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KEYNOTE ADDRESS

UNDERSTANDING THE IMPACTS OF DESIGN ON THE USER EXPERIENCE: LESSONS FROM ONLINE SHOPPERS APPLIED TO ELEARNERS

Prof. Dr. Milena Head, DeGroote School of Business, McMaster University, Canada, headm@mcmaster.ca

Dr. Milena Head is a Professor of Information Systems at the DeGroote School of Business, McMaster University (Hamilton, Ontario, Canada). She received her BMath from the University of Waterloo and MBA & Ph.D. from McMaster University. Her research interests include trust, privacy and adoption in electronic commerce, interface design, mobile commerce, identity theft, cross-cultural issues in electronic commerce and human computer interaction, e-retailing, and web navigation. She seeks to answer important questions such as: How do we build trust in a virtual environment? How can the interface be designed to help instill this trust? How do Canadians adapt to and adopt new technologies? How does this differ in cultures from around the world? How does this differ with gender and age? Currently, she is serving as the MBA Director for the DeGroote School of Business.

Abstract

Effective visual design of e-commerce websites enhances website aesthetics and emotional appeal for the user, which can have a dramatic impact on users' engagement and willingness to share their personal information to purchase online.

This talk will summarize the empirical results and implications of a series of recent publications that have outlined how design elements (such as human images, colour and interactivity components) can influence appeal, social presence, trustworthiness and eLoyalty. Differences across cultures will also be explored. While this work is within an e-commerce context, the potential implications of these results for the design of eLearning applications will also be discussed. Additionally, this talk will outline the importance of investigating research questions using multiple, diverse and complementary methodologies of quantitative, qualitative and new neuro-techniques.

E-LEARNING ENVIRONMENTS AS NICHE STRATEGY TO MATCH THE 'DNA' OF A PARTICULAR UNIVERSITY

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Abstract

Currently many eLearning platforms exist that are offered by other universities which are simply deploying eLearning technologies as media streams or online courses. The clear aim of this position paper is to find the essence where diverse universities will be able to compete on the education market in the digital future by reducing teaching costs, finding an innovative model fitting to specific strategies and especially the "DNA" of the university: strategies, industrial collaboration, departments, student needs, and administration. An adaptation of existing solutions shall be avoided to find a particular digital education profile in the field of the university context. Education by extended the existing BSc., MSc. and PhD. studies. The outcome of the presentation shall be: 1) a strategy discussion for the next 5-10 years; 2) presentation of reference pilots of introducing eLearning environments within 3 online courses that were conducted previously; and 3) a presentation of a setup test-platform and curriculum that shall extend courses step-by-step towards a fully new digital eLearning experience.

Keywords: eLearning, university strategies, education, digital universities.

1 Introduction

Currently many eLearning platforms exist that are offered by MIT, Berkeley, or Oxford which are simply deploying eLearning technologies as media streams or online courses. The clear aim of this application is to find the essence where smaller scale universities will be able to compete on the education market in the digital future by reducing teaching costs, finding an innovative model fitting to the university specific strategies and "DNA" of the university: strategies, industrial collaboration, departments, student needs, and administration. The idea that universities have to identify their own "DNA" is based on (Christensen & Eyring 2011). This work describes why certain university models fail, and why some university models succeed by identifying their own way who to cope with the intensified competition of universities. The difference to existing solutions shall be the vision of creating a fresh-innovative-competitive-digital environment to improve the "DNA" of the university rather than simply adapting existing solutions or re-attempting to establish failures of other projects. It aims at a partial transition of university learning environment towards an eLearning environment within a few years' time with a full-scale deployment thereafter. The paper attempts to investigate suitable teaching curricula that shall fit under the larger context and extend the existing media technology and management BSc. It especially shall delivery teaching and studying to BSc., MSc. and PhD studies.

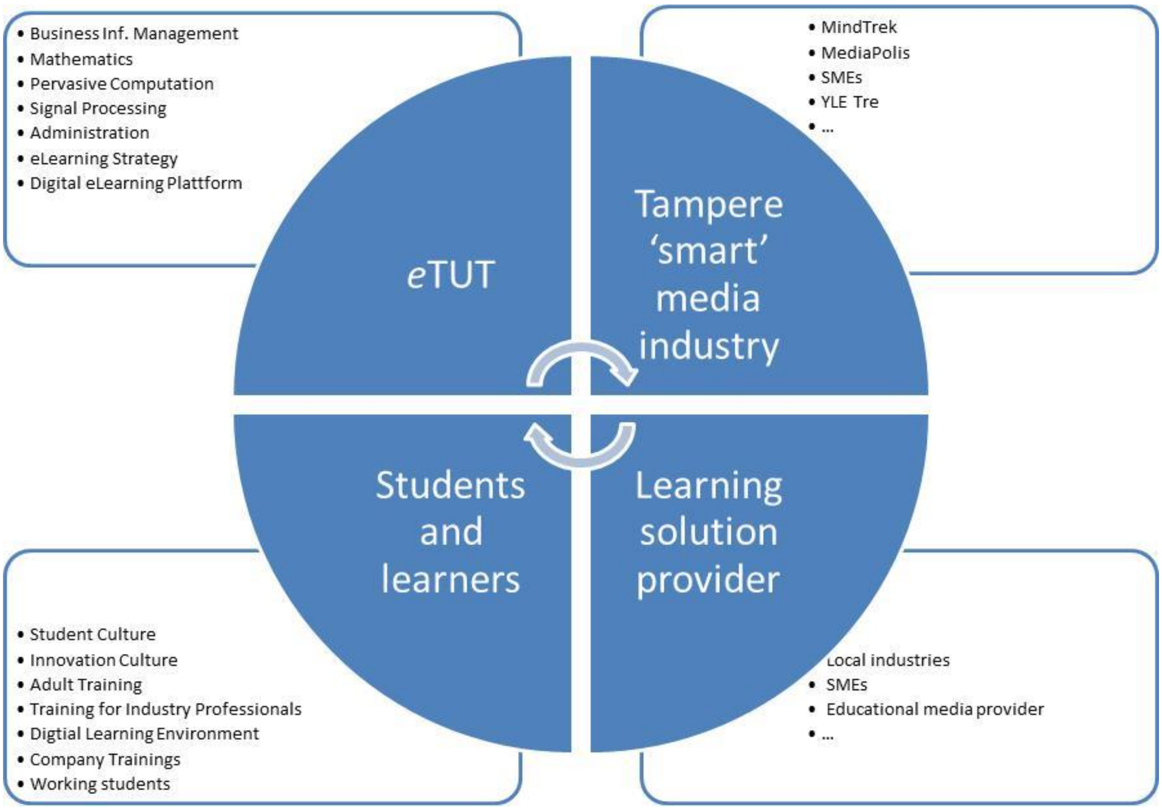

Figure 1. Overview of embedding a university between the local environment, learning solution providers, students, and learners.

