from the cubic functions and single point of equilibrium systems. The central parts of the Museum are dedicated to n-scroll, hyper chaotic and synchronized system. Many rotating attractors are in the middle of each room, like sculptures. The user can listen to sounds when he comes up to attractors. Special cameras, mounted on the sculptures, provide alternative views of the museum, directly under the user's control. The novelty bring into the last issue of Museum is a more user friendly interface and a new interaction system MEMS technology based.

Fig. 2. The avatar that accompanies visitors in the exploration of the Virtual Museum of Chua's Attractors. In the original idea of this character, the avatar is Professor Leon Chua who shows the different patterns of chaos to the visitors.

3.2 Interaction System

Moving round the museum, the avatar (and the user) can interact with attractors, listening to music and sounds produced. The environment supports sophisticated forms of interaction. By controlling the avatar users can move from room to room interacting with the objects they find there. Moreover he can visualize, modify and hear the evolution of chaotic trajectory. But the success of such virtual "direct experience" depends heavily on the design of interface and interaction techniques. For these reasons, the interaction between users and the immersive environment has been realized by an interface more usable and receptive to the user's needs, taking in account the experimentation we have done in a real class situation [25]. An enjoying interaction between the learner and the interface is possible using the Wii Remote control by Nintendo Entertainment System (Fig. 3 and 4).

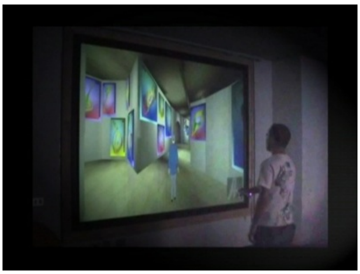

Fig. 3. An user interact with the environment by using a Nintendo Wii

Fig. 4. Using the Nintendo Wii, users can easily direct the avatar and interact with the systems

We organized the museum like an immersive 3D environment in which the real-time interaction permit to explore scientific topic usually dedicated to specialists in an original fashion. The museum space contains a number of components, and each encapsulates specific areas: sculpture of attractors, painting and agent-based interface. Understanding the relationship between educational needs and environment elements will allow us to develop the improvement of this educational museum.

4 Applications

In the Virtual Museum of Chua's Attractors we have implemented 4 main sections, which correspond to 4 different types of interaction. In the first the user acquires knowledge on the main concepts related to chaos and complexity theories, by some short video that have been realized for making simple difficult concepts. In the second section, more action-oriented, the user reconstructs the Chua's circuit in 20 steps, by interacting in a 3D environment by using a computer screen in a room in which other people are making the same activity. The construction is visualized in a wide shared 3D screen, and it is possible to use the single user's interaction or the shared users' interaction. Third and fourth sections are about the visualization of pattern generated by chaos and the realization of sound and music by using Chua's attractors. The first section is related to stories on the Chua's circuit. On a wide 3D screen, which enables stereoscopic vision, the history of the Chua's circuit has been reconstructed in a film, which uses 3D VR and mixed VR technologies. User can view the film and observe the 3D patterns in stereoscopic vision to detect uncovered particulars of these shapes. Furthermore he/she can operate to review the main stream of the story. A singular movie of this section has been devoted to the relationship among dynamical systems, human creativity and arts, especially visual arts. The educational aim of this section is to give some preliminary concepts about chaos, dynamical systems, creativity and science, how it is possible to detect the beauty in these mathematical patterns and transform them into sound and music. The second section has an application which allows the Chua's circuit construction. Users are in a room in which they are connected to the 3D screen by a computer. First they watch at a 3D short movie which illustrate in 20 steps how it is possible to connect the circuit elements for allowing the system's working. Then they have to build the circuit by themselves. Again the activity could be done by a single user or by many users together. This method is based on the idea that the manipulation experience can be very effective in this context. Physical construction of the electronic circuit can stimulate the creativity and curiosity of the students, covering step by step the assembly of circuit components. The image in Fig. 5 shows "The Chua's Circuit Virtual Builder". The arrows in the down corners of the screen allow real time user's interaction which consent the users to navigate through the different steps of the circuit building. The construction of the circuit, as shown in Fig. 6, has been again transposed in a virtual application to let the students to experience and learn all different steps.

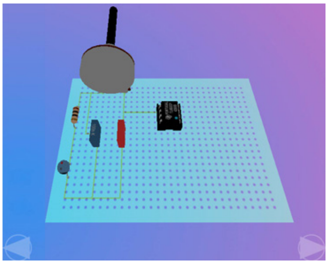

Fig. 5. Chua's circuit virtual builder

Fig. 6. Construction of the Chua's circuit

The third and fourth applications in the third section of the Virtual Museum of Chua's Attractors allows the modification of the 3D models of the attractors with a real time interaction by controlling the system parameters. Driving the MEMS interaction tool, students can experiment the modification of chaotic attractors and hear the acoustic signal produced by themselves. As is possible to see in Fig. 7, a specific mask, shaped like a star, appears on the screen allowing the user to have a visual feedback of the change applied on the values of the parameters. The system allows also a multiuser interaction in the virtual experience on chaotic system understanding, like shown in Fig. 8.

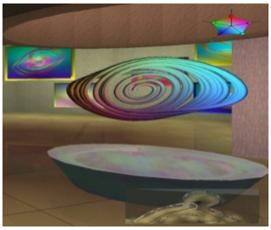

Fig. 7. Interaction interface

Fig. 8. Multiuser interaction system

The developed system allows the user creating music and sound from chaotic shapes. The mathematical models used in this environment are the dimensionless equations for Chua's Oscillator. These models, as the other generalizations of Chua's circuit, generate the sequence of numbers used to produce sound and music. Alternatively to the above mentioned interaction, a learner can use a MIDI Input Device that makes possible to change both the control parameters and the initial values, in order to obtain different kinds of sound and music. This process is very important for grasping the intrinsic nature of chaos as these variables are related to the sensibility to initial conditions of chaotic behavior. Furthermore, many translation codes have been developed, which allow a new way of understanding and studying chaos and complexity [25]. The systems allow the registration of the sound tracks produced by the students and of the patterns of the attractors visualized on the screen.

5 Conclusion and Future Work

In this paper we have presented new applications in the Virtual Museum of Chua's Attractor, related to the visualization, musification and sonification of Chua's attractors. An experimentation with different classes of students, from elementary to high school has been carried out, in order to evaluate students' learning and motivation. Analysis of results is in progress. Moreover, the environment will be downloadable from the net and a wider experimentation will be possible. The collaborative way of learning in a class will also be investigated in a further experimentation.

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Collaborative Processes in Virtual Learning Spaces – Does Structuring Make a Difference?

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Abstract. This study explores features of successful collaborative learning among university students in a virtual course. The aim was to study what kinds of interactional processes occurred when students collaborated while working in international teams and how pedagogical structuring affected the collaborative processes. The data was collected from the Technology-Enhanced Learning course, in which students (N=49) worked together for three months. In this article, two research questions are explored: 1) How did collaborative scripts affect groups' activity, participation, and course grades? 2) What kind of interactional processes occurred in group discussions in the virtual spaces? Results indicate that collaborative scripts enhanced students' activity and participation. Interactional processes in collaborative situations were more often related to off-task than on-task topics. Off-task discussions mostly concentrated on metacognitive issues, such as planning group work. Most on-task discussions were comments or answers to previous messages. This study provides teachers, educators, and educational coordinators guidelines for organizing and enhancing successful collaborative learning in virtual learning spaces.

Keywords: Collaborative learning, CSCL, university students.

1 Introduction

University students today are expected to work in teams, which often consist of students of various different nationalities, a pattern expected to continue in the workplace. People must acquire collaborative problem-solving skills in complex and unexpected situations, where adequate information is not available [11]. Teams work in various contexts, face-to-face and virtually. In these situations, collaborative learning skills are needed [21], and students should learn these skills during their education.

The main arguments for this research come from two perspectives. First, earlier studies [7], [15], [22] indicated that designing collaborative learning is challenging, especially in technology-supported learning environments. More research implemented in an authentic learning context is needed [16].

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Second, many studies have shown that applying scripts can improve computer-supported collaborative learning [23], [25]. However, there is also contradictory evidence [5], and more research is needed, especially on scripting implemented during an extended period, such as a semester or university course [8].

This study is designed to explore the quality and extent of collaborative learning processes in differently scripted virtual study phases. The specific research questions are as follows:

1. How did scripting affect groups' activity, participation, and course grades?
2. What kind of interactional processes occurred in group discussions in virtual spaces?

2 Theoretical Framework

In this study, the definition of collaborative learning is in line with the notion of Arvaja, Salovaara, Häkkinen, and Järvelä [1], who define collaboration as shared knowledge construction where knowledge is built jointly on others' thoughts and ideas [20], [21]. Research on computer supported collaborative learning (CSCL) focuses on possibilities for technology to enhance collaboration and interaction between learners, group work, and sharing expertise [6]. A CSCL environment is defined as a tool that can shape interaction between participants in co-present and geographically distributed settings [4]. Technology, such as virtual learning spaces, should also provide tools for negotiation and discussion [18], [23].

The core of collaborative learning is building joint understanding, shared meanings, and new knowledge through interaction with other learners [20]. This requires learners' commitment in joint activities and tasks [4], [19]. In addition to shared understanding of content, learners have to share an understanding of the social organization in the group and relationships between group members [23]. Successful collaborative learning requires learners' active and equal participation [2] and argumentative interaction [3]. When exploring collaborative learning from the viewpoint of the group's strategical behavior, Järvelä and Järvenoja [14] argue that the group has to be able to regulate its activities by planning, monitoring, coordinating, and evaluating.

Collaborative learning is not a spontaneous process and needs to be supported. One way to enhance collaborative processes is to structure learners' activities through collaborative scripts. Collaborative scripts include supporting activities through which collaboration is specified and structured, and responsibilities are divided among students [12], [17], [25]. Scripts comprise numerous rules for how learners should interact to achieve a joint task [19].

3 Research Methods

This study follows the principles of the case study method. A case study can be defined as an empirical study that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and the context are not evident [26].

3.1 Context, Participants, and Research Setting

The data was collected from an international virtual course called Technology-Enhanced Learning (TEL) (6 credits). Students (N=49) were enrolled at three universities: University of Oulu (Finland), University of Tallinn (Estonia), and University of Targoviste (Romania). Most participants had a background in educational sciences or information technology. The goal of the course was to design, implement, and evaluate a prototype for an advanced virtual course. Enabling collaborative learning, various technologies were applied. Most course activities took place in Moodle and SecondLife environments. Each small group had their own working space in Moodle and SecondLife. In addition, groups used other applications such as Skype and Google Docs.

Students were divided into groups of eight, and in each group there were participants from each country. However, three to five students participated actively in virtual group work during the entire course. Each group had their own tutor. The TEL course consisted of six differently structured studying phases (see Table 1). The research design is described in Table 1.

Table 1. Research design

Course structure	*Phase I: Warming up*	*Phase II: Deciding* on *working methods*	*Phase III: Writing a pedagogical script*	*Phase IV: Writing a technical script*	*Phase V: Implementing course*	*Phase VI: Evaluation phase*
Scripts for groups 1-4	Prompted discussion I	Prompted discussion II	Working with functional roles	Working with functional roles	Loosely structured discussion I	Loosely structured discussion II
Scripts for groups 5-8	Loosely structured discussion I	Loosely structured discussion II	Prompted discussion I	Prompted discussion II	Working with functional roles	Working with functional roles
Groups 9-12	Studying without scripts: basic instructions					
Data	Online questionnaire	Online questionnaire + online discussions	Online questionnaire + online discussions	Online questionnaire + online discussions	Online questionnaire + online discussions	Online questionnaire + online discussions
Analysis	Qualitative content analysis and descriptive statistics					

3.2 Data Collection and Analysis

In the beginning, all students signed a consent form in which they were informed about the data collection and asked permission to use their products for research purposes. The data consisted of discussion notes in Moodle (n=1500) and recorded and transcripted online meetings in SecondLife and Skype. Altogether, the groups had 43 online meetings in SecondLife and Skype. The online meetings lasted 45–120 minutes.

The analysis procedure was developed based on analysis methods presented by Weinberger and Fischer [24], Hmelo-Silver [10] and Järvelä and Häkkinen [13]. Data analysis progressed through two phases. In the first phase, each group's activities in each study phase were analyzed in terms of 1) the number of active participants, 2) the tools the group used for communication and group work, 3) the number of written messages and speech turns per student and tutor, and 4) the grade for the final product of each study phase. In the second phase, collaborative knowledge construction was analyzed in more detail. The most successful group was selected for more detailed analysis based on the results of the first analysis phase.

The interaction processes in most successful group were analyzed. All messages and speech turns were sorted into the categories presented in Table 2. There were 3432 units of analysis in SecondLife discussions and 260 units in Moodle discussions.

Table 2. Coding scheme for online discussions

Main category	Sub categories		Coding principle
On-task (1534 + 87)	Presenting new knowledge	Theory-based Experience –based Statement	Brings new topic based on theory or source of inf. Brings new topic based on experience or opinion. Brings new statement without explanation.
	Question	Independent question Clarifying question Suggestion	Brings new topic to discussion. Clarifies previous question or ask for clarification. States or suggests and wait for comments.
	Answer or comment	Short, declaratory comment Comment with explanation	Agrees, declaratory, repetitive answer/comment. Explains, justifies, clarifies.
Off-task (1898 + 173)	Metacognitive units	Organizing ongoing meeting Organizing upcoming work Technological issues	Organizing group work, and tasks. Upcoming meeting, division of work, tasks. Use of various technologies,technological problems
	Sosio-emotional units	Expressing cohesion Decrease tension Accompanying	Helping, rewarding, acknowledging. Laughing, joking. Express presence, mumbling, accompanying.
	Off-topic units		Topics that are not related to course contents or group work.

4 Results

How did scripting affect the groups' activity, participation, and course grades?

There were no significant differences in activity between groups whose studying was scripted differently. However, there were differences between the groups whose studying was scripted ('scripted groups') and those whose studying was not scripted ('non-scripted groups'). In general, the scripted groups were more active than the non-scripted groups. For example, the average number of messages sent in Moodle was 163 in the scripted groups and 98 in the non-scripted groups. There were also more active group members in the scripted groups (x=5, s= 4–6) than in the non-scripted groups (x= 2, s= 2–3). Groups whose studying was supported with scripts were also more active in arranging online meetings in SecondLife and/or Skype. The groups met online approximately 6 times during the course while the other groups met approximately 2 times. There were also slight differences in course grades between the scripted groups (x= 4.5 in scale 1–5) and the non-scripted groups (x=3.75).

What kind of interactional processes occurred in group discussions in the virtual spaces?

In general, there were more off-task discussions in the SecondLife and Moodle environments. Off-task units were mainly metacognitive in both environments. The groups spent a lot of time and effort organizing their ongoing and upcoming work. The role of socio-emotional units was more significant in the SecondLife discussions. A summary of the percentages of the analysis units coded in each off-task category is presented in Table 3.

Table 3. Off-task units in SecondLife and Moodle discussions (%, f=2071)

	SecondLife (%, f=1898)		Moodle (%, f=173)	
Metacognitive units	66		83	
Organizing ongoing work		42		
Organizing upcoming work		44		100
Technological issues		14		
Socio-emotional units	31		17	
Expressing cohesion		19		63
Decreasing tension		45		25
Accompanying		36		12
Off-topic	3		0	

Most on-task units were answers to presented questions or comments on previous speech turns or messages. Most of the answers or comments were short statements without explanation. They were either short agreements such as “yes” or “I agree,” or statements without further explanation like “I think it looks good.” Most of the questions presented in both environments were clarifying questions, where students asked for clarification of previous statements or questions. Especially in SecondLife discussions, the amount of new knowledge was very low. Half of the presented new knowledge was experience-based, and only one fifth was theory-based. A summary of the percentages of the analysis units coded in each on-task categories is presented in Table 4.

Table 4. On-task units in SecondLife and Moodle discussions (%, f=1621)

	SecondLife (%, f=1534)	Table (%, f=87)
New knowledge	7	38
Theory-based	16	28
Experience-based	49	53
Statement	35	19
Answer or comment	74	47
Short comment	65	58
Comment with explanation	35	42
Questions	19	15
Clarifying question	46	29
New question	32	36
Suggestion	22	35

5 Discussion

The aim of this research was to study 1) the effects of collaborative scripts on students' activity, participation, and course grades and 2) students' interactional processes in successful collaborative learning in virtual spaces. The results are in line with earlier studies [12], [13], [23] that showed the challenge of collaborative learning. Passive group members, unequal participation, and superficial discussions are common phenomena in courses where CSCL ideas have been applied. However, scripting seems to have a positive effect on students' activity and collaborative learning. Naturally, there is no straightforward connection between scripting and students' success; for example, tutoring plays a significant role in promoting collaboration. Active tutoring can enhance activity and participation, but does not guarantee them.

The analysis of the interactive processes indicates that in successful collaborative learning, groups focus on regulating collaborative process, such as planning work and progress. In successful groups, discussions were argumentative and reciprocal. In addition, the group atmosphere was open and relaxed. However, even successful group rarely explored issues from a theoretical viewpoint. Comments were usually short statements without further explanation, and discussions were often superficial.

There were differences in the quality of the interactional processes according to the environment in which the discussions took place. SecondLife seemed to provide students more opportunities for reciprocal discussions, when Moodle seemed to support metacognitive discussions, such as planning and organizing group work. Based on the results, synchronous discussions were more informal than asynchronous ones.

This study provides evidence of the effects of collaborative scripts. The study also provides insights into the quality of interactional processes in successful collaborative learning in an authentic learning context. This study also provides teachers, educators, and educational coordinators guidelines for orchestrating and enhancing collaborative learning in particular in virtual spaces.

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Supporting Collaborative Creativity with Educational Visualizations in 3D Virtual Worlds

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Abstract. Social media are known for substantial creativity support, as they allow users exploring, creating, and sharing various types of content. Social 3D virtual worlds, such as Second Life, can also be seen as a social media that have wide possibilities for being creative. In this paper, we explore how 3D virtual worlds can support creativity in educational settings, including creativity of the collaborative process and creativity of the outcome projects. We propose that this technology can support both. In order to test this proposal, we used the data collected in a case study that we conducted within Cooperation Technology course at the Norwegian University of Science and Technology in 2011. The study was supported by the EU research project CoCreat. The data are discussed to present the challenges for supporting collaborative creativity with 3D virtual worlds, approaches to understanding the concept of creativity, and our experience in creativity evaluation.

1 Introduction

Creativity can be applied to every domain of knowledge and must be seen as an important competence. There is evidence in the literature that creativity is an effective method, key component, and valuable outcome of learning [1-4]. However, creativity is not a spontaneous process and it needs to be promoted with novel solutions.

In this paper, we focus specifically on collaborative creativity in educational context. We present and discuss a part of data from an explorative case study on collaborative educational visualizations conducted using our virtual campus in Second Life within the Cooperation Technology course at the Norwegian University of Science and Technology (NTNU) in 2011. There are three reasons behind the selection of a three-dimensional Virtual World (3D VW) as the main technological platform for this course. First – it offers the opportunity to experience different forms of cooperation and mediation. Second – being unfamiliar, it forces discussion on appropriate use of technologies, critical thinking, and reflective learning [5]. Third – Second Life is known for the wide possibilities for self-expression, as it allows users to create and share any content in the world.

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Schneiderman sees creativity as a process. He identifies the following main phases in a collaborative *creative process* [6]: collect (searching for material and visualizing it), relate (consulting with peers), create (trying out solutions, creating associations, composing artifacts), and finally donate (disseminating results). These phases can be supported by social media and 3D VW that are known for significant creativity support, as they allow users interacting with each other, exploring, creating and sharing content [7,8].

Creativity can also be thought as a *characteristic of a process outcome*, a product. In a 3D VW, such a product becomes visualization or construction. However, besides the 3D graphics, this technology provides many additional creative ways of communicating ideas, such as dynamic presentations and interaction between avatars.

The objective of this paper is to discuss collaborative creativity of the student project work, including *creativity of the collaborative process* and *creativity of the resultant constructions*. In both cases, we explored the role of a 3D VW as a platform and a mediating tool. We designed the activities of the course using Schneiderman's framework and analyzed how the phases of creative collaborative process were supported. Continuing the research into the use of educational visualizations in 3D VWs, we also explore the creativity of the resultant constructions.