Many times media are simply viewed as TV, books, and newspapers – but in the context of this application media are considered as smart digital media environments in contexts. Currently the level of media and multimedia teaching is de-creasing, while digital media in various forms are increasing and require well-educated digital media experts capable of coping with intelligent technologies, management of digital services, and content creation. The aim to present efforts conducted within the NAMU research Lab, and the EMMi Lab. at the Tampere Univ. Of Technology (TUT) to visualize possible efforts in introducing eLearning into media management, hypermedia, and pervasive computation under one umbrella. The presentation of this position paper discussed previous efforts, and how a university could transit towards a digital university on a larger scale.

The advantages of a niche eLearning strategy are manifold: the university as forerunner in utilizing eLearning technologies with a niche strategy to compete with big players; involvement of Finnish SMEs providing eLearning technologies in the planning process; year-around university offerings; keeping the student base steady, rather than a selective process; standardized and modular teaching curriculum; high cost savings (especially by cutting administrative costs); enables education of off-campus students (e.g. employees, PhD students); partially solves the long-term student problematic; integration of distributed campuses and tighter cooperation between universities of offered courses); increased cross-department cooperation; and as well keeping tuition fee 'free' by reducing costs.

Within the scope of this presentation, lessons learned from the following practical lectures using latest eLearning technologies are presented (see references):

- joint virtual lecture over the Internet between Staffordshire University, UK and the Ambient Mobile Multimedia Seminar held at the Tampere University of Technology, Finland;
- cooperation lectures with Magedeburg of Applied Sciences, Germany (incl. student exchange) to demonstrate the use of latest communication technologies, and online course technologies;

- cooperative short movie production with Loyola Marymount University, Los Angeles, USA to demonstrate the ability to introduce collaborative eLearning environments into the creation process of creative art projects;
- establishment of a virtual project office for conducting European wide R&D within the UMEDIA NoE.

The presentation of the position paper shall conclude with a discussion of a project proposal that was submitted to develop eTUT – a strategy towards introducing a large scale eLearning environment at the Tampere Univ. of Technology in Finland.

During the previous years, several experimental settings have be conducted to experiment with new ways of teaching, especially emphasizing new digital technologies, teaching spread across universities worldwide, and the introduction of new didactics. A general overview about the research group activities can be found in (Lugmayr 2012). Learning-by-doing lecturing, as well as the utilization of latest digital motion picture technology has been applied within the scope of a seminar at TUT (Lugmayr et al. 2008). A major integral component in teaching was the introduction of 'Design Thinking' as method for teaching (see (Lugmayr 2011)) either within the scope of local courses, or in cooperation courses with other universities (see (Lugmayr et al. 2011)). One very important key-work in the definition of the "DNA" of the university is (Christensen & Eyring 2011), a work that is advised to be read. In the future, the following book will be published (Lugmayr & Vogel 2014) and act as a reverence work for future scientists in their career building process.

2 European Wide Virtual Project Office – 'Digitally' Managing a Large Scale NoE Partner Network

The NoE "UMEDIA" project proposal has been submitted to the European Union in 2002 under the framework programme 6 for the IST call FP6-2002-IST-1 in the subtheme 2.3.1.8. "Networked Audio-Visual Systems and Home Platforms". The total project volume was approx. 9M Euros. The project proposal has been hosted by the *Digital Media Institute (DMI)* directed by Prof. Dr. Hannu Esoka at the Tampere University of Technology (TUT). The project clustered more than 80 partners (45 academic partners, 30 industrial partners, with a SME rate of 30%) and ranged over 19 nations worldwide, and included over 100 researchers (with over 80 registered PhD students. To cope with the challenges of such a large scale project, it was organized in an onion skin structure, where 10 core partners are responsible for the general project policies, and the core network included 40-60 researcher. Besides the scientific challenges of the project, the project developed a model that should act as reference model for the integration of fragmented R&D in Europe to obtain one excellent 'virtual' research laboratory. The challenges to develop the virtual research laboratory were tremendous, and included: creation of an organizational and management model, introducing a quality and excellence control mechanism, modelling of processes to integrate common research actions, guaranteeing socio-economic and political impact, and pioneering the way how integrated research is conducted to build the *European Research Agenda (ERA).*

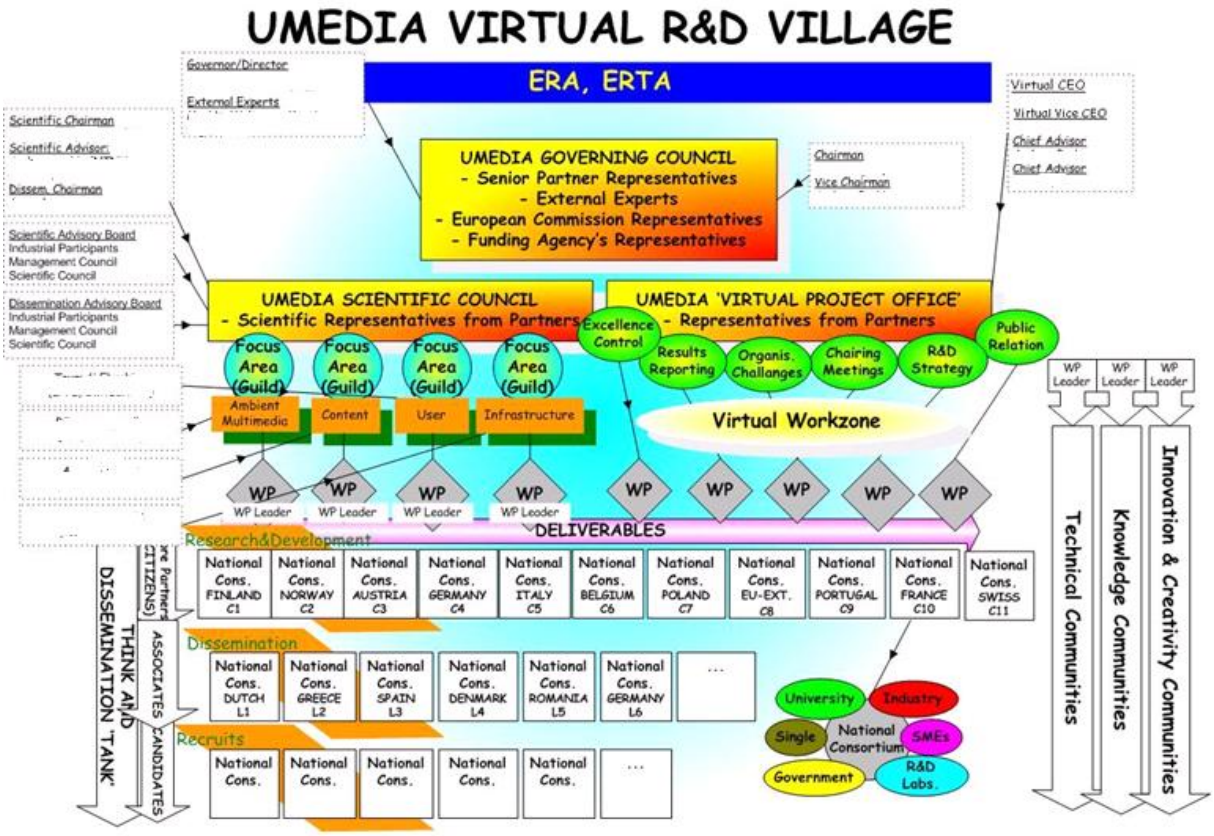

Figure 2. UMEDIA Virtual Organization Model including the Virtual Project Office

The network gathered all leading partners who played a major role in the development of media technologies, and ought to pioneer the reference strategy for the creation of a European wide integrated R&D network. On scientific level, the aim was to develop the notion of ambient media, which is currently publicised under ubiquitous computation, pervasive computation, or smart media (see e.g. (Lugmayr et al. 2013)). The aim was to protect European wide leadership in science, technology, and the commercialisation of its results in this research domain. The tight integration of existing test-beds, pilot demonstrations, and continuous creation of project spin-offs should guarantee the establishment of an international recognized concept enabling the provision of a public available knowledge pool in the wider field of media. To achieve this goal, the UMEDIA model included the following key-issues:

- *virtual UMEDIA organization:* the core solution to cope with the challenges of European wide distributed research work was the establishment of a virtual organization model, that also included a virtual project office (see Figure 2);
- *evolving excellent and strong R&D management model:* development of a management model capable of leading a large-scale consortium spread over the world to maintain the policy goals of the EU given be the Lisbon treaty, and ERA;
- *partner integration models:* integration of activities related to R&D, such as teaching, research work, networking, standardization activities, existing partner networks, and common dissemination of results;
- *thematic integration of multidisciplinary partner:* integration of inter-disciplinary partners by focus areas concentrating on different scientific perspectives (content, user, infrastructure, and technology);

- *cost-function for qualitatively measuring EU wide R&D 'de-fragmentation':* development of the UMDIA 'de-fragmentation algorithm' as quantitative measurement of integration efforts, as well as actions to outside the network (e.g. for dissemination);
- *cross-linkage of several stakeholders:* linkage of several stakeholders, in particular research institution, industry, national policies, European Commission, and standardization bodies;
- *introduction of a bonus system for performers:* to evaluate performance of partners and UMEDIA in total, a point system was developed that has been adopted from the Finnish university funding to measure and reward successful integration actions;
- *integration of large scale industries and SMEs:* maintaining tight links to national industries and SMEs to allow an active commercialization of research results;
- *maintaining the leadership function with committed excellent researchers:* development of excellence criteria and a quality control to keep the network as a world leading knowledge platform for ambient media;
- *creation of a sustainable super-network of networks:* financial sustainability through high industrial participation, subscription based services for industry/the public, public funding from national funding bodies, and continuous fund raising beyond the project duration;

The virtual UMEDIA office already pioneered many currently emerging living laboratories, innovation centres, or other virtual cross-border research networks. It provided a common technology infrastructure and piloting infrastructure to partners. The hierarchical organizational model was in principle divided into two components: the UMEDIA scientific council responsible for leading research activities; and the UMEDIA virtual project office providing the administrative support for the network. The aim was to strictly separate R&D integration and administrative tasks. R&D was considered to be border free, and only limited national cooperation was allowed as part of the research agreement. The division into national consortia related solely to the administrative processes and tasks. Thus national consortia were only administrative units due to national characteristics in applying for funding, country specific laws, SME strategies, and the optimal dissemination of results. The virtual UMEDIA office followed common international practises as demonstrated by ISO, ETSI, W3C or MPEG. To ease commercialization efforts this division allowed to threshold easy manageability and a more flexible partner structure towards future integration efforts. It also provided the advantage, that particular research results commercialization and dissemination cold optimally be adapted to national characteristics.

On the other hand, the separation allowed a worldwide integration of a network of researches through focus areas. Each focus area thematically clustered researchers and allowed the organization of particular research actions within work packages. Additional features particularly relevant for the integration of research work included the creation of knowledge communities, where work-package leaders were provided with an additional instrument to take actions. At the stage of the proposal a particular focus was on the creation of innovation & creativity communities to allow the emergence of new products and their commercialisation.

3 Worldwide Inter-University Cooperation to Supporting Common Teaching and Lectures

Within the scope of this chapter, a few successful and unsuccessful settings for online teaching are discussed. Each of the cases is examined according used teaching modality, technology, and didactic aspects. Let's begin by examining the unsuccessful cases. In 2005 we arranged a joint virtual lecture of the Interent between Staffordshire University and the NAMU (New Ambient MUltimedia Lab.) at the Tampere Univ. of Technology (TUT). The goal was to train students in digital culture, have common online discussions, go through online publications, and conduct common assignments. From the technology perspective, the course was very well equipped: online platform, online discussion forum, assignment submission system, and online lectures. The course was conducted, but did not achieve the goals that we set at the beginning. It was rather tricky to integrate students and allow an efficient virtual communication via our online platform with each other. The main identified reason were the different teaching modalities at the universities. Engineering students at TUT were used to a lecture based approach, where they had to do assignments in addition in their spare time. The different teaching modalities were rather conflicting, and it was extremely tricky to motivate students to have common lectures to discuss with their peers at the partner university. One major drawback of how we arranged the lectures was the lack of face-to-face meetings, which was tricky considering the lack of travel budget for the lectures. The main 'lecture' was to be learned for teaching staff: without face-to-face meetings, and the integration of courses with fully different teaching modalities is rather tricky. There needs to be much more emphasis on integrating the modality of courses beforehand and to apply other methods for teaching than we did. The selection of methods should enable a better integration of students to achieve more online discussions and better collaboration.

A more successful cooperation took place in the year 2012, where we conducted a cooperation lecture between the Magdeburg University of Applied Sciences, Germany. The goal of the lecture was to apply the method 'Design Thinking' to develop media products of the future. To avoid a lack of student integration, we arranged face-to-face lectures with additional remote lectures that took place before and after the student exchange. The face-to-face lectures before the exchange helped to integrate students and initiated group collaborations. During the course that took place in a face-to-face setting, students worked on the practical works that are typical for 'Design Thinking'. Thus students evaluated the end-users, developed ideas of possible practical solutions, and implemented rapid prototypes to test these. By having a week available, where students worked on a face-to-face basis together, we avoided that students don't get well integrated beyond the face-to-face lectures. From the technology side, we utilized email lists, online web-portal, Moodle, Google documents, Skype, and Dropbox. These technologies were rather sufficient to support common student activities. Nevertheless, due to the different course schedules at both universities, after face-to-face lectures common activities were rather tricky to arrange.

Another cooperation between the Loyola Marymount University, Los Angeles, USA and TUT was attempted in the year 2008. The aim of the course was to have a common lecture between engineering students, and film students. The idea of the lecture was to create a High-Definition (HD) movie in front of blue-screen. Each team of student was responsible for giving an interview about the other location in front of a blue-screen. Backgrounds where exchanged between students, and edited together. The lecture was very well planned, and we were able to create the final film-material. From the technology side, we utilized the simplest solutions for communication (Skype) and FTP for file-exchanges. This provided to be sufficient for the scope of this way of teaching. We also planned the student tasks very careful beforehand, and that these can be separated carefully.