The scope of the concept of creativity was not pre-defined in the course, and therefore, another objective of the paper is to explore how the students understand this concept in application to the project work in a 3D VW. In addition, we present some of the results of creativity evaluation and discuss the challenges of this task.

2 Study Settings

The study was conducted with 37 students working on projects in small groups (10 groups of 3–4 students in each), in which they were learning collaboration through experiences. They were forced to communicate intensively, cooperate, and collaborate in a technological environment to complete the task. They were required to create 3D visualizations of major curriculum concepts. The resultant constructions were presented to an international audience at the joint sessions and seminars (Fig. 1).

Each group was required to create and keep a blog for sharing and discussing proposals, reflecting and documenting the progress, and for the final discussion after the constructions were completed and presented. In addition, each student was required to create and keep an individual blog for weekly reflection.

As part of the course, the students participated in the Second International Virtual Summer School on Collaborative Technologies, Serious Games, and Educational Visualizations, organized by two EU projects, TARGET and CoCreat. The goal of the summer school was to demonstrate affordances of the 3D VW technology and let the participants experience different types of collaborative activities.

Fig. 1. Visualization project Awareness Lab – student role play

Two international events were conducted as part of the summer school. One of them was organized as a seminar on EU projects, which included five presentations and a question-and-answer session. The objective of this event was to demonstrate to the students how international cooperation can be established and supported using modern technologies. Another objective was to expose the students to the novel ideas and technologies behind these projects, such as serious games in corporate learning and collaborative creativity. The second event was organized as a virtual tour to the virtual campus of the College of Education (COE) at the University of Hawaii at Manoa (UHM) and augmented with feedback sessions with an invited expert (Fig. 2). Both events of the school and the role-play session attracted international visitors.

Fig. 2. Feedback sessions with an invited expert – virtual event

3 Method and Data Collection

Our approach to using educational visualizations in 3D VW for learning has been developed in several previous studies [9]. The methodology is based on constructionism – an educational philosophy which implies that learning is more effective through the design and building of personally meaningful artifacts than consuming information alone [10]. Constructionism is related to the social constructivist approach, which proposes that learners co-construct their environment and understanding together with their peers [11]. In addition, we applied role-playing, which is a widely used and effective learning and teaching method. It implies an active behavior in accordance with a specific role [12].

We consider a student group a subject within a learning community. The results of activities performed by students is an artifact, a reification of experience [13] that is shared with other community members, e.g. future generations of students.

The data were collected from the direct observation of students' activities online, pre- and post-questionnaires, virtual artifacts, such as chat log and 3D constructions, and users' feedback in the form of group blogs. For data analysis, we use the constant comparative method [14] that was originally developed for use in grounded theory methodology and is now applied as a method of analysis in qualitative research.

4 Data and Results

All 10 groups managed to complete the task. As a result, we got 10 constructions visualizing different topics. Students applied different metaphors and design approaches that can be sorted into three main categories.

Groups 6, 7, and 11have made constructions to be mostly the *scenes for their role-plays*. Even though these constructions were very different and had different level of detail, their purposes were too unclear without the presentations. Three other groups (1, 5, and 9) made their constructions as *facilities*; workplaces, which visitors could use, games, where they could play, or tools, where a single user could learn. Groups 3 and 10 have made their visualizations as *museums* or exhibitions. These groups offered a guided tour through their constructions instead of the role-play. Finally, groups 4 and 8 combined the exhibition/museum metaphor as introductions to the topic and facilities as a fun and practical experience.

In order to assess creativity, we applied different approaches. The question on creativity support in 3D virtual worlds was asked in the individual pre- and post-questionnaires. The feedback was negative, especially against the background of other similar questions, in which 3D VW were evaluated as moderately suitable for collaboration and visualization. Nevertheless, we looked into detail and analyzed the data from discussions in the group blogs, where the students reflected on their experience after completing constructions in Second Life. The discussions included the analysis of their own constructions and peer-evaluations. In addition, a group of post-graduate students from the COE UHM was invited to explore and evaluate the constructions.

We provided similar guidelines for these evaluations in the form of a set of questions to discuss and aspects to consider.

In the following, we present how the students discussed creativity in the collaborative process and creativity in the resultant constructions.

4.1 Creativity in the Collaborative Process

Within the final task, the students reflected generally on their collaborative process during the exercise, including a reflection on how creative it was.

Creative Process versus Planning. Six groups explicitly stated that the process of their project work was creative. Moreover, four groups (including some of already mentioned) noted that they had a creative and productive idea generation process. One group stated that it was hard to assess their own creativity.

– Generally, we are of the opinion that our construction process was somewhat more creative than in real life since.
– So, in regards to the process we are quite happy with our level of creativity.

Two other groups stated that their construction process was not creative. These students also stressed that they had a plan from the very beginning and just worked towards the goal.

– Our construction process has been fairly straightforward and perhaps not overly creative. We decided on a suitable topic to elaborate, and worked together […] to make a construction that could illustrate this topic in an acceptable way.

In addition, it should be noted that two of the groups recognized the possibilities creativity expression in 3D VW and that they could be much more creative, however without experience, the technology is rather difficult to use.

3D Environment Affects Creativity. Half of the groups stated that 3D VW positively affects creativity and supports generation of new ideas.

– New ideas were often generated by "playing around" with objects without a concrete plan of what we wanted to achieve but by combining elements (prims) which we liked into a greater construct.

At the same time the other groups argued that the technology, being unknown, hinders creativity.

– It affected our creativity in that manner that neither of us had any experience working in 3D CVEs. So when we were supposed to start building, we did not know what was possible, and how to do the things that were possible.

Three of the groups noted that their creativity was not affected by the technology as they were brainstorming the constructions before starting to work in Second Life and designing on paper.

– In the beginning, we spent time brainstorming about our project, at this point we ignored any technical limitations and decided that we would adapt our idea to these limitations when we started to build.

Resources Affect Creativity. The students discussed how resources and examples of similar projects available in the Virtual Campus affected their creativity.

Only one student group stated that their creativity was positively affected by the resources and other constructions in the Virtual Campus. The other groups were to different degrees certain that their creativity was not affected. However, five groups stated that they were inspired by the available resources and examples of constructions. In addition, three groups argued that resources in the campus ease the constructing process.

– We looked at the earlier projects to get a feeling of what is possible of achieving in the given time for the project. Of course, our building was a bit inspired of the style of building with multiple floors and walls surrounding the building.

Sharing 3D constructions also received a positive feedback, as the students get additional motivation from exhibiting their construction for other people.

– Sharing and exhibiting constructions in the Virtual Gallery is good because it can help newcomers introduce what 3D CVEs are capable of, what is possible to do, what types of collaboration are possible.

4.2 Creativity in the Resultant Constructions

The *resultant constructions* were analyzed by the students from NTNU, including self- and peer-evaluations, and by the post-graduate students from COE UHM. Students from both universities had similar guidance that included the question on creativity. In addition, the Norwegian students discussed how resources and examples of similar projects available in the Virtual Campus affected their creativity.

Self-evaluations. Five groups explicitly called their constructions creative. Explaining this statement, the students mentioned a number of factors. Elaborated aesthetics was the most popular indicator of creativity, but in addition, visual symbols, variety of visualization means, and the difference from other constructions were mentioned.

– We think our construction is pretty creative, because we are the only one of the groups who chose to create a round, and pretty colourful, house.

– Based on the end result we would consider the construction as very creative, as we had to use all of our creative skills to make it as good working in both design [and] conveying a message.

– We have used several means of communication, 3D objects, signs, a browser and sound. We were the only group applying "talking objects".

Three groups expressed against creativity in such constructions. They all argued that clearly presented information and intuitive functionality are more important should be elaborated before the creative elements.

– We chose to focus on displaying how it could be used through actually using it in a CVE. Functionality prior to creativity.

– The creation of the building itself was however not that creative, and we rather haphazardly joined together pieces into creating what in the end resembles a house. Here we wanted an exhibition that displayed some text about the topic as well as instructions for the game.

Peer-Evaluations. Each group evaluated projects of two other groups, following the same scheme that was used for the self-evaluations. In peer-evaluations, the students discussed the ideas behind the projects more often than the constructions or the role-plays. There were two times more positive evaluations than there were negative.

– […] to meet up with a company through this job portal, to get to know the company and an introduction to how they work and what they work with, is in fact a great idea.

In half of the peer-evaluations, the students discussed the relations between creativity and functionality, though they were not asked about that. Two common trends were most visible. First, the students often argued that elaborated functionality (including reality resemblance) of the constructions hinders creativity.

– The construction was very detailed (it really looked like a lab)! The idea of the construction was creative, but since the construction should look like a real lab, it's difficult to discuss the creativeness of it.

Second, creative ideas were recognized as hindering functionality and adding ambiguity into the constructions. In addition, in two cases creative ideas were connected with incomplete implementation of the constructions, as they would require more effort.

– In spite of bold attempt, it is not quite wise choice that combine maze with information. When one explores the maze, useful information is easily to overlook in some extent.

External Evaluations. The resultant constructions were also evaluated by a group of post-graduate students from COE UHM. They were asked to evaluate constructions without seeing the role-plays and provide feedback for the students from NTNU.

In their feedback, all the students from COE UHM stated that constructions are creative to some degree. They appreciated that such visualizations have potential to be used in educational settings as an exciting, fun, and motivating/creative activity.

– Very creative. They used a lot of visual tools. […] I think they could use a URL loader. They did represent the different types of social media well, but could have used other types of tools such as video or URLs to display them better.

However, without attending the role-plays, it was difficult to understand fully the purpose of the constructions. Therefore, many students expressed doubts about whole constructions or particular elements and suggested ways of clarifying their meaning.

– It seemed like there needed a professor available to utilize each site as it was unclear what the objectives are without someone to guide you.

In the second part, the students discussed how working in a 3D environment affected their creativity, how it supported generating new ideas or caused problems.

5 Discussion

5.1 Approaches to Understanding Creativity

Creativity turned out to be a complex phenomenon, especially for assessment and evaluation. The feedback shows that students have different understanding of what should be called creativity and creative. However, we were able to discover certain trends and regularities, which will be discussed in the following.

The first approach for identifying creativity was found in selecting certain *creative elements* in the constructions: elaborated aesthetics, visual symbols, variety of visualization means, and the difference from other constructions. The latter category implies that creativity might be seen not as an absolute value, but it is related to the community. Most of these indicators were discussed by students in self-evaluations.

However, when evaluating projects of other groups, the second approach appeared. The students stated that the *ideas* behind certain projects were creative, while the constructions themselves were called either simple or incomplete. This implies that creativity can lie also in a way of conveying the message.

Moreover, some of the projects were evaluated as creative by the reason of *creative presentations* performed live by the students. Most of such projects had simple constructions and the main message was conveyed by the role-play. Therefore, the main problem with such constructions was to understand their purpose and the idea behind for the visitors who could not see the role-play.

For example, group 1 made a tool for training aphasia patients. The construction has the design different from the others. They used interactive 3D symbolic elements, audio and textual media content. The metaphor type used is facility – learning tool, which can be used without role-play. The construction is clearly explained by text and a graphic poster, so the message is clear. However, the overall design (big blue cylinder house) of the construction has no connection either with the topic they visualized (communication), or with aphasia/medical theme.

Another example can be group 6 that made a visualization of awareness as two chemical/biological labs, working in cooperation. The construction has a more realistic design, replicating the appearance of real labs. The groups also used various media content, interactive elements, graphics, and text. They used the construction as an environment for the role-play, so without the play, it was very unclear what was the purpose of the construction. However, even those who were present at the role-play did not rate the construction very high as the play was very dynamic and some of the audience did not manage to follow. Overall, the construction visualized an example of applying the concept of awareness.

5.2 Challenges for Supporting Collaborative Creativity in 3D Virtual Worlds

Creative Collaborative Process. The design of the study and the design of the 3D environment for this course were based on Schneiderman's framework of creative collaborative process. Student self-, peer-, and external evaluation indicate that all four phases of creative collaborative process were supported. As presented in the Data and results section, the students explicitly mentioned that activities of all four phases affected the creativity of the process.

However, we identified two major challenges in applying 3D VWs for supporting creative collaborative process in educational settings. First, the technology is difficult to use or at least it appears to be. In total, more than half of the groups stated that it hinders creativity. Some were using other technologies to support idea generation process. Some others reported that they could be more creative if they knew how to use the 3D VW efficiently. Second, the community level of communication and collaboration is limited. Even though the students recognized the positive effect of interacting with the visitors and sharing of the constructions, they also noted that the community is too small and the time span is too short to be beneficial.

Creativity of the Constructions. The analysis of the data indicates that most of the groups consider the resultant constructions creative or, in some cases, potentially creative.

However, we discovered a number of challenges for creativity of educational visualizations in 3D VWs, the most important of which are presented below. First, creativity is often in conflict with functionality. Creativity goes together with new interesting ideas and unusual experience. However, too much focus on creativity makes the purpose of the constructions unclear and hinders their functionality. Consequently, it requires more effort on a clear explanation or a presentation. On the other hand, too much focus on functionality and clear presentation of the information makes construction boring and less engaging. Second, there is a difference between a creative construction and a creative way of presenting information. In other words, creativity can be found in the structure of the construction and its content (in our case, how the construction is built) or in the presentation form (how the concept is visualized).

5.3 Creativity Evaluation

The evaluation of creativity support is rather complicated by objective and qualitative measures. In the study design, we proposed how creativity can be measured [15]. We were planning to study "symmetry of ignorance" and creativity. In this perspective, we put particular attention in studying interaction among participants with different backgrounds to observe the impact on creativity. Our hypothesis was that groups with students with varied background would be more creative than homogeneous groups. However, the results present no significant difference.

At the community level, we hypothesized that sessions with the presence of external experts and students from other universities would trigger high level of creativity. The feedback indicates that the students acknowledged the possibilities of 3D VWs for international collaboration, virtual visits, and knowledge sharing as it was done during the virtual events. Some of the groups also noted that virtual events helped generating new ideas. Sharing 3D constructions and exploring the projects of other students also received positive feedback.

Different resources were provided to make construction process easier. Though this is essential to promote usage of the system, it might also hinder creativity. We evaluated the final constructions and identified that they all can be considered as original and not as a re-use of the provided resources. Self- and peer-evaluations also confirm that resources ease construction process, but do not affect creativity.

Breakdowns in construction process were studied since they might actually have led to creative problem solving. Though the 3D technology was generally found unfamiliar and challenging, it made the groups collaborate more closely as they needed to consult each other and rely on each other's support to achieve their goals.

Finally, we attempted to explore the relation between learning and creativity. Though the constructions might be very creative from an aesthetic or experiential perspective, this does not necessarily lead to learning. Most of the groups reflected that the visualization process deepened their understanding of the course concepts. However, we could not identify a strong enough connection to creativity.

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Fuzzy Enhancement of Creativity in Collaborative Online Learning

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Abstract. The collaborative online learning is an online learning situation in which more participants organized in small groups collaborate to solve a problem. Finding methods to facilitate creativity in this kind of learning situations is challenging. The problems that arise in creating of genuine online creative collaborative learning environments are numerous: constitution of the online creative learners' groups, organization of the online learning process, adoption of the appropriate instructional strategies, defining the "creativity triggers" that have to be included in the online learning situations. All these challenges are taken into consideration in this paper, and a collaborative learning model based on the fuzzy theory is proposed. This model can be integrated in online learning environments to increase both learners' creativity and their complex development. The results presented here are obtained through questioning our university staff related to the creativity issues in the instructional process, followed by simulation. Also, the necessity of a systemic approach of the online learning process aiming to achieve the objectives of the instructional process is emphasized.

Keywords: creative teaching and learning, creativity, fuzzy control, fuzzy collaborative learning model.

1 Introduction and Background

There are no doubts concerning the importance of creativity in everyday activities. Educational systems have to get a new dimension creativity-wise. It is necessary to prepare learners not only to apply the acquired knowledge and to solve problems in a classical way but also to generate new solutions, ideas, novelty and performance.

The concept of creativity has had many definitions over the time, most of them being centered on the idea of novelty. Research regarding creativity began in the 1950s. In [13], the author presents three waves of creativity research: first wave focuses "on studying the personalities of exceptional creators", while the second and the third one are based on cognitive psychology. Thus, the second wave is "focused on the internal mental processes" whilst the third wave, called the "sociocultural approach", focuses on "creative social systems: groups of people in social and cultural contexts" [13]. The outputs of creativity can be divided in three dimensions: *little c* (creativity), *middle c* (creativity), and *big C* (Creativity) [7, 12]. Each dimension is defined by the

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importance and implications of the novelty produced in the society. The “little c” means the creativity at individual level: “everyday, life-wide creativity as well as the creativity inherent within domains studied as subjects in schools” [2]. The “big C” represents the “historical” creativity: great ideas that change the world emerge [1]. The outputs of the “middle c” affect a small community of people [1].

According to Csikszentmihalyi, the components of creativity are: the domains, the fields and the individuals [3]. The domain consists of a set of symbolic rules and procedures. The field includes “all the individuals who act as gatekeepers to the domain” in the sense that they certify the novelty and the individuals “come up with a new idea or see a new pattern” [3]. Csikszentmihalyi said about a creative person that “His or her thoughts or actions change a domain, or establish a new domain” [3]. A detailed description of the Csikszentmihalyi’s Systems Model of Creativity can be found in [4].

The concept of creative learning has been developed in England, and it can be defined as the *learning process which facilitates the development of the persons’ creativity, along with the complex development of the individuals*: “self-affirmation, social identity, social role and social relations” [8, 9]. In the research studies undertaken in the project entitled Creative Learning and Student Perspectives, the following common characteristic of teaching and learning practices have been identified: relevance, ownership of knowledge, control of learning process and innovation. The relevance refers to the correlation of the learning objectives with both interests and needs of learners. The ownership of knowledge belongs to learners. They learn for themselves, not for someone else’s acknowledgement. The control of learning processes adjusts both learner control and machine control, and innovation refers to something newly created [9].

The creative learning situations are complex: the participants of the instructional process interchange their roles and the relationships between them are altered: learners become authors of their learning, and teachers become learners [9]. All participants of the instructional process work collaboratively, learners’ experiences are used, learners are engaged in diverse and multiple activities at a time, theoretical and practical activities are tied.

In this paper, we consider the definition of creativity from the sociocultural approach point of view: “Creativity is the generation of a product that is judged to be novel and also to be appropriate, useful, or valuable by a suitably knowledgeable social group” [13]. Also, we present the results obtained during a questioning session realized with our academic staff. Moreover, we propose a collaborative learning model based on the fuzzy theory that can be integrated in online collaborative learning environments.

The remaining part of the paper is organized as follows: in section 2, an analysis of our academic staff answers is presented; in section 3 a fuzzy system to control the learners’ creativity is proposed, along with presentation of the theoretical results, while section 4 includes paper’s summary, the advantages of using the proposed model, and the conclusions.

2 Analysis of the Academic Staff Creativity's Questionnaire

The purpose of this study is to identify the "manifestation" of the creativity in the instructional process from our university. We are interested in both the perception of creativity in the classroom and the teachers' points of view regarding the enhancement of creativity in our educational system.

We have interviewed eleven academic staff members from various fields/with various backgrounds: 5 -Computer Science and Engineering, 1-Mechanical Engineering, 2-Mathematics, 1-Physics, and 2-Philology.

The proposed questionnaire includes the following questions:

1. Give a definition of creativity.
2. Name an activity undertaken during the teaching and learning process, in which the students have demonstrated creativity.
3. Are your students creative? Give a percentage.
4. The creativity can be assessed?
5. Intelligence and creativity – which is the relationship between them?
6. Do you believe that traditional face to face learning supports creativity?
7. Do you believe that online learning supports creativity?
8. Do you believe that collaborative learning supports creativity?

The obtained answers are presented in the table no. 1.

In most cases, our teaching staff defines creativity as a personal capability to generate something new, original, which generates changes in a domain. The learning activities used in the instructional process are problem solving, developing applications and projects, group working, and analysis making. The percentage of creative learners is very small: 11.15%, that means that our academic staff has to make steady efforts to change their teaching strategies in order to increase learners' creativity. Learners needs to be encouraged to be creative, they have to learn not to "memorize" only. Intelligence and creativity are related according to the received answers: 5 persons affirm that intelligence and creativity are interdependent, 2 say that a creative person is intelligent but a creative person is not necessary intelligent, 2 say that an intelligent person is also creative, and 2 offer imprecise answers. At question no. 6, the answers are: 4 yes, 2 no, and 5 persons don't offer convincing answers. Only 36% from teachers believe that online learning supports creativity. All teachers (100%) believe that collaborative learning supports creativity. Creativity can be approximately measured in the view of most interviewed persons. This is the rationale of proposing a fuzzy control based model to enhance the learners' creativity. Based on the results obtained at the question regarding the relation between collaborative learning and creativity, we have tested the fuzzy controller meaning to define the composition of the learners' group that could increase learners' creativity.