4 Discussion & Conclusions

As concluded in (Lugmayr 2012; Lugmayr n.d.), the most significant issues in the process of establishing a creative research laboratory are:

- motivation of students by introducing new lectures, projects, and courses fostering creative thinking;
- creating multi-disciplinary teams, and offering cross-disciplinary approaches to allow new pathways in media education and the development of new ideas;
- creating a concise vision for motivating students to develop ideas beyond the state of the art as main motivation factor;
- continuous re-invention of methods, teaching curricula, and project themes to motivate students;
- student driven – bottom up methods of teaching to enable self-innovation and letting students work on own ideas;

- multidisciplinary education of the principal investigator to be able to create the right mode for interdisciplinary discussions, and communications;
- strong marketing, branding, and clear setting of the common vision to create a feeling that ideas will have impact;
- user experience, technology, and content creation as triangle especially suited in the field of media education;
- virtual cooperation platform as the basis of location dispersed teaching and learning and active use of latest IT infrastructure;
- involvement of team members at an early stage of studies, to enable them higher level activities such as conference organization, common research group tasks, organizational tasks, and funding applications;
- teaching as a matter of motivation, rather than simply gathering credit points or good results to keep the innovative spirit;
- consistent vision and strategy towards the creation of new knowledge and scientific pathways and outcomes;

This position paper shall identify possible directions to establish eLearning environments in a larger context, pinpoint to possible implementation pitfalls, and identify the key-issues of creating a virtual campus. In fall 2013, EMMi Lab. will start a trail in educating PhD students via an online platform to allow teaching via distance, and provide students with the possibility to do their studies within the scope of their professional work. As far the following key-issues can be identified:

- virtual cooperation platform as the base platform for location dispersed teaching and learning, which should include: video platform of lectures, assignments collection, forum to discuss between students, repository for background literature, communication between student and teacher;
- selection of suitable methods to remotely work on common publications, experiments, and enable discussions between student colleagues;
- providing the students the possibility to remotely manage administrative and organizational tasks such as record management, yearly subscription, course signups, and access to IT infrastructure;
- tightly embedding of activities into the university eco-system, including its innovation environment, local initiatives, existing infrastructure, and local service providers;
- the university as environment has to provide basic infrastructure such as eLearning tools (e.g. Moodle, online webhotels, administrative tools, document repositories and discussion forums) to allow a single research group to easily setup new activities;
- development of university fitting strategies that are capable of serving local industry and stakeholders as a resource for knowledge, applied research, and scientific results;
- cost savings through the introduction of new technologies by cutting e.g. administrative costs through standardized and modular curricula supported by online teaching platform;
- investigation of the university's own "DNA" to create a novel approach towards eLearning fitting to students' cultural aspects, optimal information systems, investigation of financial savings, modularization of curricula, avoidance of the adaptation of existing models to create a niche profile, and their suitability for eLearning;
- smaller scale tests of an eLearning platform to allow experimentation and fast adoption of new strategies;
- development of a new curricula suitable to cope with the latest challenges and educational needs across platforms and in cooperation with students, industry, and other local stakeholders.

Currently the development of the online platform is still under progress, and will be only tested in a small scale with PhD students. It's understandable, that many obstacles and pitfalls are not considered yet and will need to be resolved during the process of establishing the virtual laboratory.

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EFFECTIVENESS OF NOTE-TAKING SKILLS AND STUDENT'S CHARACTERISTICS ON LEARNING PERFORMANCE IN ONLINE COURSES

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Abstract

Note-taking activity was introduced into two types of university courses, a blended learning course and a fully online course, and causal relationships between student's characteristics such as note-taking behaviour and learning performance were analysed. The objective was to improve learning activities in the online learning environment. Metrics such as personality, information literacy and note-taking skills have been commonly surveyed and analysed in courses such as the above. The differences between causal paths in the two courses were measured using the structural equation modelling technique. The contributions of all metrics to test scores were surveyed and analysed, and the factors which were significant were extracted.

Keywords: Online course, Note-taking, Student characteristics, Structural Equation Modelling.

1 Introduction

Recently many universities have employed the online learning environment to promote learning flexibility and effectiveness. This study evaluates the note-taking behaviour of participants in online courses to measure the effectiveness of the courses and to develop methods to assist participants (Nakayama et al. 2010, 2011b, 2012a, 2012b).

Note-taking is a key activity for various types of learning, including online courses. The contents of notes taken indicate the learning progress of participants (Kiewra, 1985, 1989, Kiewra et al. 1995). The causal relationships between participants' characteristics, note-taking behaviour and learning performance have been analyzed in prior research (Nakayama et al. 2011b, 2012a, 2012c).

Surveys for blended learning course and fully online course have been conducted, and the impact of the two learning environments on learning behaviour has also already been analysed (Nakayama et al. 2011b, 2012a). These results may suggest that the improvement of courses and the development of a support system for participants is necessary.

To extract factors which have a common level of effectiveness between two courses, or are effective in one of the two, the relationships between note-taking, participants characteristics and learning performance were examined. Factors for note-taking skills were identified using the responses to two sets of questionnaire, and the relationships between these characteristics, based on the factors and performance in tests, were examined.

The following topics are addressed in this paper.

- The structure of factors of note taking skills are examined using two sets of responses, and factors common to blended and fully online courses are extracted.

- The note-taking behaviour and characteristics of participants are compared between the two courses.

- The causal relationships between participant's characteristics and learning achievement are measured and compared between the two courses.

2 Method

2.1 Courses

2.1.1 Blended learning course

A blended learning course was conducted using a distance education system with ordinary face-to-face classroom sessions (Nakayama et al. 2010). All participants were able to use online tests used as part of the learning management system (LMS) of the course. Participants were encouraged to take online tests, and they could take tests repeatedly until they were satisfied with their scores. The LMS recorded the scores of the final test, and these test scores were used in calculating overall course grades.

The total number of valid participants in the course was 40.

2.1.2 Fully online learning course

Students studied using online material which consisted of slides and oral explanations of the content. The presentation slides presented the content together with audio files automatically, as this simulated face-to-face sessions. Participants were asked to study one module per week, and weekly proctored confirmation tests were conducted. The lecturer could set participants' pace of study and monitor their progress. Also, participants were encouraged to take regular online tests to benchmark their progress (Nakayama et al. 2011b, 2012a).

The total numbers of valid participants in the fully online course was 53.

2.2 Note-taking assessment

All participants in both courses were required to present their notebooks during most modules. The lecturer assessed these individual notes every week. The references for the evaluations were the notes of the lecturer, which contained fundamental information used in the lecturer's presentations and slides. The notes were evaluated using a set scale (Nakayama et al. 2010, 2011a), and assessed as Good, Fair or Poor and recorded every week.

2.3 Characteristics of participants

The indices related to participant's characteristic have been previously surveyed using existing constructs (Nakayama et al, 2007, 2008). These constructs are Personality (Goldberg 1999; IPIP 2004), Information Literacy (Fujii 2007) and a degree of Learning Experience (Nakayama et al. 2007).

These metrics were calculated as factor scores from participants' responses to questionnaires, using the factor loading metrices.

Personality:

The personalities of participants were measured using a public domain item pool, the International Personality Item Pool (IPIP) inventory (IPIP 2004). This inventory is based on a five factor model which was proposed by Goldberg (Goldberg 1999), consisting of ``Extroversion" (IPIP-1), ``Agreeableness" (IPIP-2), ``Conscientiousness" (IPIP-3), ``Neuroticism" (IPIP-4) and ``Openness to Experience" (IPIP-5).