Table 1. Academic staff responses

Q1	Q2	Q3	Q4
a mental process which implies new concepts and ideas, always resulting something new	developing projects	15%	approx.
the capacity to generate novelty	performing analysis	1%	no
the novelty in a domain	developing applications	10%	yes
the capacity to create something original, new	developing projects	2.5%	approx.
the capacity to meet some practical and theoretical challenges using the existing material, human, and cognitive resources	developing applications	35.5%	no
the capacity to invent something new, to have new ideas leading to the creation of something useful, advancing in knowledge	developing applications and projects, group working	0%	approx.
the capacity to imagine/ create/ develop new ideas/things	performing analysis	5%	approx.
the ability to offer new solution for problems without any indications to approach them	problem solving, developing projects	12.5%	approx.
the ability to generate new ideas/ concepts	performing analysis	12.5%	approx.
the capacity to resolve new applications; knowledge + understanding imply creativity	problem solving	0%	yes
the capacity to solve problems in other areas; to find new solutions.	problem solving	17.5%	yes
Q5	**Q6**	**Q7**	**Q8**
interdependent relation	no	yes	yes
imprecise answer	yes	yes	yes
imprecise answer	imprecise answer	no	yes
intelligent person means creative person	no	no	yes
interdependent relation	imprecise answer	yes	yes
a creative person is intelligent but a creative person is not necessary intelligent	imprecise answer	yes	yes
interdependent relation	yes	depends	yes
interdependent relation	yes	no	yes
interdependent relation	yes	depends	yes
a creative person is intelligent but a creative person is not necessary intelligent	imprecise answer	no	yes
intelligent person means creative person	imprecise answer	no	yes

The literature provides many assessment tools for creativity. An interesting study can be found in [14], where different creative assessment tools are compared. Conclusions drawn out from [14] are as follows: autophotography is a creativity-relevant measure, and the openness to experience is a relevant factor to creativity [14]. Usually, the creative potential is measured using the creative personality scales based on ACL (Adjective Check List). In the fuzzy based model proposed in this paper, the Gough's (1979) Creative personality scale is used [5, 6]. The general assertions made by the teachers of PGU are that face-to-face learning enhances the learners' creativity better than online learning. The agreed opinion is that online learning environments have to integrate specific tools in order to stimulate the creativity of the learners. Collaborative learning is firmly seen as facilitating creativity. Despite being considered very important in the instructional process, creativity is hardly encountered in.

3 Fuzzy System to Control Learners' Creativity

Elaboration of an e-learning system is a complex activity requiring an analysis of the instructional process in all its aspects: target groups, learning objectives, pedagogical contents, resources, instructional design, etc. How to teach, in order to increase learners' creativity, in a given learning contextual environment, is an issue to be considered here. So, an e-learning system is composed by a set of sub-systems, which deal with the above aspects. The fuzzy controller described in this paper should be used within such a system for setting up learning and teaching scenarios, and for tailoring learners' groups in collaborative learning.

A fuzzy system to control the online instruction process working regime (learner control vs. machine control) was proposed in [10]. In this paper, the author applies the fuzzy controller from [10] "to control the creativity" in online learning collaborative systems. We subscribe to the description of the e-learning process rooted in the systemic theory proposed in [11]. A challenge to e-learning developers is to build collaborative online learning environments, which support creativity. The schema of the proposed fuzzy system to enhance the learners' creativity is presented in figure 1.

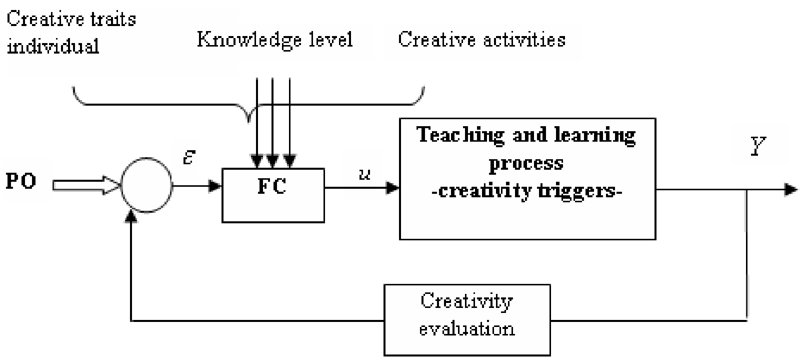

Fig. 1. Fuzzy system to control creativity

The objective of the system is a Performance Objective (PO) related to the creativity of the learners' groups. According to the classification presented above the performance objective can be a *little c*, a *middle c* or a *big C*.

The "creativity triggers" are the objects that influence learners' creativity. These "creativity triggers" can be the composition of the groups, the creative teaching and learning scenarios etc. The order u consists in activation of the creativity triggers. The output variable, u is a vector (u_1, u_2), where u_1 defines orders on the structure of the group and it can take a value in the range [0, 1]. A value closed to 1 for u_1 means that the composition of the group needs to be changed. u_2 defines the orders on the creative teaching and learning scenarios and it can take values from a predefined range. For example, we consider the range [0, 2] where a value closed to 0 means that the system uses the scenario 1; a value closed to 1, the scenario 2, and, finally, a value closed to 2, the scenario no. 3.

The native creativity of individuals is established using the CPS Gough [5], or other creativity tests [16].

The creative scenarios consist of a series of learning and teaching activities, which increase the individual's and group's creativity. Creative scenarios can be constructed based on the Shneiderman's four-phase genex framework consisting in *collect*, *relate*, *create*, and *donate* [15]. The creative activities comprised in Shneiderman's genex are as follows:

- "Searching and browsing digital libraries
- Consulting with peers and mentors
- Visualizing data and processes
- Thinking by free associations
- Exploring solutions—what-if tools
- Composing artifacts and performances
- Reviewing and replaying session histories
- Disseminating results" [15].

A creative online learning space is defined by all the elements, which contribute to increasing of learners' creativity in the online learning environment. The goal of the proposed system is to provide for a creative online learning space. Attributes of a creative online learning space are presented below:

- Uses a creative learning-teaching scenario,
- Provides deeply understanding, rather than simply memorization,
- Uses various communication channels,
- Promotes multidisciplinarity, integrates various topics,
- Elicits learners' ideas.

The output of the system (Y) is the individual creativity. The creativity is assessed by qualified persons, who define the component field of the Csikszentmihalyi's Systems Model of Creativity. A group of persons (teachers or not, but all capable of certifying creativity) evaluates the outcomes of the learning process, and estimates the level of creativity. So, the output of the system Y is a number in the range [0, 3]. For example: 0 means no creativity; value 1 means little c; value 2 means middle c; value 3 means big C. The PO is 1 for little c, 2 for middle c, or 3 for big C.

The error ε is defined by the difference between PO and *Y*. In the case of PO=1, if the error is positive, the fuzzy controller emits orders to change the structure of the groups, or to use another creative scenario. In the case of *PO*=1 and if the error has a negative value, one sets the value of *PO* to 2 or 3 and the fuzzy controller regulates the process in order to achieve a higher level of the creativity.

The fuzzy controller is a Mamdani controller; the accumulation of the activated conclusions uses the max operator. Three linguistic input variables are defined: a creative level of the group, the knowledge level and the error ε .

The creative level of the group variable has the range of discrete values from -12*pers_group to 18*pers_groups, where pers_group represents no. of persons in a group. The total of adjectives in Gough's scale is 30 (18 are pro creative individuals and 12 are contra creative individuals). The universe of discourse of the knowledge level is the range [0, 10]. The knowledge level of the groups has in the range [0, 40] (pers_groups=4). The range [0,3] gives the universe of discourse of the *Y* variable. The universe of discourse of the error is the range [-2, 1] in the case of PO=1, [-1, 2] in the case of PO=2, and [0,3] in the case of PO=3.

The fuzzification transforms input data to degree of membership. The defuzzification method is a COG (Center of Gravity) method. The linguistic variables and terms are presented in the table no. 2.

Table 2. List of variables used in fuzzy system

Linguistic variables	Type of variable	Linguistic terms
Creative level of the group (CG)	Input	B, M, S
Knowledge level of the group (KG)	Input	B, M, S
Error (ε)	Input	NB, NM, NS, ZE, PS, PM, PB
U=(u_1,u_2)	Output	B, M, S

In the case PO=1, the rules of the fuzzy controller are presented in the figure no. 2.

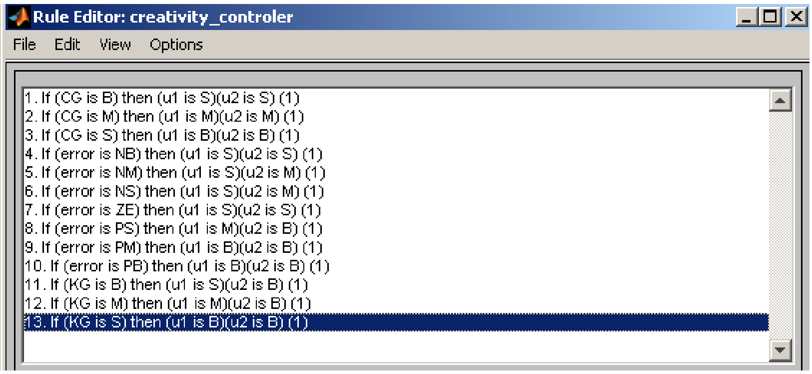

Fig. 2. Rules of fuzzy controller

The memberships functions are triangular, and they have the form presented in (1).

$$\varphi_{m,d}(x)=\begin{cases}1-\left|\dfrac{m-x}{d}\right|, m-d\le x\le m+d \\ 0, otherwise\end{cases}, \; m\in R, \; d>0 \tag{1}$$

To simulate the way the fuzzy system works, we have used the MATLAB 7.1 software. The fuzzy coverings of error is presented in figure no.3.

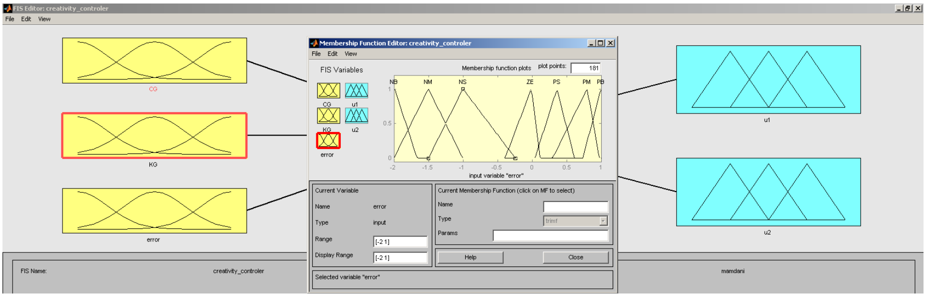

Fig. 3. Fuzzy covering of error

The inference rules model for $\varepsilon = 0.614$ is presented in figure 4.

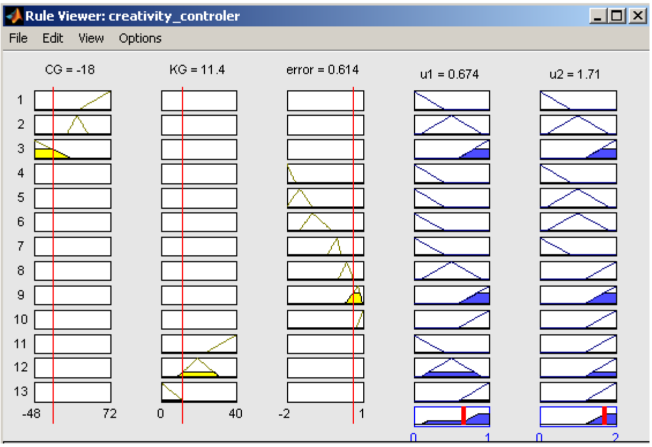

Fig. 4. Fuzzy covering of error

The interpretation of the results is: if error is 0.614, and the level of group's creativity is low (-18), and the knowledge level is 11,4, then u1=0.674 and u2=1.71, that means the structure of the group has to be changed and the scenario to be used is the scenario no. 3. According to the results above, we conclude that if the error increases, then both the structure of the group and the creative scenario need to be changed.

4 Summary and Conclusions

The results obtained in our research study show the necessity of development and implementation of creativity-centered learning and teaching strategies. Online learning environments have to include specialized software modules to boost students creativity. The proposed fuzzy controller is easy to implement, and it offers a control of learners' creativity in the online learning and teaching process. Also, collaborative learning, classroom-based or online, provides for building of appropriate frameworks that trigger learners' creativity.

We will pursue future research on the concept of "creativity control", aiming to find ways to stimulate creativity through a guided learning process.

The proposed approach may be applied in instructional processes in various fields: Mathematics, Computer Science, Literature, Engineering Science etc. In our view, the future of online learning and teaching technologies will have to include tools that facilitate learners' creativity.

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Creative Re-instrumentation of Collective Learning Activity

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Abstract. The implementation of networked, digital media applications in formal higher education provides opportunities for supporting and re-instrumenting various conversational and productive actions of creative collaboration. Successful re-instrumentation of collective learning activity depends to a large degree on the construction of viable, distributed environments of instruments and resources and a compatible perception of the potentials for actions (affordances) within its boundaries. This paper discusses some selected examples from an intervention study in higher education that focused on the self-directed re-instrumentation of collective learning activity and the formation and development of distributed learning environments.

Keywords: re-instrumentation, creative collaboration, learning contract, affordances, collective learning activity, distributed learning environment.

1 Introduction

In many ways we can currently witness how more and more areas of human activity get gradually augmented and transformed through the expansive growth of digitisation and networking in our societies. Through the co-evolutionary development of this increasingly dominating medium and our human dispositions new instruments and affordances (perceived potentials for action) emerge. Thus, a growing number of individuals experience that the digital realm is gradually penetrating a wide range of activities in their life. They individually and collectively experience and experiment with the digital instrumentation of all types of activities (in the workplace, in their social life with friends and family, related to hobbies and leisure, and so forth). This opens up opportunities for new forms of creative collaboration in all kinds of areas of human activity in general, and for networked, collective learning activity in particular. Learning activity (German: Lerntätigkeit) is here understood as the specific cultural-historical form of intentional human learning (see for example [7, 22]) that emerged as the main instrument to adapt and shape the self, according to the cultural demands of the print and book culture [15]. Fiedler [8] argues, for example, that in the light of the ongoing digital transformation, educational research practise in formal higher education should construct the currently dominating forms of individual and collective learning activity as an explicit object of inquiry and intentional change. It should

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aim for the development of "qualitative new forms of emancipated learning activity" (p. 28) that is increasingly de-coupled from teaching activity and its particular patterns of control and responsibility. The systematic re-instrumentation of learning activity through digital, networked tools and services is considered an important and potentially powerful lever of change in this regard.

In the remaining paragraphs we explore how networked, digital media applications can be used to re-instrument collective learning activity in higher education to support new forms of digitally mediated, creative collaboration. Furthermore, we discuss the use of digital, networked artefacts for the gradual explication and "bootstrapping" of (inter-)personal learning projects, and the formation of specific, distributed environments of instruments for their mediation and realisation. The paper continues with the presentation of some condensed, illustrative examples from an intervention study in which students had to establish and further develop their own distributed environments of instruments to mediate the range of conversational and productive actions that were necessary to realise their creative collaborative effort.

2 Re-instrumentation of Collective Learning Activity

The continuously expanding array of digital media applications enables a new level of openness and flexibility of instrumentation for creative collaboration. Combining various (often loosely-coupled) tools and services offers quite powerful ways of managing, repurposing, and remixing digital artefacts of all kinds of granularity in order to support various conversational (regulative, coordinative, and so forth) and productive actions in the context of co-creation. They offer the potential to create shared (and quite often distributed) "learning through-doing" environments that are available anywhere, anytime, and on demand [6]. Collectives may form temporary, distributed environments for collaboration, where parts of each collaborator's personal (learning) environment partially overlap. Personal learning environments entail all the instruments and resources that an individual is aware of and has access to in the context of a project of intentional learning at a given point in time [9,20].

A distributed learning environment emerges when individuals engage in collaborative actions to realise a specific, inter-personal learning project. They are initially maintained for the duration of the collaboration [9] but can be re-activated and further developed over time. These distributed environments are also dynamic in terms of their components, structure, and extension. They are adjusted and defined according to the needs, preferences, and abilities of the collaborating actors. Collectives can alter or extend their environments by replacing its components or by complementing them with additional ones. Some components can also be eliminated or temporarily excluded if they do not longer serve the conversational and productive action objectives of the collective.

Digital tools and services enable, support, and mediate conversations on subject matter (terminology, concepts), processes (distribution of work, roles, media), and production [9]. However, all types of actions are highly intertwined and individuals can switch rapidly from one to another. In distributed, loosely coupled, networked settings, these actions need to be mediated by an appropriate selection of tools and services. Collaborative settings require explanation, negotiation, and mutual acceptance of selected technologies in order to form a functional, distributed environment for digitally mediated collective action [24]. However, selecting tools and services for creative collaboration requires the construction of a shared, or rather compatible, understanding of their affordances (perceived potentials for action).

3 Perceived Potentials for Actions

The term “affordances” was coined by Gibson [14] as part of his ecological framework of perception and action. This framework considers perception more as a direct process of translating environmental action potentialities into action. Gibson originally defined the affordances provided by an environment as opportunities for action. According to him, mutuality between an actor and the environment constitutes the basis for the actor’s perception and action. However, alternative definitions of and approaches to affordances exist. For example, Greeno [16] sees affordances as an opportunity to describe the properties of the environment that permit certain activities. Albrechtsen et al. [1] extended the affordance definition as follows: affordances are “cues for action relevance, displayed in the context of a virtual ecology of work” (p. 32). In this paper affordances are understood as perceived potentials for actions and are evoked and changed dynamically. This happens in the interplay of individual task objectives, the activation of previously experienced emotions, a history of realised learning activity, and the human and the material resources students have at hand (see, for example [9,4]). For an individual actor the affordances within a distributed (learning) environment are influenced and somewhat limited by the collective perceptions of her collaborating co-actors [13,21]. Thus, the affordances (as perceived potentials for action) of certain instruments need to be explicated, negotiated and monitored within the collective to enable the formation of a distributed environment of instruments and resources that enables the realisation of collective learning activity through concrete inter-personal projects of creative collaboration and co-production.

4 Bootstrapping Personal and Inter-personal Learning Projects

It seems apparent that the delineation of collaborative, inter-personal learning projects and the formation of viable, distributed environments of mediating, digital instruments, requires a considerable amount of conversational exchanges among the participating actors. However, conducting unaided conversations - with oneself and others - around aspects of learning activity and its instrumentation is a formidable task for many (see for example [19]). This is already the case with individual learning activity, let alone collective learning activity that is realised under the conditions of distributed actors who depend on the digital mediation of their conversational and productive actions. In adult education a relatively well-established instrument for supporting the development of increasingly emancipated and self-determined learning activity is the use of so-called "learning contracts" (also, less frequently, "learning agreements" or "learning plans"). In general, a learning contract is understood as a negotiated and explicated agreement about what and how an individual - or collective - will “learn” and how possible outcomes and products will be measured (see for example [3,5,17,23]). Depending on how this instrument is implemented it can be used as a systematic, conceptual vehicle for externalising, self-monitoring, and self-managing learning activity [2]. It can be an effective tool to help adult learners become (self-determining) subjects of their own projects of learning and self-development [18]. Initially, learning contracts are drafted in the form of a structured, written outline of what and how an individual - or collective - intends to achieve within a concrete project of learning and change [17]. These descriptions remain open for revision and adaptation through the majority of the overall run-time of the actual project to accommodate the fundamental unpredictability of most learning trajectories [3]. What is actually carried out is documented through *records of action* of various forms. Reviewing the project outlines at various stages provides individuals and collectives with a chance to reflect upon their expectations and intentions on one hand, and the effectiveness of their actions and use of instruments on the other [26]. Occasions when certain aspects of what was projected have not been executed successfully can be interpreted as particularly significant opportunities for reflection [17].