Information Literacy:

The survey inventories were originally developed by Fujii (2007). The survey construct consisted of 32 question items, and 8 factors were extracted, as follows: interest and motivation, fundamental operational ability, information collecting ability, mathematical thinking (reasoning) ability, information control ability, applied operational ability, attitude, and knowledge and understanding. These 8 factors can be summarized as two secondary factors: operational skills (IL-1) and attitudes toward information literacy (IL-2) (Nakayama et al. 2008).

Learning experience:

A construct consists of a 10-item Likert-type questionnaire was used to measure learning experience. Three factors were extracted, as follows: Factor 1 (LE-F1) -overall evaluation of the e-learning experience, Factor 2 (LE-F2) -learning habits, and Factor 3 (LE-F3) -learning strategies (Nakayama et al. 2007).

2.4 Survey of note-taking skills

Note-taking skills may affect learning achievement (Nye et al. 1984). To evaluate the note-taking skills of participants, a set of survey questionnaires was developed using a Likert scale (Nakayama et al. 2011). Three factors were extracted, as follows: NT-F1 -Recognizing note taking functions, NT-F2 -Methodology of utilizing notes, NT-F3 -Presentation of notes. This construct is often used to survey note-taking skills with minor revisions (Nakayama et al. 2011, 2012a, 2012c). The details of the question items will be explained in the results.

2.5 Procedure for Causal analysis

Causal analysis was applied to a set of metrics extracted from the fully online course. The causal relationship model was designed as a structure where learning performance is affected by participants' characteristics and note-taking behaviour (Nakayama et al. 2011b, 2012a). The model was developed step by step. Two subset models were created using the two sets of data from the courses. The first subset model was of characteristics and note-taking behaviour, and the second subset model was of the relationship between note-taking skills, learning experience and test scores. Finally, a unified model was created using the two subset models, and the causal relationships of metrics were examined. The calculations were conducted using AMOS structural equation modelling software (Toyoda, 2007; Kline, 2005).

3 Results

3.1 Note-taking assessment

The results of note-taking assessment surveys are summarized in Figure 1(a) for the blended learning course and 1(b) for the fully online course. The percentages of note assessment levels are illustrated across the weeks of the course. Though the frequencies of the assessment levels are almost the same for the two courses, the balance between the "Good" and "Fair" percentages varies slightly. The percentage of "Good" is the highest in the blended learning course, while the percentage of "Fair" is the highest in the fully online course, as most participants have reproduced the presented content in their notes. When mathematical equations were explained, the difference in frequencies was relatively small. These tendencies were confirmed in a previous report about surveys of both types of courses (Nakayama et al. 2011a, 2012b).

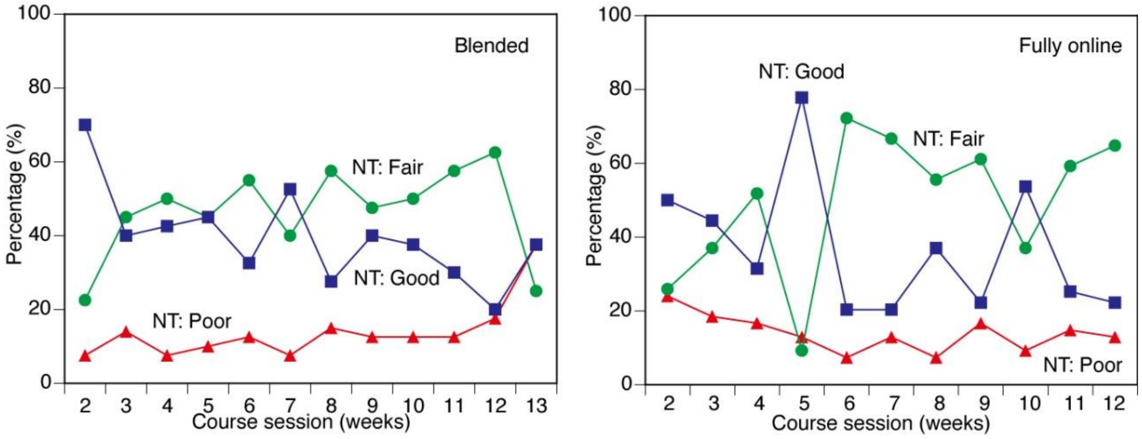

Figure 1: Grade percentages of note-taking assessments in (a) a Blended course (Nakayama et al, 2010), (b) a Fully online course (Nakayama et al. 2011b)

Overall scores of weekly ratings of notes was calculated for each student and course. The overall scores were used to divide participants into two groups consisting of high (High) or low (Low) levels of note-taking assessment.

3.2 Factor structure of Note-taking skills

The factor structure was extracted from the survey data for the fully online course (Nakayama et al. 2011b, 2012a). The survey data for the blended course was merged with it and an exploratory factor analysis was conducted again using Promax rotation. The factor loading matrix for 17 question items is summarized in Table 1 (Nakayama et al. 2012c). Three question items from the two courses were excluded, when being compared to the previous results for the fully online course.

The results again show the three factor structure, such as NT-F1 -Recognizing note taking functions, NT-F2 -Methodology of utilizing notes, NT-F3 -Presentation of notes. There is some correlation among factors since the structure was derived using Promax rotation.

Table 1: Questionnaire for note-taking skills and factor loading (Nakayama et al. 2012c)

No.	Question item	F1	F2	F3
1	I understand the syllabus summary of this course	0.55	-0.09	0.00
2	NT during sessions to understand the course contents	0.79	-0.05	0.02
3	NT during sessions to clarify the contents	0.73	-0.04	0.09
4	NT during sessions to review the contents later	0.53	-0.01	0.02
5	NT is for understanding the whole course not only the session topics	0.81	-0.12	0.00
6	I understand well the contents of items in my NT	0.54	0.11	0.08
7	NT consists of what teacher presented and talked about	0.61	0.17	-0.17
8	I think about the meaning and importance of words during NT	0.58	0.18	0.07
9	I think about the relationship between items presented during NT	0.57	0.24	-0.06
10	I use NT to revise the notes taken after the session	-0.04	0.91	0.00
11	I use NT to write some additional information in the notes taken	-0.05	0.91	0.00
12	I think about relationships between the content of the notes taken	0.14	0.80	-0.02
13	Notes of surveyed contents are added to notes taken	0.02	0.59	0.18
14	Notes are taken so that other participants can understand the contents	0.13	-0.11	0.70
15	Notes are taken so that even non-participants can understand the contents	-0.01	-0.03	0.79
16	Classmates are considered when notes are taken	-0.06	0.15	0.67
17	I have NT skills	-0.05	0.20	0.55
	F1: Recognizing note taking functions	1.00		
	F2: Methodology of utilizing notes	0.40	1.00	
	F3: Presentation of notes	0.22	0.31	1.00
	Contribution ratio	0.25	0.20	0.14
	NT: Note-taking			