While the potential effectiveness of this general approach is well documented in the literature, we tend to agree that the term “learning contract” carries some rather unfortunate, legalistic and bureaucratic connotations. We have thus started to simply refer to *outlines* of personal or inter-personal learning projects when we introduce conceptual and procedural aspects of this approach to our participants. These *outlines* and their revisions are then used to support an overall process of “*bootstrapping*” such projects through a range of recording, reviewing, and revising practices. In principle, this can all be carried out using paper-based artefacts. However, distributed, digitally mediated settings obviously require an alternative realisation. Thus, we repeatedly implemented the overall instrument (see for example [10,25] making use of dynamic web-publishing applications (such as Wordpress) that were originally designed to predominantly support the authoring and publishing of individual weblogs. In such settings, our participants realise their learning project outlines (including their revisions), records of action, and/or items of experience/reflection through publicly accessibly posts, each published under a unique “permalink”-URL (for a more detailed description see for example [12]). Over time, this practice affords the mediation of numerous conversational, reflective exchanges. All published items remain universally addressable. They can be commented on, (hyper-)linked to, and drawn into a wide range of additional digital tools and services – eventually forming a personal - or inter-personal and distributed - learning environment [9].

What is important to note here is that in collaborative settings in particular the explication, ongoing revision, and documented execution of a concrete learning project within an open, addressable medium, allows for the direct exploration and negotiation of its mediating instrumentation among participating actors. The learning project and its ongoing, explicated realisation provides the context and the conversational anchors for the collective construction of shared meanings and expectations regarding the use of distributed instruments and resources - which ideally results in the formation of a viable, distributed learning environment over time.

5 Contextual Aspects of Our Intervention Study

At Tallinn University we recently carried out another cycle of our ongoing intervention research in the context of a course titled “e-learning methods & technology” that is offered to students of different Master programs at the Institute of Informatics. Over the years this course had become a test-bed for the iterative implementation and evaluation of intervention ideas and concepts related to various aspects of individual and collective learning activity and its manifestation through personal and inter-personal learning projects (and their instrumentation). In particular, we had focused on the systematic re-configuration of patterns of control and responsibility over instructional functions (see for example [25]) in higher education. During a recent iteration of the course 41 participants registered, of which 35 actually completed the full study period. The formal objective of the “course” is the acquisition of important dispositions (knowledge, skills, orientations, and so forth) for the execution and further development of individual and collective learning activity and its digital instrumentation (with a range of networked tools and services). The overall period was broken down and structured into two separate learning projects. The first project was carried out individually, while the second was based on collaborative group work (5-7 participants, 9 groups). Only three official face-to-face meetings were scheduled during the study(-) and collaboration period. These meetings were dedicated to participants’ presentations of their work and related feedback and discussion. The rest of the project work was first organised and carried out individually, and later within the various groups. This was mostly done on distance, though some groups decided to organise additional face-to-face work sessions for their collaborative projects. Both, the individual and group work were originally mediated only by a minimal “seed” configuration of web-tools (wikiversity page, individual weblogs). This seed configuration, however, was only presented as a starting point for further explorations of instrumentation options and the gradual development of distributed environments of instruments and resources within the various groups. Our main instrument for supporting this (potential) development was the implementation of individual and collective "learning project outlines" and their conversational use as we have described it in the previous section. We were particularly interested in how student groups formed and developed their distributed learning environments for the mediation of their self-defined, inter-personal learning projects.

6 Collaborative Use of Applications and Students’ Experiences

The following paragraphs provide some rather condensed, illustrative accounts of how three (out of nine) student groups formed and developed their distributed learning environments. The accounts focus on the aspect of digital media applications as instruments for mediating various conversational (regulative, coordinative, and so forth) and productive actions while carrying out inter-personal learning projects. Part of our intervention study focused on the retrospective reproduction of how the various groups explored, selected, and combined various digital instruments over time to mediate their particular projects. This was achieved via the analysis of qualitative data gathered through the explication and iterative elaboration of the inter-personal learning project outlines developed within a group, their records of action, and the student's reflective writing about their collaboration experiences. In addition, digital traces of group work (conversational and productive actions) were used to cross-validate our understanding of the boundaries of the particular distributed learning environments the various groups had developed.

Group 1

Formation and Development of Distributed Learning Environments

Group 1 decided first to carry out an analysis of every group member's personal landscape of tools and services to identify a common set of instruments, which could potentially support their various regulative, coordinative, and productive actions during the collaborative work. During the initial face-to-face meeting (in the early stage of the "course") the group members shared their e-mail and Skype accounts and decided to carry out a joint session making use of GoogleDocs. One of the group members created a common document in GoogleDocs for all members. As the members of group 1 were active users of social media tools and services, the initial list of potential instruments for collaboration was rather impressive. For instance, one student was an active user of Twitter, Del.icio.us, Google Calendar, Google Map, Skype, MSN; another participant made regular use of Wordpress, Pageflakes, iGoogle, Yahoo messenger. After presenting and analysing every group member's landscape of tools and services in the group's GoogleDocs, the group decided to use Skype and GoogleDocs as the main instruments for supporting their collaboration. They explained their choice by the fact that GoogleDocs enabled the group members to share and access documents while offering core tools for co-production as they can be found in stand alone applications such as Word, Excel and Powerpoint. In addition the group pointed out that all its members could see changes and their respective time of occurrence. It was added that GoogleDocs also allowed for synchronous presentations and parallel text-based discussions. In addition the group settled on a joint Google calendar for coordination.

Reflection on Collaboration

All the members of this group claimed that their collaborative actions and setting up their distributed environment of digital instruments went rather smoothly and without major challenges. Group member 1 claimed that "*already in the beginning it was clear that GoogleDocs is our most popular tool. That's why we also decided to choose this one. The actual reason for using it is that most of us already had a Google account and using GoogleDocs doesn't require to create an additional account. Our purpose was to have a quick and comfortable information flow between group members. One of the advantages of GoogleDocs was also its easy way to present schemas, which was important for our collaborative work*". Group member 2 added that "*to be able to share documents between group members makes collaboration much easier; to work on a joint artefact, which is accessible for all the group members equally, which can be changed by everybody and is visible to everybody, is a great advantage* *for a collaborative work*". Group member 3 admitted, "*this is a great example of doing great collaborative work from distance and discuss about it*". Group member 4 claimed that *"thanks to the group work I managed to start using social media applications"*.

Group 2

Formation and Development of Distributed Learning Environments

Group 2 started with a face-to-face brainstorming session. For brainstorming established tools such as pencil, paper and laptop with a MS Word program were used in addition to group members' previous experiences with different tools and services. The brainstorming session ended with distributing work tasks among group members. The next steps were carried out from distance. The group continued with researching tasks for their learning project using Google and Bing. In addition a lot of inspiration was gathered from various Weblogs, webpages of companies, Youtube and Vimeo. Regulatory tasks were supported by Skype, MSN, e-mails, but also mobile phones were used. GoogleDocs and Wordpress were used for supporting their co-production efforts and for presenting their final artefact. Writing tasks for their joint project were divided in a way that every member had a dual role of writer and reviewer.

Reflection on Collaboration

Group member 1 in group 2 declared, "*the group work worked out very well. Our chosen communication channels functioned well and served our purposes. I must say that all the required roles were presented for a successful group work. Everybody dedicated to group work with great responsibility*". Another group member found the first face-to-face meeting very entertaining, which provided a good basis for future collaboration. She said that "*we had not talked to each other and we were all very different in terms of our jobs beyond study activities, mental frameworks, interests and ages. However, in a few minutes it felt that we had known each other for years. We found a topic for our group work very quickly and from the beginning finding compromises was easy. I realised again that an old e-mail works very well for collaborative work. I also had a chance to work on a GoogleDocs document, which turned out to be quite useful for our purposes*". Group member 3 pointed out that *"using social media applications for supporting our group work was a very positive experience as it also provided an opportunity to learn from the group members"*.

Group 6

Formation and Development of Distributed Learning Environments

Group 6 started their work by sending e-mails to every group member with some initial ideas about the potential final artefact (the product of their intended collaboration) as a starting point. These ideas were discussed and negotiated using the MSN texting client. Time for these MSN enabled discussions was negotiated and agreed via e-mails. The MSN conversations were also used to set up a common goal for their collaborative work, to discuss and divide tasks, and to give feedback to group members' work in progress. In addition, evaluation criteria of their intended outcome were defined during these MSN conversations. The final product of their collaboration was realised through a joint group weblog (Blogger). In order to get information about new posts in the group weblog, a common Pageflake page was created. All the members of the group made use of RSS webfeeds. The group members had access to the group weblog for posting and commenting. Furthermore, new information related to the development of the final artefact was also shared via e-mail. MS Visio and Mind24 were used to present ideas visually.

Reflection on Collaboration

All members of group 6 were satisfied with their contribution. They claimed that "*everybody in the group worked hard, was present and was very eager to comment each other's work*". One of the group members noted that they managed "*to divide tasks in a way that everybody was satisfied and could do exactly what was their expertise and according to their liking. Even the final presentation was done all together, which gave a real group feeling*". Group member 2 added that "*I also liked that we were active by sending e-mails for commenting, sharing ideas and complementing each other's ideas*". Group member 3 admitted with surprise that "*it is really possible to carry out successful and creative collaborative work supported by social media applications. It is demonstrated with our group work. I learned to get to know my group members, and none of us become a social loafer. I like to do group work via MSN discussions*". Group member 4 added that "*this collaborative work taught me how to do a group work if every member sits geographically in a different location*".

7 Concluding Remarks

The accounts of participants that we presented above show how the various student groups engaged in the exploration and negotiation of networked media applications that could eventually serve as instruments within their collective learning activity. The examples illustrate how students explicated, reviewed, and adapted their individually perceived affordances of particular applications within their group work context. They constructed a compatible understanding of perceived potentials for action that made it possible to temporarily merge parts of their personal learning environments (of instruments and resources) and to gradually develop a viable, distributed environment for mediating their collaborative actions. We tend to interpret these results as an indication that intervening into current teaching and studying practices with the attempt to decouple collective learning activity from teaching activity and its particular patterns of control and responsibility, can actually produce viable and creative realisations of digitally mediated, collective learning activity. It seems noteworthy that altogether students reflected rather positively on the process of constructing and negotiating mutual understandings on how to mediate their collective learning activity. It is relatively easy to find support for the claim that creative collaboration in face-to-face settings should allow individuals and collectives to transform their environments themselves by physically moving things around and selecting, or creating, instruments according to occurring needs and requirements. Creative collaboration mediated by networked, digital media applications, however, is rarely envisioned along such lines. We would like to suggest that distributed environments that are organised and developed by their participating members can themselves be conceptualised as an instrument for creative collaboration. Within self-directed instrumentation of activity new patterns of control and responsibility, ownership, provision, and so forth, can emerge. Thus, we hold the perspective that digital instruments should be freely chosen and adapted by students according to the specific purposes of their collective learning activity and the concrete learning projects they attempt to carry out. Any initial understanding and conception of what tools and services might be successfully drawn into a particular group work needs to be tested against its actual execution. Through the run-time of a learning project a whole variety of adjustments to what makes up its environment are normally required. Throughout our ongoing intervention research in higher education (see also [25,10,11]) we are collecting growing evidence that the realisation of a reflective-conversational use of *learning project outlines* via open, web-publishing tools and services, can serve as a powerful instrument for supporting the explication of the boundaries and components of a particular project, its environment, and intended outcome. It can serve as a conversational artefact that allows group members to construct a compatible understanding of how to carry out and mediate collaborative work in a digitally mediated and networked setting. We would like to claim that higher education institutions would be well advised to promote more experimental, self-directed re-instrumentation of learning activity within their boundaries to allow for the advancement of dispositions (knowledge, skills, attitudes, and so forth) that are necessary to operate and collaborate creatively within the digital realm. Individuals and collectives need to be put in a position where they can actualise and develop dispositions that help them to model and shape their own learning projects and their specific environments within the ongoing digital transformation.

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Using Quality Criteria for Assessing and Comparing Open Courseware

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Abstract. Despite the momentum of the open courseware movement around the world, no quality criteria and metrics for evaluation of open courseware or open educational resources' repositories are available yet. Therefore, learners and instructors have no support and guidance in their quest for locating the most suitable learning resource that fulfills their educational aims. The same is true for developers, who have no guidelines for designing and building such educational resources. We present here an evaluation and comparison between two open courseware on data structures and algorithms, which are available from two important open courseware providers and that comply with different open courseware paradigms. Both evaluation and comparison rely on our socio-constructivist quality model, which consists of a set of quality criteria that serve as general guidelines for development, use, modification, evaluation, and comparison of open educational resources and open courseware.

Keywords: open courseware, open educational resources, quality assessment, quality criteria, open courseware on data structures and algorithms.

1 Introduction

Nowadays learning is more and more a continuous lifelong and life-wide process that is no longer limited to dedicated spaces, times or modalities, in which learners themselves are both consumers and providers of knowledge that evolves towards a public good that can be accessed, shared, used and reused, adapted etc. Thus, users and communities contribute to social construction of knowledge, based on today's ubiquitous technologies. They provide further for open educational paradigms that are expected to provide for fulfillment of both needs and challenges of the 21st Century's knowledge economy and learning society. The growing number of open courseware and open educational resources projects worldwide has a key contribution to these emerging open educational models.

Such initiatives have evolved either as a unique university project or as a repository or consortium that cumulates educational resources from various sources. The most well-known it is, of course, the MIT OCW program – now having more than 2100 courses online, with which has started the OpenCourseWare (OCW) movement more than a decade ago. Since then, more and more universities have been offering open access to a growing number of their courses: Stanford, Carnegie Mellon, Harvard, Yale, Berkeley, Rice, Open University, Michigan, Carlos III and Politécnica of

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Madrid, and so on. In addition to these open courseware programs that are hosted by top universities, wide-ranging open courseware repositories are available, the most prominent being OpenCourseWare Consortium, Open Education Resources (OER) Commons, and The Saylor Foundation's Free Education Initiative [1, 2].

In spite of the scale, pervasiveness, and impact on users worldwide, the open courseware movement lacks a quality assessment framework on which users, being them learners, teachers, faculty, or developers, to rely on when they evaluate, choose, compare, design, or develop open courseware and open educational resources. Thus, learners need support when choosing the most suitable instructional resources that match their educational needs. Instructors are interested in locating those instructional resources that support meaningful instructional activities, which provide for reaching the expected learning goals, objectives, and outcomes, and for achieving reflective learning. Faculty who are or want to become involved with open courseware may be interested in how challenging and rewarding this participation can be [3]. Finally, developers need guidance when approaching the construction of such resources.

Related work is extremely thin with just a few works approaching the general subject of quality assurance for OCW and OERs in the context of assessing the impact of these paradigms in education nowadays. All these works emphasize on the importance of quality of OCW/OER resources, and on the need for continuous quality evaluation and assurance [4-11]. However, despite of their concern, none of these works has attempted to elaborate some criteria to be used for quality evaluation and assurance. In one of our previous works, we introduced a set of such criteria *that serve as general guidelines for development, use, modification, evaluation, and comparison of OERs and open courseware, from a social and constructivist perspective* [12].

In this paper we evaluate and compare two open courseware on data structures and algorithms, which are available at two providers that comply with two different open courseware paradigms. The evaluation and comparison are performed against our proposed set of quality criteria. Moreover, this work attempts to work those quality criteria on the chosen open courseware, and to learn from this experience how to develop further the initial set of quality criteria towards a quality assessment framework.

The structure of the paper is as follows: the second section presents briefly our set of quality criteria, the third one presents the evaluation of the two open courseware versus the quality criteria, followed by their comparison, while the last one includes the conclusions and some future work ideas.

2 Set of Criteria for Quality Assurance of OCW and OER

We summarize here our set of criteria for quality assurance of open educational resources and open courseware, which we have introduced and presented in much more detail in [12]. They are applicable for assessing quality of either small learning units or an entire courseware. These criteria have been grouped in four categories that refer to content, instructional design, technology, and courseware evaluation. In the remaining of this section these quality criteria will be briefly outlined in Table 1. For the time being the evaluation is subjective, being based on more than 20 years of author's experience in Higher Education, particularly here, in teaching data structures and algorithms.

Table 1. Criteria for Quality Assurance of OCW and OER

Content related	*Criteria that reveal to what degree an educational resource allows learners to have engaging learning experiences that provide for mastery of the content.*
	• readability • uniformity of language, terminology, and notations • availability of the course syllabus • comprehensiveness of the lecture notes • modularity of the course content • possibility to select the most suitable learning unit • opportunity to choose the most appropriate learning path • top-down, bottom-up or combined approach • availability of assignments (with or without solutions) • *resource related*: accuracy, reasonableness, self-containedness, context, relevance, availability of multi-media inserts, and correlation with the entire course
Instructional design	*Criteria that address the instructional design, and other pedagogical aspects of teaching and learning for that resource.*
	• goal and learning objectives • appropriate instructional activities • learning outcomes • availability of the evaluation and auto-evaluation means • learning theory • instructional design model • *reflective learning opportunities* in which the desired outcome of education becomes the construction of coherent functional knowledge structures adaptable to further lifelong learning [13-16]
Technology related	*Both open educational resources and open courseware are expected to benefit fully from ICT technologies, to have user-friendly interfaces, and to comply with various standards.*
	• conformity with standards for interoperability • compliance with standards for accessibility • extensibility (both instructors and learners) • user interface's navigational consistency and easiness, along with its multimedia appearance • supporting technology requirements at user's end • the prerequisite skills to use the supporting technology • multi-platform capability • supporting tools • security of users' confidential information

(Table 1. *Continued*)

Courseware evaluation	*Despite of the original claim of just offering high quality educational materials, all major open courseware initiatives have recently become more involved with their learners. Hence, regular assessment of effectiveness of open courseware becomes essential, along with using the results for further improvements.*
	• *courseware overview*: content scope and sequence, intended audience, grade level, periodicity of updating the content, author's credentials, source credibility, multiple-languages, instructor facilitation or semi-automated support, suitableness for self-study and/or classroom-based study and/or peer collaborative study, time requirements, grading policy, instructions on using the courseware • availability of prerequisite knowledge • availability of required competencies • matching the course schedule with learner's own pace • availability of repository or institutional policies • freeness of bias and advertising • providing a formal degree or a certificate of completion • appropriate user interface • suitable design and presentation of educational content • *participatory culture and Web 2.0 facets*: contribution to the content, collection of users' feedback, collaboration with fellows, sharing the development/using experience

3 Evaluation and Comparison of the Two Open Courseware

This section includes the evaluation of the two open courseware on data structures and algorithms that have been announced in the Introduction. They have been assessed using the quality criteria introduced and explained in very much detail in [12], and summarized here in Section 2. The evaluation is followed by a comparison between the two open courseware "candidates", based on the proposed quality criteria.

3.1 University of Washington's Open Courseware on Data Structures and Algorithms against the Quality Criteria

This section includes a short description of the University of Washington's Open Courseware on Data Structures and Algorithms [17], followed by our quality assessment for this courseware, against the proposed set of quality criteria. The evaluation will be performed for each category of quality criteria in turn. The Computer Science and Engineering 373 course entitled *Data Structures and Algorithms* covers the fundamental data structures and algorithms. The available courseware includes the lecture notes, the homework assignments, some solved problems and exams, along with the grading policy for the enrolled students. For the time being, beside its obvious openness, this courseware does not address any other issues related to the open courseware paradigm. While some of the available information is of interest only for University of Washington's students, most of it is useful for external users as well.

Content-Related. The lectures that are available in two formats, namely .pdf and .ppt, are easy *readable* and very *uniform* in terms of language, terminology and notations, as they have a unique author. In addition to the lectures, learners have access to java programs and animation in Javascript that are useful when learning about data structures and algorithms. The offered materials are characterized by uniformity, except for the animations, which come from various online sources. The *course syllabus* for the course taught in Spring 2012 is available. The courseware is *modular* and quite *comprehensive*, covering all the necessary topics related to the subject. As the courseware main target is the enrolled students, the *assigned homework* is available without solutions, some of them being accompanied though by some support links or files. However, the homework specification includes more detailed *how to* instructions, along with style guidelines and grading information. The selection of the *most suitable learning unit and learning path* can be done simply provided that the learner has some previous knowledge of the subject. The courseware may be approached *top-down, bottom up or combined.* Each available instructional resource is *accurate, reasonable, self-contained*, and *relevant in the context* of learning about data structures and algorithms, being *correlated* with the entire course as well. Some very nice *multimedia inserts* are available. They illustrate by folk dancing some well-known sorting algorithms. Further podcasting is expected as well. The courseware comes with various *links* to several resources: the textbook, which is available to buy, rent or loan – for regular students only, supporting development environment's manual and tutorial, materials on Java programming and data structures and algorithms, along with links to other external resources such as Wikipedia or Wikihow entries.

Instructional Design Related. The general *instructional goal* is presented both in the course description and in the *course syllabus,* which presents also the *learning objectives* of the entire course, while for the learning units no *learning objectives or learning outcomes* are available. Most of the available instructional materials provide only for *basic instructional activities*. For *auto-evaluation* or *evaluation*, learners may use practice problems and exams – with solutions - both for midterm and final exams. The actual midterm and exam of Spring 2012 are available with solutions as well. *Reflective learning* has not been yet taken into account for this courseware. No aspects related to the *learning theory* or to the *instructional design* are available.

Technology Related. The courseware complies with *interoperability* standards. However, no *web accessibility* issues are considered yet. Only the instructors may *extend the instructional resources*. The user interface is basic. The course syllabus presents briefly the *technical requirements*, while the *prerequisite skills* of using the supporting technology are left out, being probably considered basic. The courseware is *multi-platform*, and the *supporting tools* are described in the Links page. No interaction of external users with the courseware is allowed, and therefore no approaching of issues regarding *privacy and security of confidential information* is necessary.

Courseware Evaluation. The *content scope and sequence* may be deduced from the Lectures' page. The intended *audience* or *grade level* is not explicitly affirmed in the course web site. No information about periodicity of updating is available. *Authors' credentials* and *source credibility* are very good. No availability in *multiple languages* or *support for learners* have been provided. The courseware may be used for *self-study* or *classroom based study*. *Time requirements* to cover the course materials are not available. *Grading policy* is presented, but it refers only to University of Washington's students. No *instructions on "how to"* use the courseware and its components are available. The *prerequisite knowledge* and *required competencies* are stated both in the Syllabus and in the course home page. The *learning pace* is independent by the *course schedule*. No *repository policies* are presented. The courseware is *free of bias and advertising*. No *degree or certificate of completion* is envisaged for now. Learners may not *contribute* to the resources. Very thin *collaboration* with fellow learners is allowed for enrolled students only. The discussion forum is also closed to external learners. Anonymous *feedback* from users may be given only via the form available via the home page. No inside information about the *development journey* or about the *experience* of using this open courseware, since beside its openness as such, no other issues related to open courseware are taken into account. The *user interface, design and presentation of the instructional content* are basic.

3.2 The Saylor Foundation's Open Courseware on Elementary Data Structures against the Quality Criteria

Saylor.org has been launched by The Saylor Foundation as a free online university and it is *seen as a zero-cost alternative to those who lack the resources to attend traditional brick-and-mortar institutions, and as a complement to mainstream education providers that will both motivate people ..., and lead to institutional change amongst education providers* [18]. The Foundation's goal is to offer to learners the chance to overcome the barriers of pursuing mainstream college education: fixed class schedule, physical distance to a campus, rising costs of tuition, fees, and textbooks etc. Currently, saylor.org provides the appropriate content that is necessary to earn the equivalent of a degree in any of the top majors in the USA. The course CS 201 - *Elementary Data Structures* is one of the 200 courses freely available at The Saylor Foundation site, which is mandatory for the Computer Science program [19]. This course provides students with an introduction to elementary data structures and algorithms. The courseware overview includes the learning outcomes, the course requirements, and the learning units. Syllabus, readings, web media lectures, automated assessments, and the final exam are also available from the course home page. In addition to these components, the course homepage offers also the course's description in a nutshell, as the *course information*, which includes general information about the course designer, the primary resources, the necessary requirements for completion, the needed time commitment, along with tips and suggestions on how to navigate through the course materials, on how to proceed when a learner struggles with a concept, and on the usefulness of taking notes while covering the available instructional resources. Further on, we detail our quality assessment for this courseware based on the quality criteria.

Content-Related. The *readability and uniformity* of the course materials varies as the learning units have several authors. The course content is a mix of HTML readings, web media lectures, and assignments (quizzes), along with the final exam. The instructional materials may come from other educational institutions, collections or repositories, all of them being free, online materials. Saylor.org states that all the materials have been carefully *selected, framed, and/or developed by their professors* so that they will provide for achievement of the announced learning goal. As for any Saylor's course, the detailed *course syllabus* is available from the course home page. The courseware is *modular* and very *comprehensive* as shown above. *Assignments (quizzes with solutions)* are offered. Selection of the *most suitable learning unit and learning path* can be done straightforwardly as the courseware is very intuitively developed. The courseware may be approached *top-down, bottom up or combined*. However, the general recommendation for beginners is to follow through all the materials in the sequence in which they are presented. Each instructional resource is *accurate, reasonable, self-contained*, *relevant in the context* of learning about elementary data structures and algorithms, and it is properly *correlated* with the entire course. *Multimedia inserts* are available. Only *links* to the course readings are offered.

Instructional Design Related. Both the *course's syllabus* and the home page state the general *instructional goal* of the courseware. Unlike most of the open courseware, in Saylor's case, the *learning objectives and outcomes* of each course are available at two levels: *course*-wide and *learning unit*-wide. The existing *instructional activities* are very limited in offering meaningful learning experiences, while *reflective learning* is not taken in consideration yet. As for *auto-evaluation or evaluation* means, only *quizzes with solutions* (the assignments) or *without solutions* (the exam) are available for now. Each time the final exam is taken, learners are offered different questions. No information about the *learning theory* or the *instructional design* is presented.

Technology Related. The courseware fulfills the basic *interoperability standards*. Accessibility is approached only in its larger sense rather than as *web accessibility*. For the time being, only the instructors may *extend the instructional resources*. The *user interface* is advanced and suitable. The supporting *technical requirements*, the *supporting tools,* and the *prerequisite skills* of using the technology are presented in The Saylor Student Handbook. The courseware is *multi-platform*. Both the Terms of Use page and the Handbook show the saylor.org's policy regarding *privacy and security of confidential information*.

Courseware Evaluation has shown the following: the *content scope and sequence* are shown both in the course syllabus and in the course home page. The course's *intended audience* and *grade level* are explicitly addressed only on saylor.org's home page. No information about periodicity of updating is available for now. For some learning units *author's credentials* are obvious, as they are professors at prestigious universities, while for others learners have to rely on *source credibility*, which is substantial in our opinion. The course materials are available only in English. Some *semi-automated* support with respect to the assignments is available. Currently, the courseware may be used only for *self-study* and *classroom based study*. However, when considering the latest saylor.org's developments (forums, e-portfolios etc.), it seems that *peer collaborative study* is envisioned as well. Both the syllabus and the course information page provide a *time advisory*, which shows the needed time requirements for completion of each learning unit, and of the entire courseware as well. Student handbook details the *grading policy* and *instructions on "how to"* use the courseware and its components (the latter is available also in the course information page). The *prerequisite knowledge* and *required competencies* are presented in the course home page. There is no predefined schedule, so learners may use the courseware at *their own pace*. The Student Handbook includes also the community standards, i. e. the *repository policies*, along with the statement regarding the *freeness of bias* and *advertising*. *A certificate of completion* having a unique identification code is provided to each learner after she has passed the exam with a score of more than 70%. For the moment, learners may not *contribute* directly to the resources or *collaborate* with fellow learners. However, they may submit materials that might get chosen to be published on the saylor.org, and the forums are starting to grow. *Feedback* from users is collected via a user survey. The *development journey* and the *experience* of using saylor.org are presented briefly in the Student Handbook. The *user interface, design* and *presentation of the instructional content* are well elaborated and user-friendly in our opinion.

3.3 Comparison of the Two Open Courseware Based on the Quality Criteria

We present here a comparison of the two open courseware. To make the comparison easier to follow, two acronyms will be used, namely UW-DSA and SaylorDS.

First, we have to acknowledge that each of the two evaluated open courseware has strong points and weak points, so we cannot state which one is the most beneficial for users, being them learners, teachers or developers. The main merit of UW-DSA is, in our opinion, the broadness of the covered topics, the large range of instructional materials, and the source's credibility. What it misses the most is its engagement with prospective external users, and the participatory culture aspects. SaylorDS has a far better user interface and supporting framework, most probably due to the fact that Saylor.org is aiming at becoming an open online university, where *independent learners are ought to return with pleasure and confidence that the courseware materials are connected to them in a meaningful, unique, transformative way* [18]. It also covers a suitable variety of topics in the field, offering high-quality OERs, many of them coming from top universities and educational organizations worldwide.

Neither of the two open courseware provides for true engaging, reflective learning, but it seems that saylor.org is starting to address this issue, even though for the time being this is true only for some other of their courses, and not for SaylorDS. Moreover, they provide some sort of certificate of completion for each of their courses. Related to that, cheating issues are acknowledged as well. What is also worth mentioning is that both courseware build up on other *open educational resources and open courseware*, which increases the expectations, the benefits, and the confidence of users worldwide with respect to the open courseware movement.

4 Conclusions and Future Work

The OCW initiative has appeared in the larger context of open systems, building up on the reality that opening of the software infrastructure has unleashed the creativity of software developers in unimagined ways, and thinking that something very similar will happen to education, as Charles Vest, the President of MIT, declared when OCW was launched [20]. In our opinion, opening the courseware to people worldwide, and therefore providing for *the dissemination of knowledge for the public good* [21] and for creative collaboration, will create promising opportunities for boosting creativity, because no creative collaboration may appear in absence of knowledge, as creativity may be seen as *the mastery of information and skills in the service of dreams* [22].

This paper's contribution consists in the evaluation and comparison of two open courseware on data structures and algorithms that is performed against our set of quality criteria. Basically, this work has attempted to validate those quality criteria, to put them into practice, and, to learn how to improve them during this process. The choice of the two "candidates" is due to their provenance, i.e. two different open course providers, which comply with two very different open courseware paradigms.

During the evaluation process we have learned that some criteria need to modified or extended, e.g. the security of confidential information is just a component of the terms of use that need to include further aspects such as netiquette, anonymity, various restrictions applicable, copyright and licensing etc. Also, links to other related relevant resources has been added as a criterion. Furthermore, accessibility needs to be seen not only as web accessibility, but in a larger context, as it concerns access of as many people as possible to open education. New quality criteria have proven to be necessary as well, which concern learner's support for other learners, opportunity for peer collaborative learning, and availability of quick guides of relevant software. First future work idea refers to devising a suitable scoring or rubric system that will help elaborate some metrics for open courseware, based on existing quality standards (such as ISO/IEC 25000 SQuaRE standard), educational theories and best practice. This way, users may be provided with a valuable mechanism for choosing the most suitable educational resource and the appropriate learning path to fulfill their educational needs. More, developers may also use that mechanism to tailor their "final products".

Second, the learning theory and the instructional design model are not yet considered by the open courseware designers and, in our view, they could benefit massively by relying on pedagogical theories and valuable practice in this respect. We have to research further how the close the gap between educational specialists and developers, maybe by offering the latter ones some semi-automated frameworks for approaching the pedagogical aspects. Finally, our final conclusion is more of a hope, but at the same time, a belief that having many open courseware and open educational resources available the struggle for quality will be encouraged for users' benefit, being them learners, instructors, faculty, developers, and even educational institutions.

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The Development of a Scale to Assess Creative Collaboration via Online Tools

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Abstract. The CoCreat project aims to explore the potential of mobile technology and web based social media to enhance creativity in a variety of spaces and amongst a range of age groups by supporting collaboration. The project itself studies a series of different collaborative spaces in which a variety of web based technologies are applied, developed and tested. The environments vary from urban and rural contexts, to higher education and elementary school contexts, and elderly people. In order to develop the proposed models that show how creative collaboration is structured and can be scaffolded, we need first to identify how creative collaboration occurs in the different collaborative spaces. In order to do this we have reviewed a wide range of previous literature on creativity and collaboration to inform the development of an assessment scale for creative collaboration. This paper presents the most relevant literature, the resulting criteria identified as having potential to be used to assess levels of creative collaboration and the scale itself.

Keywords: Collaboration, creativity, assessment, ICT, online.

1 Introduction

Nowadays people are living in changing and multifaceted environments, where they confront complex problems and situations. Previously learned ways of acting are no longer useful in solving these problems. New, creative and innovative solutions are needed. In this respect creative collaboration seems to be crucial. The generation of creative ideas and of innovative solutions to problems can be fostered through enabling and encouraging collaboration between people with different perspectives, and, in workplace settings, between people from different disciplines. Alongside the recognition that creativity frequently arises amongst groups of diverse people collaborating in particular ways, there is a groundswell of interest in regarding creativity as a fundamental competence that may be developed at school (European Commission, 2009: Cachia et al, 2009). Whether at school, or in the workplace, creative collaboration is seen as process where different topics and problems are explored from novel perspectives and where the results of collaboration and collaborative learning are not defined in advance (e.g. Sternberg, 2006).

There is already research evidence to suggest that social computing tools and approaches can provide new opportunities for creativity and thereby enhance learning

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outcomes (Ala-Mutka, Punie, & Redecker, 2008: Redecker, 2009), but concrete models and guidelines for enhancing creativity are still needed. Our primary focus in the study of technology enhanced collaboration is not the technology alone but in understanding the nature of the experience that is made possible by technologies together with pedagogical tasks. Thus the project integrates and adapts context-aware social mobile media technology (e.g. mobile phones, handheld computers) and social media applications (e.g. wikis, weblogs, 3d spaces) for collaborative learning purposes.

2 Previous Research into Creativity and Collaboration

2.1 Creativity as the Property of an Individual

At one time, much research on creativity was based on the notion that some people are creative and others less so, and sought to understand the reasons why this should be the case (Sternberg, 2006). Early psychologists such as Guilford and Torrance invested significant amounts of time in developing psychometric measures of creativity. This focus on the individual extended throughout much of the 21st century, and has provided us with a concept that is widely used in creativity studies, namely divergent thinking (Guilford 1959; 1967).

Divergent thinking, the generation of novel ideas and associations, is considered to provide the foundation for creative production on the basis that it requires ideational searching without directional boundaries and is deter-mined by fluency, flexibility and originality. It has also been asserted that an individual's ability to think divergently does not by itself produce creativity; critical thinking skills are also required (Glassner & Schwarz, 2007) i.e. there are "different sides of divergent thinking"; a generative and an evaluative side (e.g. Silvia, 2011, p 29). Importantly, for those interested in learning individuals can enhance their divergent thinking, e.g., by training cognitive and neural mechanisms and engaging in improvisation (Gibson, Folley, & Park, 2009).

However, we are concerned with the question of how to activate divergent thinking in collaborative situations in different contexts, we therefore now turn to consider how collaborative creativity has been conceptualised.

2.2 Approaches to Collaborative Creativity

Contemporary research on collaborative creativity has moved away from regarding creativity as a property of an individual and towards a consideration of creativity as emerging from processes of human activity within a social and physical context. This development was spurred by both the recognition that significant creations are almost always the result of complex collaborations, and by theoretical developments that embraced the social and environmental as well as the individual. A well-known empirical study of collaborative creativity that takes this approach is that of John-Steiner who surveyed famous creative couples in the field of science and art (John-Steiner, 2000). John-Steiner's work belongs to a sociocultural tradition based on Vygotskian approaches to thinking, learning and acting. A further example of research in this tradition is that of Sawyer and DeZutter (2009) whose notion of ‘distributed creativity’ is developed from distributed cognition (Hutchins, 1995), an approach concerned with how cognition is distributed across people, tools, and environments. Accordingly, Sawyer and deZutter’s approach takes as a starting point that creative activity takes place in real-world settings that are deeply contextualized and in activity structures that are fundamentally collaborative. Their work focuses on groups that are organised such that the outcome of collaboration is unscripted (and therefore unexpected creativity could result).

The relatively unconstrained and unstructured groups that Sawyer and DeZutter studied may be contrasted with the more constrained and structured groups that one might expect to find in workplace settings, which Paulus and Nifstad (2003) observe have more generally been the site for the study of group creativity, the exception being some early work by Torrance (1972) in educational settings. Furthermore, Grossen (2008) and Glăveanu (2011) point out that earlier studies on creativity in groups can be distinguished by the researchers’ conception of collaborative creativity as well as by their settings. Whether creativity within the group is ‘embedded primarily at an individual level and, furthermore, localized within individual cognitive processes ‘(Glăveanu, 2011, p.476) or the ’emphasis is put on mutuality, sharing, negotiation of a joint perspective or shared meaning, coordination, intersubjectivity’ (Grossen, 2008, p. 248). An example of the former approach is Amabile’s (1983, 1996) studies of social and contextual factors in creativity, which were found to include mentoring, modeling, family influence and social reward. The latter approach though belongs to a sociocultural tradition and has been a key influence on research concerned with ways of facilitating creative collaboration using Information and Communication Technologies (ICTs).

2.3 Creative Collaboration and ICT: A Key Concern of Contemporary Research

A review that predates our own was prepared by Loveless in 2003 for the UK based research organization Futurelab and this review was updated in 2007. Within her review, Loveless (2003, 2007) describes a number of creative activities where schoolchildren used digital technologies to support collaboration. These included: videoconferencing with artists, sharing digital images and works of art with peers in other schools, storytelling and role play in virtual reality environments and virtual puppet play. Simple digital communication tools (Messenger, Chat, Notes) have also been found to support group creativity (Dennis and Williams, 2003). In the following sections we focus on the variety of ways in which researchers have approached the task of designing ICT tools to support such creative collaboration.

Amongst studies in which technology is used to support creative collaboration the trend is to analyse the process of creative collaboration into stages. However, before we begin to discuss stages we feel it necessary to clarify what we understand as 'creative collaboration' in terms of two models of collaboration described by Mamykina et al (2002). These are, firstly, the assistant, or conveyor model, common in commercial creative team settings, in which a leader oversees a process and divides work between team members, and, secondly, the partnership model, in which individual control is relinquished and team members with complementary interests work for mutual benefit, although not necessarily for the achievement of a single task. The partnership model does not exclude leadership but it may appear in a less explicit form than in the form described as 'the assistant model'; for example, leadership can be shared, distributed or not present at all. An example is seen in Keskitalo and colleagues' (2011) study of global teams collaborating on a task using Second Life. Successful collaboration was seen in a team in which members established a plan and separated responsibility for different tasks early in the creative process, effectively distributing leadership between members and across timescales. There is a developing breadth of interest in such regulation of creativity in group processes (to include self-regulation, the regulation of others, and collective regulation) and this is discussed in Section 2.7.

Several authors whose work investigates the partnership model identify creative collaboration as involving two stages. The first is the building, or establishing, of a shared language, shared vision and shared knowledge between collaborators. The second stage is the communication through which ideas are generated and developed (see for example, Weakley and Edmonds (2005), Mamykina et al (2002). Furthermore Vass et al (2008), who studied children's classroom based, collaborative, creative writing, divide this second stage into the generation of ideas and the review of ideas. From their study of artists working with technologists Edmonds et al (2005) suggest there are three stages to the development of creative collaboration once common ground is reached: creative conceptualizations, construction and evaluation. Runco (2004) goes so far as to consider a six-phase model in the context of individual creativity process (see Section 2.7), emphasizing the social validation that occurs in the last phases of the process. It is noteworthy that each of the frameworks outlined above include stages that correspond to the generative and an evaluative sides of creativity suggested by Silvia (2011). For other authors, such as McFadzean (1998) who conceptualises creativity as a continuum, the processes of building common ground and the generation of ideas are inseparable, and together understood as the building of intersubjectivity (e.g. Craft, 2008) or interdependence (Sundholm et al, 2004).

2.4 The Design of Technologies to Support Stages of Creative Collaboration

For Weakley and Edmonds (2005) a necessary condition for collaborative creativity is the development of common ground between collaborators. Their paper reports on a study in which they devised and tested a prototype virtual space to support the exchange of knowledge and expertise between physically distant collaborators. They also acknowledge the desirability of supporting the development of interpersonal relationships and discuss ways in which the development of trust can be supported by technological means. Edmonds et al (2005) go on to suggest the following characteristics as being desirable for software designed to support creative collaboration.

- Support for communication (verbal and non-verbal)
- Support for the establishment of common ground
- A way of establishing trust between users

- A way of recording and reviewing past decisions
- A stable identity for group members
- A way of establishing user profiles (who knows about what)
- Support for sharing prototypes

One of the points that Weakley and Edmonds (2005) also highlight is the role of non-verbal communication between co-present collaborators. Co-presence is thus an advantage to collaborators, yet, as Sundholm et al (2004) and Ramberg et al (2004) make clear, even experienced, co-located collaborators face difficulties.