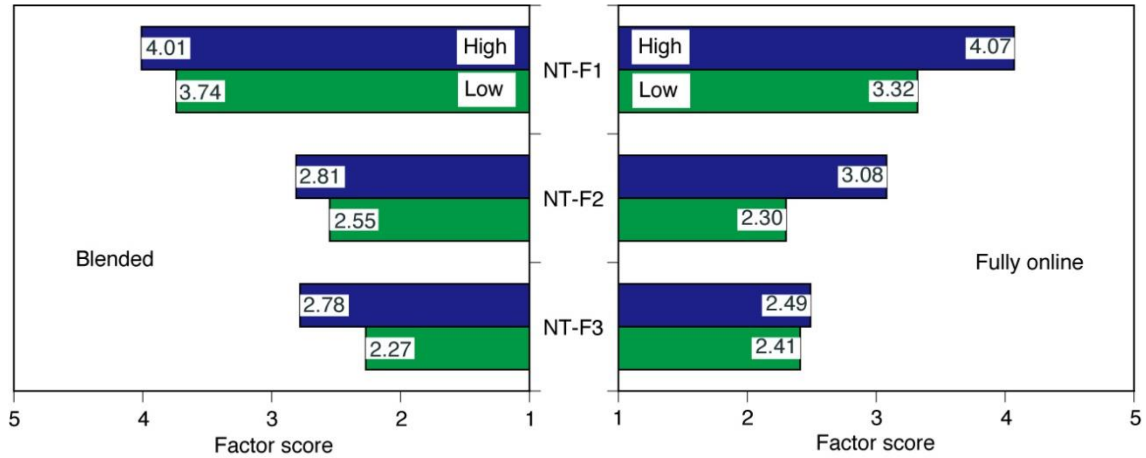

Figure 2: Factor scores of note-taking skills between two note-taking assessment groups in both Blended and Fully online courses. (Nakayama et al. 2012c)

3.3 Effectiveness of learning styles and note-taking assessments

Three factor scores were calculated as a mean of the major contributing responses for each factor using the factor loading matrix as mentioned above. The factor scores are compared between high and low groups of note-taking assessment in the two courses. The results are summarized in Figure 2; the left side shows the blended course and the right side shows the fully online course. The means of first factor score (NT-F1) are higher than the median in both note-taking groups. According to Figure 2, there are some differences in factor scores. To determine the effectiveness of the courses and note-taking assessment groups, two-way ANOVA (analysis of variance) was conducted. The first factor is the course and the second factor is the group of note-taking assessments. In the results of the F-test for the first factor (NT-F1), the factor of the group is significant (p<0.01) while the factor of the course is not significant.

For all variables of constructs, the same analysis was conducted. As a result, similar statistical effects such as the significance of the factor of the group (whether High or Low) was confirmed for the following variables: IPIP-3 (Conscientiousness), Information Literacy (IL-2: attitude), Note-taking skills (NT-F2: Methodology of utilizing notes), Learning Experience (LE-F2: Learning Habits), Online test scores, and Final exam scores (Nakayama et al. 2012a). These results suggest that most constructs were not influenced by course factors, i.e. whether blended learning or fully online, but the factor of the group was affected by the differences in the scores of the constructs.

Table 2: ANOVA of note-taking factor 1 (NT-F1: Recognising note taking functions)

	df	SS	Mean Square	F	
High-Low group	1	5.90	5.90	13.6	p<0.01
Blended / Fully online	1	0.73	0.73	1.7	
Interaction	1	1.29	1.29	3	p<0.10
Error	89	38.55	0.43		

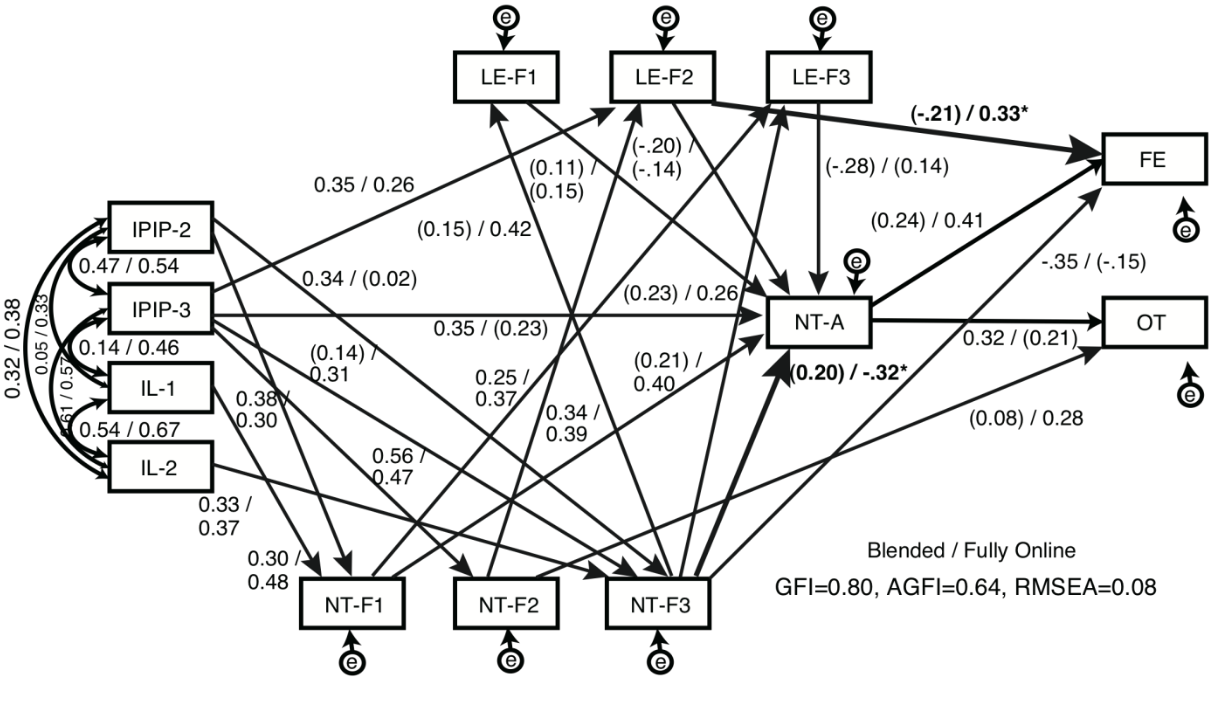

Figure 3: Results of causal path analysis using both Blended and Fully online courses.

3.4 Causal analysis of note-taking activity between blended and fully Online courses

The correlation analysis was conducted on the metrics for the above mentioned metrics, and some causal relationships were created step by step.

Causal paths for all metrics, and two subsets of causal relationships were created. The first one indicates the causal paths from participant's characteristics and note-taking skill factors and assessments (Nakayama et al. 2012c). The second one was created from factors of note-taking skills (NT-F) to note-taking assessment (NT-A) and test scores (OT: Online test, FE: Final exams) (Nakayama et al. 2012c).

According to the results of causal relationships such as subset analyses, the overall relationship was created using all metrics. Figure 3 shows the results, which are illustrated using major indices. Though the contributions of factors for learning experiences are relatively small, their effects are displayed in the figure in order to display their contribution clearly. According to the calculation, some significant paths were created with the causal coefficients. In Figure 3, coefficients which are not significant are indicated using (). This figure suggests that some factors of personality and information literacy scores affect learning experience, note assessment and test scores via factors of note-taking skills.