Sundholm et al (2004) were using Schneiderman's (2000) framework of eight staged activities (searching and browsing, consulting with peers and mentors; visualizing data and processes; thinking by free associations; exploring solutions; composing artefacts and performances; reviewing sessions and disseminating results) as a basis for studying different design teams' use of an interactive lab space. Meanwhile, a study by Ramberg et al (2004), carried out in the same lab, focused more closely on the use of technology that facilitates the production of representations (drawings, sketches) of design ideas produced by co-located members of a team.

These investigations focused on the potential of teams to produce and to use external representation, and the role of technology in facilitating that activity. A similar emphasis on the role of technology to support representations also found in the work of Facer and Williamson (2004) who made a study of children using prototypes of digital environments designed to support collaborative approaches to creative storytelling and to explore the potential of multimodality. Facer and Williamson concluded that the rich multimedia environment of the prototypes allowed the children to externalise their ideas for sharing with each in other in a variety of representations which children of all ages could manipulate and around which they could discuss and refine their ideas.

2.5 Creative Collaboration and the Role of the Emotions

In their studies of technological environments to support creative collaboration, all the authors whose work was described in the previous section also refer in some way to the role of emotions or trust between collaborators. A good example of this is Ramberg's (2004) reporting of the embarrassment of participants in making sketches in public, or Sternberg's (2006) reporting of the creative contributions of members as interruptions to the process, often in the form of jokes. Mamykina et al (2002) observed that relationships of trust are important for facilitating the development of creative ideas between collaborators, while Kimbell (2000) makes the point that for creative collaboration to occur between schoolchildren using digital tools and environments the relationship between the children and their teacher must involve trust and allow for some risk. This theme, of trust, was also highlighted by Sullivan (2011) in her study of creative solutions found by sixth graders working on a robotics problem in a science lesson. Sullivan's main finding was that a mixture of both playfulness and seriousness was effective in supporting design process. Similar findings were made by Eteläpelto and Lahti (2008). Other researchers have emphasised the role of playfulness in creativity. Examples are Barnet & Kleiber (1982) who identify playfulness as being the basis for creative thoughts.

Further support for such an emphasis in research is provided by Craft (2008) in a review of papers on collaborative creativity "*acknowledging cognitive, emotional, social and spiritual dimensions and offering ways of understanding 'co-construction' as a new consciousness, understanding better the role of emotions in particular in developing trust at emotional, social and cognitive levels*". Turvey (2006) pays tribute to Craft's earlier work as he explores the development of a conceptual framework for studying primary school children's engagement in online communities centered around designing websites. Turvey's (2006) framework includes space for exploration of personal identities, increased socialization through the use of collaborative online tools and the potential for group cohesion as participants work towards a common goal of creating and sharing knowledge.

2.6 Creative Collaboration, the Space of Dialogue and the Value of Tensions

Wegerif (2008) explored whether and how it was possible to assess the creative moment in shared thinking. His study considered the role all playful, informal interactions between participants, regardless of whether the interactions appeared to be relevant to the creative task, which collaborators were working on. Through reference to the dialogic approach of Bakhtin (Bakhtin, 1986) Wegerif demonstrated that the involvement of potential and actual collaborators in off-task talk can be understood as 'opening of a space of dialogue'. The Bakhtinian argument, that it is through tension and disagreement (although clearly within an atmosphere of trust and collaboration) that new ideas are generated, adds a significant thread to this discussion. This notion of a tension is implicit in the work of some other authors. For example, Luther and Bruckman (2008) pointed out that one of the roles of the leader is his or her role of placing constraints on collaborators. In Wegerif's terms this constraint can be considered to be a different voice, in tension with the free-floating, infinite variety of possibilities that the creative members of the team might express. Though Luther and Bruckman describe it more as a 'relationship between innovation and convention, a good example is the genre convention of the story that provides a constraint in relation to which children were able to generate ideas (Vass et al, 2008).

Several authors, including Loi & Dillon (2006), Dillon et al (2001) and Fischer and Shipman (2011) explore the role of tension in creativity. Karlgren and Sins (2011) suggest that where tensions exist, group members have to reflectively analyse their own activities in the group questioning how they deviate from the established norms and practices that they would favour. Engagement in doing so is itself part of a creative process since they have to search for solutions to overcome the tensions. Karlgren and Sins also argue that externalizing tensions is a means through which opportunities for creative efforts in collaboration can be increased. Indeed some designers of technological environments to support collaborative creativity go so far as to base their work on tension, breakdown, or conceptual collision. Fischer and Shipman (2011) base their designs on the premise that where situations are sufficiently open-ended and complex, collaborators will encounter breakdowns. For them the challenge for designers of ICT tools and environments to support creativity is not to reduce heterogeneity and specialization, but to support it, manage it, and integrate it.

Tensions are therefore the basis out of which creative ideas might be generated but are also of crucial importance for the co-ordination of the process. Skills in regulation are important in this context; these skills include the regulation of self, of ones emotions, and skills in regulating others. The importance of the full variety of regulation skills is made clear in the study by Eteläpelto and Lahti (2008) who found that the emotional atmosphere and power relations within groups of student teachers in their study were significant obstacles to creative collaboration. Other studies of regulation focus on temporal regulation and its relationship to creativity.

2.7 Time Regulation in Creative Collaboration through Supportive Technologies

Considering creativity as a series of stages as discussed earlier or as a process, for example, Lubart's (2001, p. 295) "sequence of thoughts and actions that leads to novel, adaptive productions" leads us to consider the temporal dimension of this process both in the individual and collectively. According to Runco (2004, p.1) the creative process consists of six phases, the collaborative process too has a longitudinal nature because the general duration of the activities. According to Reimann (2009) half of the CSCL activities analyzed in the ijCSCL between 2005 and 2007 have duration of more than a week. Considering the long-term duration of collaborative activities, we should consider the stages of development of the groups of people engaged in these activities. Thus learning time regulation in CSCL considers "time perception, allocation and regulation as a capacity bounded both at the individual and collective level by the temporal script of the task and the temporal patterns of each of the team members" (Romero, 2010, p.1). Time regulation in creative collaboration could be a challenge, because of the need for combining individual and collaborative levels of regulation. Under the general learning regulation approaches (Hadwin, Järvelä & Miller, 2011), we consider time regulation as the specific regulation of the academic time that is carry out by a student (time self-regulation), two students (time co-regulation) or the group (socially shared time regulation). It should be noted that in the collaborative spaces of the Co-Creat project learning time regulation is considered not only in traditional Virtual Learning Environments (VLE) but also in mobile learning environments which increases the time span of accessibility from the students' point of view.

3 Summary

Creative collaboration in the Co-Creat project has been dissected through three different levels. The first level refers to feelings for belonging together or in same group. In the second level people act together and in the third level they construct new knowledge and creation. Technology can be used in each level for enhancing rich interaction and consequently richer opportunities for learning. The following criteria have arisen from the above literature review as being criteria necessary to, and therefore having potential to be used to assess levels of, creative collaboration:

- Extent of use of imagination and divergent thinking
- How the setting provides opportunities for collaboration itself, such as the degree of co-presence
- Existence of common ground (shared knowledge and goals) and opportunity to develop awareness of it
- Extent to which possibilities of externalizing representations (sketching, writing, modelling) are exploited
- Extent to which participants feel that atmosphere identifies with the following:
  - an atmosphere of playfulness or joking as well as seriousness
  - safe atmosphere and trust between participants
  - a degree of apprehension, or of disagreement or tension
  - problem boundaries stretched or broken
  - tolerance of ambiguity
  - engagement in the task
- Extent of expression and exploratory talk enabled
- Self and socially shared regulation of time spent on learning

The resulting assessment scale devised for the project (which can be found in full in the research report at http://cocreat.wordpress.com/project-reports/) asks for the participants in the CoCreat collaborative spaces' ratings of both the presence of the factors listed in Section 3 above as being suitable for the assessment of the extent of creative collaboration in a group task and their importance to a successful outcome.

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Computer-Based Creative Collaboration in Online Learning

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Abstract. Creativity is a key learning objective in higher education, both in face-to-face and online learning contexts. In this study we discuss the concept of creative collaboration and the way this competency could be supported by the use of computer-based environments in online learning. The analysis of the creative process in the context of individual creativity is carried out using McFadzean's [1] creative continuum and the Assessment Scale for Creative Collaboration (ASCC), which has been developed in the context of the CoCreat Lifelong Learning Project. The results of the collaborative creative process show a high relation between the creative process and the social interrelations between the students, but do not show a relation between the collaborative creative process and the time pressure perceived by the students.

1 Creativity in Higher Education

Creativity has been defined as one of the strategic learning objectives in higher education in recent years. The big changes produced in the world in recent years have made it necessary to consider creativity as a strategy for enabling future citizens to succeed in an increasingly complex world. Creativity refers to the generation of ideas that are original, valuable or useful [2]. For years, creativity has been conceived as an individual trait, but also as a process and the product of the process [3;4;5]. In this paper we consider creativity from a socio-cognitive viewpoint as both an individual and shared process. We also define the concept of creativity individually and collectively, before considering the importance of collaboration in the creative process.

Creativity is not merely an original act or idea, it is also an accepted new solution that is collaboratively (co)constructed and shared by a group. Creativity output may result in an act transcending the creativity creator [6] and producing "changes in an existing domain, or transforms an existing domain into a new one. What counts is whether the novelty he or she produces is accepted for inclusion in the domain" [7]. The importance of the usefulness of the ideas or acts that are considered as creative is highlighted by Franken [8]. This author considers "creativity as the tendency to generate or recognize ideas, alternatives, or possibilities that may be useful in solving problems, communicating with others, and entertaining ourselves and others". In recent years, the increase of collaborative learning and teamwork in the workplace in a context of increasing productivity has underlined the relevance of the collaborative

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creative process in the contexts of group work. Moreover, in recent studies, creativity has been considered as a collaborative and situated process [9] that could not be understood as an individual process. Technology has been seen as an opportunity to support creativity both in individual and collaborative modalities [10] despite there not being an agreement on the impact that technology has on the development of the creative collaboration process.

2 Creativity as a Collaborative Process

The analysis of the creative process in the context of individual creativity is carried out using McFadzean's [1] creative continuum, which considers the different stages of the creative process of collaboration that could be applied both in individual and collective settings. The time factor and the time quality is an important aspect of understanding learning activities [11; 12; 13], and especially in the creative process of collaboration. McFadzean's creativity continuum is a model for analysing the collaborative creativity process by considering a continuum ranging from paradigm preserving to paradigm breaking.

	PARADIGM PRESERVING	PARADIGM STRETCHING	PARADIGM BREAKING
Problem Boundaries	Unchanged	Stretched	Broken
Creative Stimulation	Low	Medium	High
Stimuli	Related	Unrelated	Unrelated
Association	Free	Forced	Forced
Expression	Verbal/Written	Verbal/Written	Unlimited
Examples of CPS Techniques	Brainstorming Brainwriting Force Field Analysis Word Diamond	Object Stimulation Metaphors Assumption Reversal	Wishful Thinking Rich Pictures Picture Stimulation Collage

Fig. 1. Creativity continuum adapted from McFadzean [1]

In addition to analysing the creative collaborative learning process using McFadzean's [1] creative continuum model, this study also investigates the students' perception of creative collaboration and the contextual variables of interest. A first element analysed is the degree of perceived co-presence during the teammates' task. The teammates' engagement perception is one of the main factors of students' satisfaction in collaborative tasks [14]. If the teammates' perceived engagement could support the creative collaboration process, the students' perception of an imbalance in their teammates' engagement could make them feel frustrated by the collaborative activity [15]. Tolerance of ambiguity has been analysed as another of the factors related to creativity [16]; the novelty of the creative solution implies a certain playfulness and acceptance of ambiguity in the creative process and outcome definition.

The degree of disagreement or tension between the team members is also considered as one of the factors that could be involved in the teammates' creative collaboration. A certain degree of disagreement and tension could support the creative collaboration [17]. The Assessment Scale for Creative Collaboration (ASCC) [18] has been developed to consider these different factors involved in the creative collaboration process. The ASCC has been created within the context of the CoCreat Lifelong Learning Project. One of the research objectives of this study will also be to analyse the reliability of the ASCC instrument in the analysis of creative collaboration.

3 Time Pressure and Creativity

Within the different factors analysed in the ASCC [18], the time pressure experienced by the students is considered a key factor to understanding the creative collaboration process as a continuum in the context of a flexible long-term task in online learning. Time pressure is defined as a specific kind of stress that is experienced by an individual who perceives that they have less time than required to develop a task. McGrath [19] explains time pressures as the imbalance between individuals' resources and the situational demands. Time pressure is defined as either subjectively perceived time pressure or the imposition of a deadline [20]. In this study, the time pressure is understood as a subjective perception of stress in the context of a long-term task where the students have several weeks to complete the collaborative task.

Prior research on performance effects has demonstrated clearly that time pressure increases the rate of individual and group performance [21; 22]. However, results have been much less consistent on the quality of performance and creativity. Amabile and colleagues [23] and Andrews and Smith [24] observed that time pressure influenced negatively on creativity.

4 Hypothesis

Three hypotheses are analysed in this study. The first hypothesis (H1) proposes that in creative collaboration, a higher level of social interaction will lead to a higher level of creativity. The second hypothesis (H2) states that a low perception of time pressure will lead to higher creativity, in the context of creative collaboration tasks. Finally, the third hypothesis (H3) proposes that in the creative collaboration context, the creative continuum phases of McFadzean's [1] creative continuum will be observed.

5 Methodology

The study involved 64 online learners of the Bachelor's degree in Audio-visual Communication. The students were engaged in the course "Introduction to Creativity in Advertising". The task proposed to the students during the course was carried out in dyads. The students were required to develop a creative advertising project during a period of four weeks. In terms of temporal resources, the task is considered as a long-term task [25] with a high institutional temporal flexibility [26]. The students were invited to answer the ASCC [18] at the end of the creative activity.

5.1 Methodology

The Assessment Scale for Creative Collaboration (ASCC) aims to analyse the students' perception of creative collaboration and the contextual variables of interest, such as the degree of co-presence during the task, the tolerance of ambiguity, the interest in the task, the degree of disagreement or tension between the team members and the time pressure.

The ASCC is based on 16 criteria that have been related to the creative collaboration process of the learners. For each criterion the students should answer one or more specific questions on a scale of 1 to 7 according to (1) how much it was present during their project (presence subscale) and (2) how important it was to their group's success (importance to success subscale) :

1. Shared knowledge and goals
2. An atmosphere of playfulness as well as seriousness
3. Safe atmosphere and trust between participants
4. A degree of disagreement or tension
5. Possibilities for externalizing representations (sketching, writing, modelling)
6. Degree of co-presence during the task
7. Opportunities for divergent thinking
8. Tolerance of ambiguity
9. Engagement/interest in task
10. Level of collaboration itself
11. Opportunities for exploratory talk
12. Adequate knowledge base
13. Problem boundaries stretched or broken
14. Amount of use of imagination
15. Degree of expression enabled
16. Time Management during the creativity task

A rating scale has been chosen so as to shorten the questionnaire, as obtaining the same level of information using Likert scales results in many more statements than shown above. A scale of 1 to 7 has been chosen to enable Spearman's rho correlations between variables to be conducted without challenging the parameters required for the accuracy of the statistic.

6 Results

The preliminary objective of this study is to assess the reliability of the ASCC [18] developed for analysing the factors involved in the creative collaboration process. The analysis of the reliability of the analytical instrument "Assessment Scale for Creative Collaboration" shows a high Cronbach's alpha (α = .833) in the presence subscale and in the importance to success subscale (α = .892), which leads us to consider this a reliable instrument for the self-assessment of the collaborative creative process.

After assessing the reliability of the ASCC survey, we analysed the results of the creativity level achieved by the students in relation to each of the hypotheses of this study. The first hypothesis (H1) could be maintained because the results of the collaborative creative process show a high relation between the creative process and the social interrelations between the students. The second hypothesis (H2) should be rejected in this study because the results do not show a relation between the collaborative creative process and the time pressure perceived by the students. The third hypothesis (H3) should be partially rejected because McFadzean's [1] creative continuum phases were only observed in a small number of the dyads. The students did not show a resistance to changing their paradigm.

7 Discussion and Prospective

The creative process in collaborative learning should be analysed by considering the students' experience in their creative process and their collaborative learning, but also by observing the creative process in time. McFadzean's [1] creative continuum is particularly suitable for observing the creative collaborative process in the dyads, allowing the completion of the information provided by the ASCC [18].

As observed by Eteläpelto and Lahti [9], group settings are related to creative collaboration. In this study we observed a higher number of interactions in students showing a higher level of creativity. The interaction process in creative collaboration is observed as one of the important factors in the level of creativity showed by students. In addition to this quantitative observation of the interaction activity between the dyads in the creative collaboration tasks, further studies should consider the specific episodes developed in these interactions to analyse the specific processes that contribute to supporting creative collaboration.

In this study, the perceived time pressure did not affect the creativity levels of the dyads. This could be explained by the high institutional temporal flexibility [26] within a long-term task [25]. In this context, the students developing the task over four weeks perceived a low level of time pressure. In future studies we will increase the time pressure by reducing the number of days devoted to the task.

Finally, in the creative collaboration context of the observed dyads, McFadzean's [1] creative continuum phases were only observed in a small proportion of the dyads. The dyads showed a diversity of different patterns in their creative collaboration. In this sense, each dyad showed a specific temporal pattern in their collaboration [27]. In most of them there were no "paradigm preserving" phases. This could be analysed also in terms of the topic of the course, related to creativity in advertising, where the students did not have an initial paradigm to preserve, and showed a high degree of openness to the creative solutions proposed by their teammates and themselves.

Further research should allow for better characterisation of creative collaboration and control of the time pressure to enable the influence of this temporal factor in the quality of the creative collaboration to be observed. Moreover, future research in the field of creative collaboration could contribute towards consolidating the mixed-method analysis considered in this study and consider not only the specific population of the online campus but also students in face-to-face universities.

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Trust for Supporting Learning Creativity in Online Learning Communities

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Abstract. This paper addresses the effort to investigate the potential of using real time data for helping teachers in assessing and monitoring learner's commitments towards learning collaboratively at a distance in online scenarios. We aim with this to recognize group vulnerabilities and being able to help teachers intervene (when needed) and support positive actions and contributions among learners and therefore reinforce learners autonomy and motivations to engage in everyday creativity skills and innovations.

Main results achieved so far are translated in an attempt to report evidence gathered through observation (as a pilot test) a real case scenario (a international Technology enhanced-learning course) aiming to understand three major aspect of the potential of trust in leverage support positive actions and creative contributions. Results provide a linking evidence towards the potential of trust awareness in support positive actions and creative contributions in the classroom.

Keywords: Creativity, Trust, learning interactions, e-participation, Technology Enhanced Learning.

1 Introduction

Today's learning is part of a reflection process, that is the a mix of reunification of knowledge with the development of communication skills in multicultural environments. This settings points as well towards a need for develop creative and innovation skills [16] where collaboration should be supported by a participatory learning environment and it's community. The technological artifacts had been a major key in support this shift change, even so this technological artifacts per si cannot replace the human focus of the learning process and their ability to engage in everyday creative skills [20].

In the attempt to understand what motivates collaboratives learning actions we investigate the potential of using Trust as a potential factor for foster and support interactions (within Technology Enhanced Learning scenarios). As Trust is an important key when forming a relationship, foster participation and contributes for supporting iterations and collaborations, this is because it reduces

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the level of uncertainty in a relation [10], leading to more collaborative and innovative learning environments [8, 11, 27].

Trust is although hard to measure as it can be affected by many direct and or indirect indicators. We will support our research on our previous efforts on understand the potential effects of Trust in supporting Online Learning Communities. Reseults that lead us to conclude that when there is Trust, activities tend to proceed more smoothly, actions tend to be more decisive, and people work with greater confidence.

This paper reports the attempt towards understand the importance of creating Trustful relations to support positive actions and develop creative contributions. The main achieved results so far reports that influence in learners behaviours. It points to three main aspects to observe regarding trust and it role in leverage supportive and positive actions, that is observe (1) how learners perceive others intentions in a given context, (2) second observes learner's commitments changes towards a particular activity (level of cooperation) and final (3) observes learners perceptions towards the use of the communication mediums for learning purpose (reactions, intentions of use and actual use). But first and before present the achieved results we will establish a background context and motivations towards this study.

2 Background

Above we point out to the potential of Trust to collaborative and innovative learning environments. As Trust can reduce the uncertainty of a relations, minimizing the risks of expectation failure in some degree. But the potential of Trust in forming healthy relations is not something new. That is why this concept is rather complex to understand and includes a multidisciplinary approach.

We can find that Trust is a issues address in diverse on areas of knowledge like sociology, psychology, economics, and management science. For example from a sociological perspective Trust is seen as a reflection of behaviors, choices and decisions [7–9]; for psychologists, trust is seen as an attitude or intention [6, 19]; on the other hand social psychologists interpret trust as a interpersonal phenomenon [13–15, 30], and economists see it as a commitment in a form of a rational decision (as a game) [1]. For scholars in management science, trust has been recently connected with the notion of docility introduced by Simon (1993) [22] to describe the tendency of people to trust social channels as a major basis for making decisions. Trust has also been approached in HCI [3, 5], in CSCW [18, 27] and other computing systems and technologies contexts [2, 29].

In the field of Technology Enhanced Learning (TEL), a significant relation between Trust and academic performance was identified building on three trust factors: trust towards teacher and facilitators and learner's interactions, trust towards the online learning environment and Trust towards the technological infrastructure [23].

Further, a socio-technical model of trust was developed which depict trust as a construct informed by attributes such as trust predisposition, reciprocity, predictability, honesty, benevolence, and competence, determining the extent to which one relates with one's social and technical environment [25].

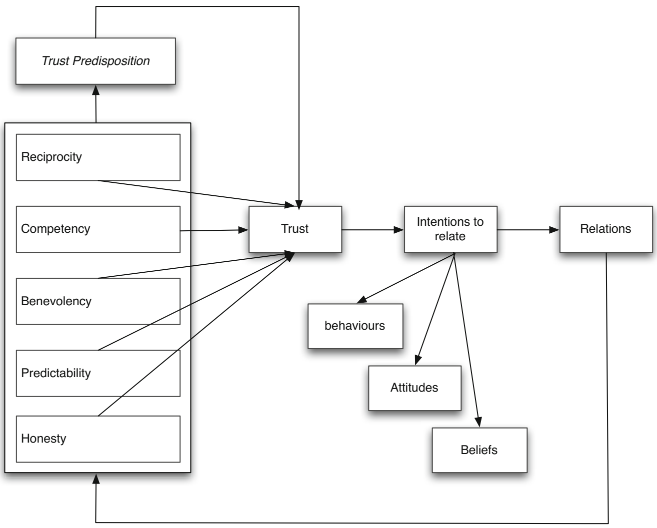

Fig. 1. Trust social-technical model

This model builds on what one perceives to be trustworthy and is influenced by a number of factors such as the history of participation and perceptions of the communication medium and of other users [4, 14, 28]. Using this model as a research lens, relations were found linking trust to openness and sharing [24], to privacy [12] and to collaboration [26] in online learning environments. On the literature we further read that Trust influences the degree of engagement and commitment towards specific activities; and the degree of peer engagement and willingness to establish communication [8, 17, 21, 27].

The herein proposed to further explore this issues and attempts in perceiving Trust as an interaction facilitator construct by observe a real case scenario (a international Technology enhanced-learning course) aiming to understand and investigate possible implications of Trust in support positive actions and creative contributions.

3 Research Approach

The research delineated herein provides one more effort towards understanding possible implication of trust in develop sustainable online learning communities and on support learning. We describe the results achieved from observing and analyzing a real case scenario (a international and distance course) to better understand how we (teachers) can use Trust focus as a way to support and mediate learner's interactions within the course. This attempt to see teacher perspective when examine learners' Trust commitments when needed to engage in collaborative actions aims to increase our awareness towards the study of the Trust focus in this context to increase collaboration and support creative learning processes.

The instrument: to achieve above research goals we applied a course observation procedure which included a initial survey instrument and weekly diary logs. The survey was conducted online and explores students background profile information (gender, age, nationality etc). Explores students learning views and patterns (on safeness perceptions, privacy preferences) and finally explores students use of social media towards learning. Accounted for fifteen (15) questions. The diary Log procedure observed students discussion, group interactions and final achievements) and make possible interconnections between (1) how learners perceive others intentions and how this affects the collaboration context, second (2) how learner's commitments (level of cooperation) towards particular activity changed collaboration patterns; and final (3) How the communication medium (reactions, intentions of use and actual use) affected learners' trust perceptions.

The course: started in 24th of February and was about "Designing technology enhanced learning (TEL)". Was a international distance learning course, with participants from four different countries, Finland (University of Oulu); Norway (Norwegian University of Science and Technology Trondheim); Romania (Valahia University of Targoviste); and Estonia (Tallinn University). The courses lasts 14 weeks (a semester). Course learning environment are SecondLife and Moodle and learning activities are planed to foster international students collaboration. Evaluation process, includes peer-evaluation discussions, reading tasks; commenting on weekly topic and individual and collaborative studying. Student's are expected by the end of the course to design, development and implementation a TEL course. Course load and contact hours include 15 hours of lectures and individual and collaborative studying in virtual learning environment for 145 hours.

Course contextualization: The observed TEL course is part of a European project called *CoCreat — "Enabling Creative Collaboration through Supportive Technologies"* (http://let.oulu.fi/cocreat). This course is deployed by nine (9) partners from eight (8) different European countries. Project main purpose is to find new solutions for promoting creative collaboration in terms of new and innovative learning models based on social media and mobile technology. Most activities performed in the course involve collaborative tasks, collaborative thinking and reflection. In the course students were initially divided into small groups (from 4 to 9 students maximum) and different facilitators and tutors were assigned to each groups. All learning activities were design and coordinated by a teacher/tutor who coordinate overall group activities. The kick-off meeting was made via Adobe Connect Pro in 24th of February, and students had face-to-face meetings with the local facilitators twos week before the start.

Participants: forty-nine (49) students answered to the survey from a sample of fifty-five (55), three survey answers were consider invalid due to be incomplete, which resulted in a sample of forty-six (46) questionnaires for analyze (6 Estonian, 18 Finnish, 1 Norwegian and 22 Romanians).

4 Achieved Results

In this section we will address and describe the results from two perspectives, first we analysis students' questionnaire answers and then compare those results with log observation diaries made by tutors and learning system.

Overall results show that most participant had a higher degree and their age average was of 31 year old. The youngest had nineteen years old and the oldest 52 years old. Majority uses Internet and social applications in a daily bases (85,71%) and consider very useful activities like reading and sending e-mail, search for information, learning activities and sharing ideas in formal education contexts, see figure 2.

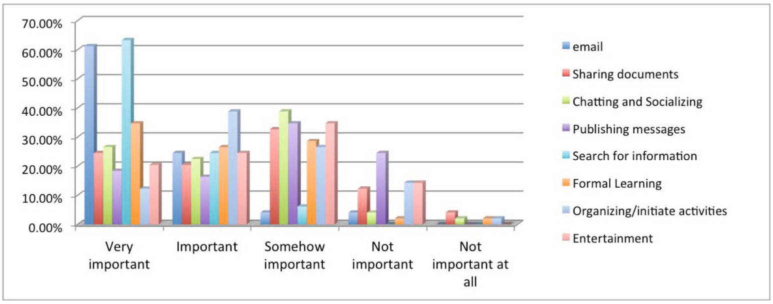

Fig.2. Activity and daily routines

Survey analysis shows also that participants in general feel safe to share in e-collaborative learning context (57.14%) or in social network (44.90%), (e.g. Google docs, EtherPad, dropbox, Facebook, google+, Twitter). By safe we mean felling a degree of control who will read or have access to their shared resources, comments and assignments.

Feel safe, as well, when sharing in close learning environments (42.86%). Results also reveled, that students are undecided on regard their safety when interaction with open environments (e.g.blog-post in Wordpress/Blogger, Wikiversity), public blog-posts, public forum discussions or Second Life, see figure 3.

Regarding students privacy preference, seams students prefer to keep the information private by default, especially the grading (36.73%) information, feedback and comments (36.73%).

The inquired students claimed to publish very often, especially information about friends or themselves. They, also, use online tools or services in a daily bases. Tools most used are mobile wireless devices (32.65%), search engines (59.18%) and social networks (40.82%). Regularly use collaborative sharing tools

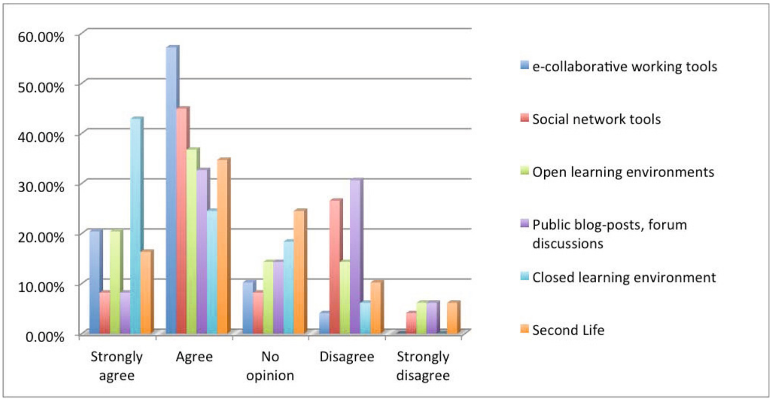

Fig.3. Privacy awareness towards eLearning tools

(42.86%), but not so often use computer assessments and close learning environments. Not use at all, or used at least a few times collaborative drawing and social bookmarking services. Students expect, as well, that teacher clearly define course privacy rules (42.86%), in regarding what will remain private or public in the course.

In the diaries analysis we aimed not to examine learner's profile but instead their interaction and working patterns regarding three main issues (1) how learners perceive others intentions in a given context, (2) second how learner's commitments changes towards a particular activity (level of cooperation) and final (3) how learner's act (reactions, intentions of use and actual use) when using a communication mediums for learning purpose.

This course in fact gave much emphasis to students' collaboration and online social activities, fostering as well group participation whenever needed. Activities were performed always at a distance and online. To fulfill the learning assignments students needed to actively collaborate and cooperate with each other (in groups). Tools used to deploy the course were Moodle or SecondLife.

The tutor/facilitator role consisted in observing the interaction context (discussion, interactions and fulfillment of tasks) and find patters that lead to understand learner's trust behaviors and attitudes and write them in a weekly diaries.

The observation period included a 10 week and two group were observed the "TechDesigners" and the "ThoseTwoLives"

[OBs1] Week 1 and 2, "Get to know each other" (asynchronous).
[OBs2] Week 3 and 4, Decide about working methods (asynchronous and synchronous).
[OBs3] Week 5 and 6, write the pedagogical script (asynchronous and synchronous).
[OBs4] Week 7 and 8, provide peer-to-peer feedback (asynchronous).
[OBs5] Week 9 and 10, write the pedagogical script (asynchronous and synchronous).

Students' trust commitments: During the first two weeks students basically took time to know their environment or as we saw spend their time to making a social engagement with colleagues, tutor and communication tool.

Also started to establish their initial Trust decision. But the real commitment only come up on week 3 and 4, when students' needed to decided their working methods to be able to fulfill an group activity task.

In other words student's social engagement started when needed to articulate their ideas with other group elements.

The work set, took place aftwards (during week 5 and 6) when needed to deliver their first assignment, the pedagogical scrip.

Although, some seamed confuse and not understand what actions they need to do, and seam more interested in the overall course perspective. Aiming to understand what would be their role to achieved course expected results.

In sum, until week 5 students started to reevaluate their commitments and other's commitments towards the fulfillment of a particular task and course. In fact in the end of week 4 and until the end of week 5 students synchronously (via Second Life) agree on actions, structure and each others role for then work asynchronously (Via google Docs) in their task.

Those who seamed more online social active (but not necessarily face to face social active) tend to be more successful in perform their activities. Group learning capacity and competency was affected by this as well. During tis period student's level of empathy was higher as well as their group working bound and commitment.

Communication and support: Tutor support during the synchronous communication, was also important to mediate the decisions and to establishes the communication climate (the initial trust bound). Also, we no tested some tension between those more online social active students (on asynchronous communications) and the others. What lead us to believe that could be a bias towards students who use Internet as daily tool from others.

Another finding was the student's tendency to associate familiarity with a tool to it efficiency. The tendency was to choose working collaborative tools that most were familiar with or at least one or two member knew, like and had work with it. If not, if they where less familiar with some tool they become less willing to use it.

During Week 5 and 6, student's Trust commitments become important to continue the work and be committed towards fulfilling the course aims. In here the initiator-contributor role assumed by one member of the group helped to create that trust bound among others. Tutor support also help to achieve that commitment but those student's who need to be supported by the tutor/facilitator seamed less committed and less motivated to work in group and collaboratively. Where less creative as well.

Also, students interactions and activities become more lively and creative when foster by a group member than by a tutor/facilitator. One attribute that influence the initiator-contributor role and the willingness to collaborate among group members was how and how fast other's react to their initial messages (tranparency, reciprocity and benevolence). For example: during week 4 and 5 we observe that in spite of one initiator-contributor from the group "ThoseTwo-Lives" attempted to initiate the interaction process, other's did not reacted or reacted to late to the message so the result of the task was done a week later need tutors intervention and was weak if compared to the other group. Students' from the "ThoseTwoLives" group found more difficulties in collaborating and working together and that affected their performance and creativity in the end. In fact most of the work was done individually and group collaboration was done only if there was no other way.

International perspective: we observed cultural misunderstandings between student's who are online social active from the others who have limited access to computers and Internet.

Those where no tested more when defining rules on how to act and how to behave in the group. Most of those misunderstood were dismissed in synchronous conversation and through tutor/facilitator mediation support.

Group commitment Vs creativity: The ones more committed expect active discussion and participation, some even claim the need to have prompt (daily) asynchronous communications among group members. Also the more committed students took the initiative to articulated the group work activities and collaboration procedures.

Most of synchronous meetings were used to established group bound and trust commitment to perform a specific task. During those periods some social active students in asynchronous communications become more shy and less active. In here student's competency and honesty, besides reciprocity and benevolence determined the interaction process. In this environment the role of the teacher was mainly for provide support and scaffolding.

Working methods: Group working methods differentiated from group to group, though in the end the majority of the groups achieved pretended results. Group Trust were more vital and often more stressed near the end of a task. Rules, ideas on how to collaborate and perform the task were discussed during synchronous meetings and then ideas were fulfilled asynchronously by each member.

5 Closing Remarks

This work's major contributions are towards the intersection of areas such as trust, creativity and collaboration.

So far the achieved results clearly distinguish learners commitments as an important feature for learning success. Commitment that is important to be supported by group trust bound.

Contradictory to what we expect open or close activities seamed less important for ensure the success of the activity and the group interaction although creativity and collaboration can be related with level of commitment and Trust bound.

Competency, reciprocity and benevolence were important attributes to ensure students initial work Trust articulation. Predictability, honesty and competency as well as reciprocity were important attributes for engaging the group bound through time and ensure group commitment.

In return, tool familiarity and usefulness were important attributes with communication efficiency. More important than privacy or secureness.

Future aims are towards to develop guidelines on how to help teachers in support student's trust to leverage positive actions and create collaborative environment who lead to creative contributions.

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Exploring Creativity with e-Learning 2.0: A Personal Account

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Abstract. This article shares a personal account on the effect of learning with access to a wide range of information and computational tools on personal creativity. It is an ethnographic narrative study, presented as a first person account on the perceived creative added value of learning within an open, very flexible and constantly evolving curriculum, deployed over a heterogeneous and assumingly experimental learning space.

Keywords: Creativity, online learning.

1 Introduction

Creativity is an important human attribute and although computers are becoming more and more complex, their technology still fails to reach the human ability to engage in everyday creative skills [1]. However, technology can be seen as a means of supporting the realization of one's creative potential and expressing creativity by providing convenient access to a wide range of information and computational tools [2], such as it happens in the case of Tallinn University's master program on Interactive Media and Knowledge Environments (IMKE).

IMKE is a six years old international master program with an open, very flexible and constantly evolving curriculum: Open and very flexible in the sense that students are encouraged to get part of the necessary credits by enrolling in courses from other curriculae, either from the university, from Estonia or from elsewhere; and Constantly evolving in the sense that the set of freely elective courses is updated yearly to reflect an always evolving understanding of what interactive media and knowledge environments are and also to provide our students the necessary edge in a highly competitive professional field. On top of this, we should add that part of IMKE's courses is tough by foreign specialists, whose contributions play a important role on every instance of the program.

From the scenario introduced above results a master program, which has as main characteristics a dynamic morphology and a very heterogeneous learning environment. While IMKE's dynamic morphology is mainly fostered by flexible university regulations and all the external contributions, its heterogeneous learning environment is encouraged by our vision that every lecturer should used the approach she or he sees as the fittest in each course. As a result, IMKE course modalities range from

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strictly face-to-face to fully online without any face-to-face contact; from simple (paper) file sharing to intensive use of a specific learning management system; some open learning environment agreed upon by students and lecturers. IMKE's community welcomes this heterogeneity as it allows for a hands-on experimental approach to many of the topics addressed in the curriculum but also raises questions and problems. One being, just as an example, the difficulty students feel in keeping up with everything related to their master program and their colleagues, as all are encouraged to keep personal blogs on top of every system account they must get hold of to participate in the program's activities (this issue was actually partially addressed by a team of students that developed and deployed an aggregation service to help them cope with all the details).

2 e-Learning 2.0 and Creativity

e-Learning focused mainly on using technology as supportive factor in the learning process. The concept however, evolved into e-learning 2.0 [3], a neologism for Computer Supported Collaborative Learning, when social software was added to the equation. From this point on, content was not only produced by the teachers, but also students were able to contribute to the creation of course content, in a bottom-up way, handing students more control over their studies [4].

As a technological infrastructure, e-learning 2.0 affords [5]:

- Accessibility: online and easy access to vast amount of information through different mechanisms like gateways, portals, websites, knowledge networks and shared communities of users;
- Speed of change: the immediate access to rapidly changing information is the most important feature of new technologies, which enables unprecedented speed of access to materials as they change;
- Diversity: learning is not happening in one place, but you can inform learning via overseas web sites, access to subject experts or use simulations to replicate complex behavior;
- Communication and collaboration: because the wide use of technology, new means of communication and sharing information have occurred (emailing lists, forae, chat rooms). At the same time, physical appearance is no longer mandatory and new forms of groups have developed – communities of practice;
- Reflection: mainly the use of asynchronous technologies, which decrease the importance of simultaneous appearance of members of one group. There for, building archived materials available from earlier discussions becomes easier;
- Multimodal and non-linear activities: learning has been promoted as a linear activity, where in fact new knowledge is acquired through non-linear approach [6]. Non-linear learning on the contrary, encourages learning in the "natural" way by looking information for that topic which has attracted the interest at the very specific point. Multi-modality supports this approach;

- Immediacy: the speed of information exchange has increased enormously leading into consequential intensification of working patterns of the request to immediate responses.

Affordances thus providing the necessary and convenient access to a wide range of information and computational tools as a way to support the realization of the students' creative potential while fostering the expression of their creativity [2].

However and while these affordances account for what we do with e-learning 2.0, they should not be mistaken by causes as the production of practical effects depends of each others intentions [7].

With these notions in mind, we now proceed for a first person account of studying Tallinn University's Interactive Media and Knowledge Environments master program.

3 The Context

As a student in the Interactive Media and Knowledge Environments master program at Tallinn University, which combines intensive week-long study sessions with flexible independent study, allowing the students to combine their studies with full-time work, the personal experience revealed, how the emphasis is put on promoting an open and flexible learning environment. Various course descriptions of the curriculum revealed the high usage of different communication tools and social media forms for conducting learning activities. Most courses used blogs or wikis instead of paper-based materials and also students' were required to keep a personal blog, as a digital portfolio, for their studies. Some of the courses had face-to-face meetings, whereas others put a lot of effort into using different communication tools (*Skype*, *FlashMeeting*) and study environments (*iCamp*, *Moodle*, *Sakai*, *IVA*).

During the two years of master studies, one of the authors participated in 26 different courses and made personal observation on how the courses were structured, conducted and facilitated. Out of these 26 courses, two were fully conducted online; 15 used a blended learning approach combining face-to-face meetings with course blogs or wikis and other e-learning 2.0 tools; and 9 were classroom based.