In comparing path coefficients between two the courses, there are significant differences in the paths from NT-F3 (Presentation of notes) to NT-A (note-taking assessment), which is mentioned above, and also significant differences in one path from LE-F2 (Learning habits) to FE (Final exams) ($p<0.05$). For the fully online course, these path coefficients are significant, and relationships are clearly recognisable, such as the relationship between learning habits and final exam scores, and the negative relationship between note presentation skills and note assessments.

These results can provide limited information, thus some ideas for improving learning are possible. Inspiring participant's consciousness of note-taking skills by taking into account the question items in Table 1 is one example. If these instructions improved the factor scores of learning habits, the scores of the final exams may be affected positively. In particular, the effectiveness of this may be expected in a fully online course, since some path coefficients from note-taking skills to both note-taking assessment and test scores are significant. As various factors such as work collaborations between students affect learning performance in a blended learning, most variables do not contribute significantly to other variables. However the participants have to encourage themselves to learn in a fully online course, as some factor scores of note-taking skills and the learning experience contribute significantly. The differences in factors contribution are confirmed between the two courses.

Table 3: Results of ANOVA for scores of both online tests and final exams.

	Online test			Final exams		
	Factor	BL / FO	Interaction	Factor	BL / FO	Interaction
IPIP-1	0.32	0.02	0.80	4.14*	0.02	0.01
IPIP-2	3.54	0.17	0.38	2.50	0.06	2.72
IPIP-3	1.77	0.14	0.21	0.67	0.00	0.86
IPIP-4	1.92	0.02	0.77	0.06	0.05	5.63
IPIP-5	0.89	0.04	0.15	0.07	0.00	0.18
IL-F	0.00	0.08	2.85	0.57	0.00	2.12
IL-S	2.73	0.28	1.27	0.27	0.00	4.51*
NT-F1	2.72	0.15	0.01	1.47	0.01	0.37
NT-F2	6.69*	0.03	0.06	0.16	0.01	2.83
NT-F3	4.23*	0.14	0.05	0.69	0.00	2.06
LE-F1	1.02	0.03	0.35	3.09	0.03	1.08
LE-F2	1.22	0.07	0.10	0.11	0.13	4.05*
LE-F3	0.55	0.10	0.01	0.97	0.00	8.80**
NT-A	6.84*	0.02	0.83	6.27	0.08	3.62
**: p<0.01, *:p<0.05						

The above mentioned results suggest that scores of the final exams are not only affected by note-taking assessments but by various factors such as learning habits. To extract these factors, analysis of variance (ANOVA) for the scores of online tests and final exams was conducted using factors such as the two groups of the metrics and the two courses. Two groups (high and low) were created for all metrics using the means of scores as well as the means of the note-taking assessment groups. The analytical procedure is similar to the analysis used in Table 3.

The results of the F values for scores of online tests and final exams are summarized in Table 5. The factors are two groups of metrics, the two courses and the interactions between the two factors. In evaluating the significance of the main effect, two of the three factors for note-taking skills and note-taking assessment are above the level of significance for online tests. For final exams, only extroversion (IPIP-1) and note-taking assessment are significant. The factors for the two courses are not significant for any of the metrics, and the interaction factor is significant for some metrics regarding information literacy and learning experience. Therefore, as these metrics may also affect learning performance in some way, they have to be considered when developing and introducing an online learning course.

The statistical analysis shows that all factor scores affect test scores, online test scores and final exams. Once again, note-taking assessment groups significantly affect test scores of both types of exams. Therefore, note-taking directly provides learning benefits in the both tests. These points should be taught to all participants, in order to improve their education.

4 Conclusion

To determine the causal relationships regarding note-taking behaviour between student's characteristics and learning performance for both blended and fully online courses, some common metrics in the two courses were surveyed and analysed. All participants were required to submit their notes in order to evaluate note-taking activity.

According to the results of the analysis, a common factor structure in note-taking skills between the two online learning environments was confirmed. The causal relationships between various metrics of student's characteristics and their performance were examined. These results suggest that most metrics affect each other, and affect the test scores. There are some differences in path coefficients between the two courses. The contributions of all metrics to test scores were evaluated through analysis, and significant factors were extracted.

The improvement or enhancement of these factors may contribute to learning performance in both leaning environments. This will be a subject of our further study.

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SIMPLE MEASURES TO ENCOURAGE MORE NOTE-TAKING IN THE ERA OF ELECTRONIC NOTEBOOKS AND THEIR EVALUATIONS

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Abstract

It is important to have students take notes so as to increase their concentration. We examined how students take notes by providing paper notebooks and PC notebooks, each of which are provided with a fill-in-blanks section and a free writing section. The results show that, 93.9% of the fill-in-blanks areas of paper and PC notebooks were written, while only 14.0% of the free writing areas were. In test results, questions related to the "fill-in-blanks" area resulted in significantly higher scores than those related to the free-writing area. Further, comparisons between the paper and PC notebook users showed that the PC notebook users earned higher scores on the questions related to free-writing section.

Keywords: Electronic Notebooks, Electronic Textbooks, Measure of Note-Taking, Fill-in-Blank section, Free Writing section, Evaluation of Learning.

1 Introduction

DiTT (Association of Digital Textbook & Teaching 2012) has proposed to the Japanese government the distribution of electronic notebooks and electronic textbooks to 10 million elementary and junior high school students around the country in three years. The plan calls for distribution to 30 thousand schools with 670 thousand teachers using the devices. The electronic notebooks and electronic textbooks have numerous merits and compared with traditional paper notebooks and textbooks they also have a wider variety of applications, however, if used improperly they can also become a bad influence on the students. Simple and easy ways to use the devices for effective learning must be compellingly presented, even to those teachers with limited or no computer skills or experience.

There have been some studies analyzing the relationship between the amounts of notes students take in class and their post test scores. They concluded that there is a strong correlation between them (Kishi, Thukada and Nojima 2004). Also, several studies examined the effect of free note-taking on reading comprehension skills. They also indicated that free note-taking has a positive impact on grades (Nozaki et al. 2005). However, there is no research that suggests how students could be motivated to take more notes. On the other hand, about the effect of the acquirement of knowledge by the note-taking, the coherent knowledge was not provided (Hartley and Davies 1978), (Hartley 1983).

The use of a projector with computer, instead of writing on the blackboard, is effective in speeding up lectures, but students become passive in class and take fewer notes compared with the use of blackboard. To compensate for this effect, we made an arrangement to give repeated tests outside class. As a result, the increased number of tests improved students' grades (Yamamoto, Nakayama and Shimizu 2012). This, however, does not mean that students are more focused during the class.

In the mean time, some studies have evaluated the effects of different input mediums in e-learning, such as pen- tablet and paper, key boards and tablet PCs, on memory retention and understanding. The analyses performed from different viewpoints indicated that tablet PCs are the most effective (Ando and Ueno 2011). Moreover there are many studies about note-taking (Nakayama, Mutsuura, and Yamamoto, 2010), (Weener, 1974), (Kiewra, 1989), (Trafton and Trickett 2001), (Nakayama, Mutsuura, and Yamamoto, 2011).