In fully online courses, like the New Interactive Environments (NIE), the study materials were uploaded in a course blog, the results of individual assignments were presented in each students' personal blog, the meetings conducted via *FlashMeeting* and all participants could get feedback through *EduFeedr*. With the Ethics and Law in New Media (ELNM), the study materials were uploaded in *Wikiversity* and discussions were carried both in the course's forum and via weekly Skype meetings, while the results of individual assignments were also presented in each students' personal blog.

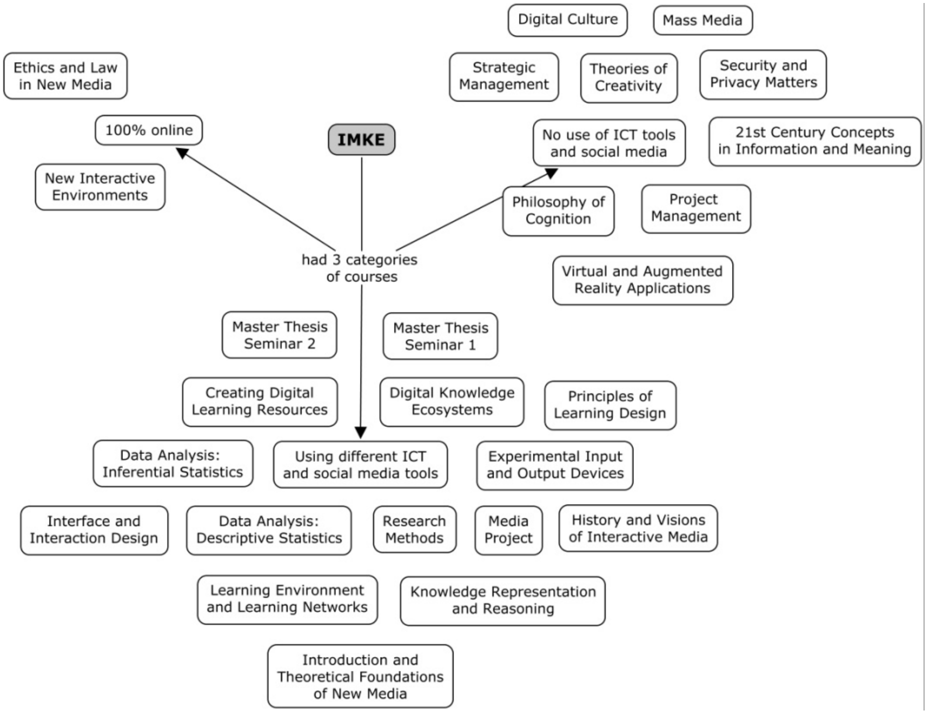

Fig. 1. IMKE's course categories

In blended learning format courses like the Introduction and Theoretical Foundations of New Media (ITFFNM), students had weekly face-to-face meetings and any reading materials as well as assignments were shared in *Dropbox* or published in the course blog. The Media Project (MP), also a blended learning course, had two face-to-face meetings in the beginning and in the end, two intermediary meetings using *FlashMeeting* and all relevant study materials and discussions managed by an environment called *iCampus*, an *Elgg*-based environment.

Finally, in classroom based courses, which did not require any technology for contacting and socializing with colleagues, the students chose independently social media tools to support either their teamwork or individual tasks.

Table 1. e-Learning tools used in some courses

Course	Blogs	Wikis	File sharing	Communication	Aggregators	Face to face
MP				X	X	X
NIE	X	X		X	X	
ELNM	X	X		X		
ITFNM	X		X			X

All-in-all, 17 were one way or the other representing e-learning 2.0 and less than half had the approach of e-learning by having paper based materials or PowerPoint slides as the only ways of presenting study materials. Even in those cases students used Google docs or Skype for collaborative working on their own initiative.

This heterogeneity highlighted flexibility as an advantage of using e-learning 2.0 tools. As most IMKE students work full time, the stress was no longer on how much you are able to do, but on how efficient were you able to be.

Being a full time working student, it is also vital to have the access to course materials or do assignments when there is spare time and therefore this approach helps to manage time more efficiently.

The importance of flexibility was revealed also in the case study of Conole et al. [8] where the students, who had to work, had children, lived from a distance or had high workload, appreciated the access to an integrated set of online-related information and resources.

4 Information Access, Computational Tools and Creativity

Overall, studying IMKE was a rather positive experience. As said before, the curriculum promoted the usage of technology to foster openness and flexibility and from a student's perspective, the courses, that left the most positive impression, usually provided only the frame for the course, leaving the content to be created by the students i.e. the students had to be more independent and aware of their wishes and in return, more freedom and responsibility was provided to them. This freedom and independence led to supporting students' creativity.

The other positive factor was the introduction of various possibilities in the form of making the students explore independently or use in their assignments different applications and/or learning environments. Therefore once again, the students chose their own way to solutions, while exploring and experimenting different applications and environments through which the development of their creative side was supported. This kind of approach was also more beneficial in the sense of inducing the students to be more creative in general as already used solutions were adapted to different situations and the students couldn't "cruise their way" with a single approach without exploring alternatives.

The interactive communication via Skype or FlashMeeting provided the students with higher range of flexibility for participating in course meetings. Also when the courses had blog as their central body, the students got relevant information quickly. For example there were courses, where the course blog acted as the main body, providing all information needed (administrative issues, course related assignments, feedback of the conducted tasks, study materials) online and therefore were accessible whenever the students needed. It is known, that uniting your school activities with personal and work routine, is quite challenging, especially if you need to participate in face-to-face meetings. Interactive communication lost the restriction of physical space and most probably increased the general participation level. The need for physical meetings was also small for courses using course blogs, as there were contact session at the beginning and end of the course, but general communication was done via commenting each other's assignments and posting feedbacks.

If there was something to be changed, then I would suggest limiting the variation of different tools in the sense of them being compulsory. Not all students are impressionable when it comes to using new tools/environments, especially if the student does not belong into the Net Generation [9]. When the students have chosen IMKE program, they need to take into account the wide range of possibilities they'll be introduced to, but the fact that master level students are older and more conscious, makes them more standoffish toward enforced solutions. There should be kept the possibility that student can choose his/her own tool together with the agreement of the teacher, which by the end can lead to the students exploring even more in the field of opportunities provided by Social media.

5 Closing Remarks

As it happens with the Interactive Media and Knowledge Environments master program at Tallinn University, the technology facilitated application of creativity to using a stock of knowledge to promote novel problem solving has, in many cases, lead to innovation, as proposed by Yusuf [10].

The combinatorial power of IMKE's e-learning 2.0 learning environment is nothing new and has been present in many other learning settings, but it seems to be much more apparent and useful in open and flexible learning environments such as the one herein described, as curricular structures fades into the background and the activity tends to focus on creatively dealing with each learning challenge.

Also, the idea that this kind of learning environments is permeable to context may challenge the traditional conception of course materials and students' digital portfolio as context adaptation is now much easier to achieve.

Most course materials and portfolio are usually designed for a specific purpose. However it appears that e-learning 2.0 facilitates breaking this principle due to its inherent context permeability. Thus, it might be helpful to think of an e-learning 2.0 environment, which is not limited to helping us in solving a particular task, but it has a broader purpose of helping us to creatively adapt to our environment as a whole. This is due to the fact that e-learning 2.0 environments, given their context-permeability, can be more easily integrated into distinct contexts thus facilitating creative approaches to address each inherent challenge.

Creativity is then encouraged, as the context for both course materials and portfolio does not need to be preset, facilitating opportunistic usage. Further and has highlighted but the first person account provided in the previous sections, e-learning 2.0 settings enable both teachers and learners to act on their environment thus increasing the possibility of successfully adapting to it.

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A Student Perception Related to the Implementation of Virtual Courses

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Abstract. This paper aims to characterize the point of view of the students regarding virtual courses in education, but in particular the study is based on the experience gained by the students in the *Designing TEL course*, organized in the frame of CoCreat project. Thus, it was noticed that a very important role in the development of virtual courses was played by using Wiki and Moodle platforms. Even there are still some problems on implementing virtual courses using those platforms, *Designing TEL course* can be considered a successful one.

Keywords: virtual course, Wiki, Moodle, cooperation, internet, access to information.

1 Introduction

In the past 20 years, the Internet has produced a large impact on the social sector, communication, information, and its immediate effect was observed on science and education. This environment, yet contradictory, had the fastest growing among other services through all sectors of the economy and helping the global flow of information. Its success is seen by the speed of conquest of the population: in only 5 years of development, it won an audience of 50 million users, something hard to achieve in its time for other features of humankind (Fig. 1). [1]

Indeed, the popularity of the Internet is due to technological developments, but also because the Internet may include other facilities such as TV, radio, telephone, that makes it superior to other services.

Although officially, the Internet conquest by education began in recent years due to obstacles arising in teaching classical education, unofficially Internet influenced our education since its inception. Popularize it, indirectly, made a source of information, documentation, communication and misinformation, loss of leisure time and addiction. [2]

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To use the Internet for teaching purposes, everybody should be aware of all the problems that may arise during the implementation, adoption as supporting material. After the elimination of all factors that could decrease the quality of learning, in the future, total assimilation of the classic courses by the virtual courses is possible.

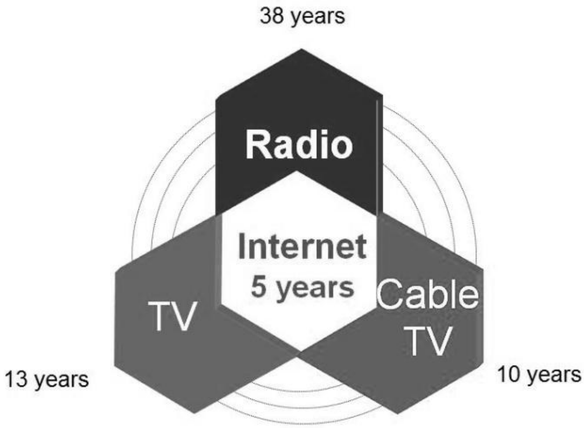

Fig. 1. Time to reach a large audience of 50 million users

Increasing in scale, the Internet has caught also the education field. There are various reasons why it was the Internet that was used for teaching in this environment:

- Increased number of students;
- Decreased quality of learning;
- Increased costs of teaching.

As example, one of the solutions designed in some UK universities was to create online platforms (e.g. Wiki) for certain courses, to facilitate the teaching practice and attracting the attention of students for learning.

The effect was not exactly the desired one, because the student's position towards virtual classroom presentation was not a good one. Student behavior can be easily explained statistically speaking. Most would choose to learn through online platforms (e.g. Wiki) due to the mess of course, lack of time, lack of interest. [3]

However, there are studies showing that Wiki platforms can be a way for students. In international educational projects, it was noted that learning is possible through wiki platforms, but only in cases where students are involved in solving collaborative goals. [4]

2 Method

In the frame of CoCreat project, starting with February 2012, till May 2012, it was organized the *Designing TEL course*. In this context, students tried to be familiarized with the key concepts, theories, and approaches of *Technology-Enhanced Learning*.

There were created 12 mixed groups of 6-7 students from different countries. Monitoring the group's activity was done by a tutor. Generally, a tutor led two groups of students simultaneously. For communication, between groups and tutors, it was chosen the English language. The main tasks that students had to perform were: the creation of a teaching script, a technical script and the design of a virtual course.

2.1 Pedagogical Script

By carrying out this task, it was aimed to find out the student's opinion on the structure of a virtual course. Through collaborative work, students have developed a teaching script with the following structure:

- Name and scope of the course
- Learning theory
- General description of the course
- Description of the target group
- Pedagogical model
- Tutoring and teacher's behavior
- Evaluation

Depending on convenience, students have created the teaching script on various platforms like: Moodle, Wordpress and Google Docs.

2.2 Technical Script

By running this script, the students have mentioned the resources they need to achieve a virtual course according to the teaching script. Technical script structure was as follows:

- Basic idea of technical implementation of the web course
- Structure of the web environment
- Communication
- Learning materials
- Testing the web environment

Most students believed that the best platforms are the „wiki" type. That is the reason for 7 groups of 12 used this kind of platforms. Free access to the virtual course was important for 9 of 12 groups.

The virtual course must have a communication module, as an important instrument for students.

Moodle platform has been chosen by 3 groups, and the blog type platform by 2 groups. All groups emphasized the easy way of navigation within the course and used a friendly and attractive interface.

3 Results and Discussions

The many possibilities offered by Internet are often mistakenly associated only with recreation, which can often go in waste of time (games, social media, video, music). [2]

The *Designing TEL course* attended by students from different European universities (Romania, Finland and Estonia) has tried to implement a virtual course where teams formed with different ethnic composition were able to face intercultural communication. Each work team was coordinated by a tutor who established tasks for the team members.

Due to the experience gained during this project, students have understood certain aspects of how to implement a virtual course. To attract the interest of students, some issues in this area need to be made clear:

- Free access to information;
- Quality of information;
- Virtual course layout;
- Students cooperation in addressing objectives;
- Communication means

3.1 Free Access to Information

If we talk about a course at a class level, a group of students, from school, university, then it should be noted that a course that can be easily accessed from anywhere without restrictions is preferably to one which is hidden behind some limitations. There can be obstacles such as accessing information by paying money, restriction by IP, password-based login, loading pages with too many ads. These hinder access to information leads to loss of interest from the student. [5]

This has its explanation in classical practice: a website with many restrictions and too many commercial purposes has a less number of visitors compared with a noncommercial or less commercial one.

Let's consider the most important aspect - the financial one or the payment for information. Indeed with the growth of the Internet, there have been many scientific bases with quality content but which ask for money for the information provided. There is nothing illegal and surely they have a pretty big impact on scientific and technological development. But, in terms of education in the society as a whole, these bases have a much less important role compare to some database information such as Wikipedia. [6] Of course, it is not a basis as professional as SpringerLink or Science Direct, but because it provides free access, makes it more accessible to a larger circle of people.

This thing is observable through traffic from Google on two online platforms. Although the scientific basis www.sciencedirect.com has the number of pages indexed in Google, less than about 10 times to wikipedia.org, the number of visitors is less than about 2000 times. These data refer only to traffic from Google.com and do not take into account the number of visitors who access these two databases directly without using any search engine (Fig. 2).

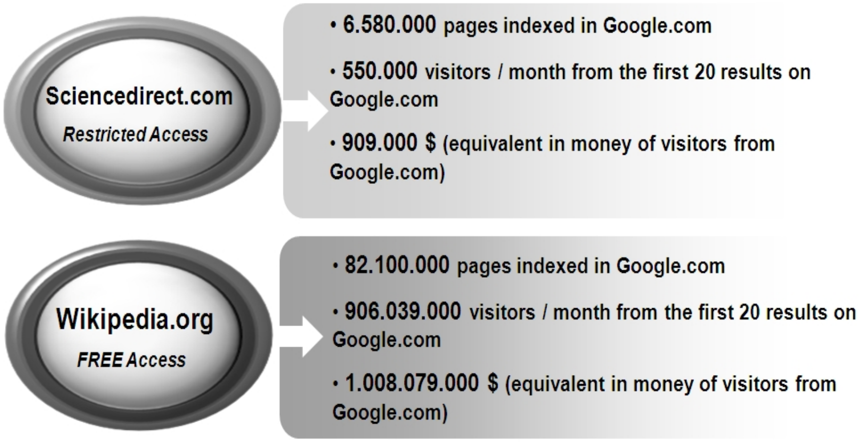

Fig. 2. The difference in traffic between a knowledge base with certain restrictions and an open access one (Data from Semrush.com for April 2012)

The importance of open access virtual courses is very high; such an investment is not only for students of a university but for the entire community. [7]

For all the *Designing TEL course* groups it was important that the course should be accessed from anywhere. 9 groups of 12 said that access to information should be freely without restrictions. Only changing or adding information is based on a login.

3.2 Quality of Information

It is still a contradictory problem related to Internet. Classical libraries acquire information, in general quality information, from different areas, while the Internet has accumulated some of this information, but also a lot of unnecessary and confusing ones. Information on the Internet often is confusing, difficult to access due to various obstacles (banners, advertising, poor website structure) (Fig. 3). [8]

There is another aspect of the problem rather of the virtual course structure. It cannot be made as a book, only with text, images and classic diagrams. It is a need to have other components such as animations, video, mobile charts and so on. If we exaggerate with the latter, we face again a lower quality of virtual course.

Although each group of students has done just an example of virtual course, the quality of those courses remains very important, and that it is easily understood from the materials they used. It is evident that the quality of the information increases the confidence level of the virtual courses.

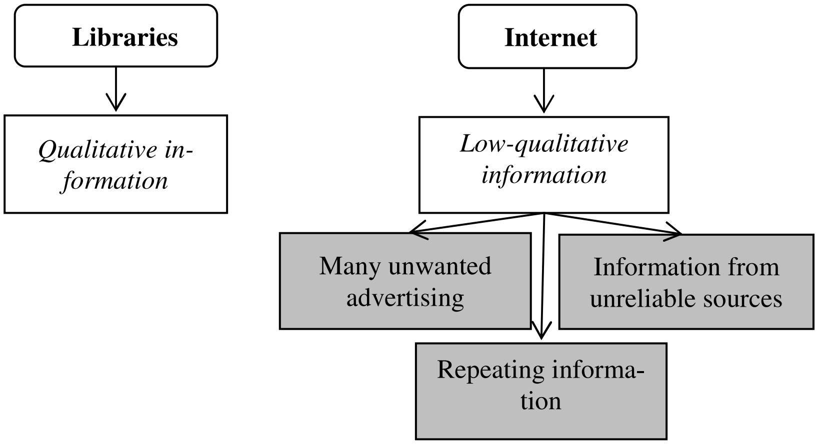

Fig. 3. Key features of the two sources of information: from libraries and from Internet

3.3 The Aspect of the Virtual Course

The competition of Internet websites has led to very attractive designs with which the new courses that have just been implemented cannot compete yet. Often they appear mundane because the author or authors still remained with the concepts of classical teaching that does not have the same effect. An aesthetic virtual course has a great impact on student attention and nice effect rate & quality information leads to better feed-back.

The simplicity and the elegance of the wiki platforms are the strongest points in implementing the virtual courses. Students, generally, are not attracted to complicated interfaces because of the difficulty in navigation.

3.4 Cooperation between Students to Achieve the Objectives

Cooperation between students makes them more interested in the quality of learning. Organization into groups - where each member has something to do -, makes them move faster than when they are working individually. There is a stimulating focus of the students on the course because of their friendly cooperation. Quality increases because cooperative learning is possible depending of what the teacher taught them through interaction with colleagues. The best environment would be a Wiki platform that students are able to operate. Platform may be restricted for the privacy of students and only after the objectives are completed it can appear online to everyone.

3.5 Communication Means

Communication is a matter to which attention should be paid. By example, implementing a virtual course in the UK, noted that students do not leave comments to those courses which normally are classic courses. This phobia was explained by the fact that students did not feel comfortable in their environment. Some students did not want to be the first to comment, others waiting to comment on someone else or they don't have time to do it and so leaving some unresolved targets. [3]

Creating special channels of communication between students and also between students and teacher could solve this problem. The circle shrinks to a family one and so the student finds it easier to communicate. A great success was represented by the Moodle platform in the *Designing TEL* course, even this is used also in several universities in Romania, Finland and Estonia. It had a positive effect on communication between students and in achieving objectives. Similar results were obtained in a project between two universities in Italy and Egypt. [4]

For communication, students prefer asynchronous mode. The fact that they can leave messages or comments at any time makes them more interested in the virtual course. However, the synchronous mode of communication is welcomed as well, especially among students. Cooperation and communication helped the objectives to be made simpler.

4 Conclusions

It is not so easy to change from traditional teaching to virtual courses, but it's time to make this transition. But it is impossible to do this so suddenly, because this is difficult for parts, students and teachers, to formulate a new type of teaching. Gradually, however, education will become more accessible to all people or at least that's how it should be, and the Internet environment will be the key in promoting it.

By reaching the target points mentioned in this paper, it will be easier to organize students in the learning process. Transition must be slow for teachers and students to have time to adjust. Teachers must change their teaching methods by connecting to information technology, and students must indicate how it is easier to assimilate information.

In the *Designing TEL* course, through students' practice, it was understood that a successful virtual course must have a structure similar to a wiki platform, which can be accessed without restrictions. The quality and the appearance of the information's presentation it is also very important. The presence of a communication module facilitates cooperative work for students in groups. All criteria observed on this project represent a very important stage for virtual courses' implementation. The students' perspective on this project will help teachers to create more interesting and explicit courses for them.

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