This study compares fill-in-blanks style writing (herein after called "fill-in") and free-style writing (herein after called "free"), as a simple and practical note-taking method, based on an experiment described later. Analyses were done on the amount of writing and test scores. Moreover we examined whether or not there were any difference between the note-taking mediums(paper notebook and PC notebook, i.e. writing software installed in personal computers) in terms of their effect on the test scores.

We divided students into two classes, class A and class B. And we gave two sequential lectures on career planning to each class. Both first and second lectures of 110 minute each were given at one o'clock in the afternoon. Although 10- minute break was given, this is the time period when students are expected to lose concentration. The summary of the results are presented below.

1. The amount of writing in the "fill-in" section was 6.7 times that in the "free" section.
2. The test score of "fill-in" section were 1.6 times higher than that of the "free" section.
3. The use of PC notebooks led to higher test scores than that of paper notebooks.

"Fill-in" is obviously a simple note-taking method, but the significance of this study is that it quantitatively verified it by conducting an actual classroom experiment. We also believe that the "fill-in" method is useful for formative evaluation since it provides instructors with immediate feedback.

2 Method

In the experiment, 121 freshmen of a vocational school were given a lecture on career planning once a week. All students but 16 in one department owned a personal computer, and therefore most students had no problem using a PC as a note-taking tool. The Table 1 shows details of the classroom experiment.

Round of Lecture	Class (day of the week)	Media of note		Contents	notes) Number of Questions (full marks)
		Paper(learners)	PC(learners)		
First	A (Mon.)	Paper(66) (fill in)＋**free**		For 1round	[5]＋**5** (20marks)
	B (Thur.)		PC(48) **free**＋(fill in)		**5**＋[5](20marks)
Second (next week)	A (Mon.)	Paper(16) (fill in)＋**free**	PC(47) (fill in)＋**free**	For 2round	[10]＋**10**(20marks)
	B (Thur.)	Paper(54) **free**＋(fill in)			**10**＋[10](20marks)

Note) on the test sheets, [Numbers] indicates the number of questions related to “fill-in” note-taking, and **Numbers** indicates the number of questions related to “free” note-taking.

Table 2. Details of the classroom experiment

Two lectures on “Useful hints when charring out service-related operations” as part of a career planning were given over two weeks. In this experiment, students were grouped into Class A and Class B. Class A comprises 67 students from the Hotel Course, Office Business Course, Patisserie Course and Animal Health Technician Course, while Class B comprises 54 students from Creative Design Course, Total Beauty Course and Pet life Care Course. The lectures were administered on Mondays for Class A and on Thursdays for Class B.

The first lectures were exactly the same for both Class A and Class B, and so were the second lectures. In the lectures, an instructor added comments during the presentation using an overhead projector. He chose two important words on each screen and circled them in red and further emphasized them by sliding a rectangle to encircle each word, via an animation function.

Students are instructed to either take notes on paper notebooks given to them, or input notes in their own PC notebooks. For “fill-in” note-taking, both type of notebooks were provided with rectangle input areas covering some words and phrases in lecture materials, while a large square-shaped input area were given at the bottom of each page for “free” note-taking.

The students were not informed about the experiment or tests so as to prevent their expectations from entering the data. However, they were instructed to “write (or input) as much as possible on the distributed sheets of paper or their personal computers”. The test given after the second lecture was designed to have double the input area and double the number of questions of the first test. This was to reduce bias between the first and second tests, assuming that the students would have expected the test after the second lecture.

To prevent bias between the two groups, Class A was assigned to use paper notebooks and Class B to use PC notebooks for the first lecture, and vice versa for the second. In addition, “fill-in” and “free” materials were presented alternately on the projector screen as well. Further, the order of “fill-in” and “free” presentations in Class A in the first lecture was reversed for Class B (See Table 1 and Figure 1).

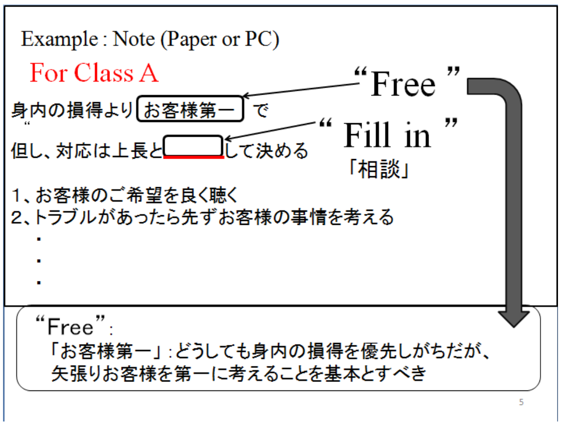

Figure 1. Example of Note for Class A

It should be noted that because 16 students in the Patisserie Course did not own PCs, they used paper notebooks in both of the first and second lectures.

As for the tests, the first one, which has the total of 10 questions (five "fill-in" and five "free" questions), was administered during the last 10 minutes of the first class. In the second test, to reduce the effect of the expectations the students might have formed after the "first test", we included 20 questions, double the first one, and allocated 15 minutes. The full score for both the first and second tests were set at 20. When measuring the amount of writing, if there was any kind of writing, it was counted as one unit of writing regardless of its content, correctness or length, for both "fill-in" and "free" sections. In the tests, if students wrote exactly the same words or phrases as had been presented in a lecture, ○ is given, × otherwise.

3 Results

3.1 Evaluation of bias in test scores between Classes A and B, and between the first and second lectures

To evaluate the results, first, we examined whether or not there was any bias in scores between Classes A and B. The result is shown in Table 2. As it shows, the average of the total of two scores for Class A was 11.16 points, and for Class B 10.94 points. The difference between the two was 0.22, showing no statistical significance (t=0.35, N.S.). The data of students who were absent from either one of the tests was excluded from the analyses because comparisons cannot be made.

ClassA n=127	ClassB n=107	Difference	*t value* Significance
11.16 (4.34)	10.94 (4.80)	0.22	0.35 N.S.

Numbers indicates test scores, Full marks=20, (Standard deviation)

Table 2. Evaluation of bias in test scores between Class A and B

Next, we examined whether or not there was any bias between the first and second lectures. The result is shown in Table 3. As it shows, the average score of the first lecture was 11.12 points, and the second 11.01 points. The difference was 0.11 points, showing no statistical significance (t=0.19, N.S.).

First n=128	Second n=115	Difference	*t value* Significance
11.12 (4.61)	11.01 (4.40)	0.11	0.19 N.S.

Numbers indicates test scores, Full marks=20, (Standard deviation)

Table 3. Evaluation of bias in scores between the first and second lectures

3.2 Comparison of the amounts of writing between two types of notebooks

We compared the amount of writing between the “fill-in” and “free” sections for paper notebooks and PC notebooks. The results are shown in Table 4.

When measuring amount of writing, if there was any kind of writing, it was counted as one unit regardless of its content, correctness or length. We expected students to write down key words or matters that they thought important. As Table 4 shows, the average unit of writing on a paper notebook was 9.17 units for the “fill-in” section, and 1.27 units for the “free” section, showing a statistically significant difference of 7.90 units (t=29.82, p<0.001). On a PC, the average unit of input was 9.71 for the “fill-in” section and 1.6 units for the “free”, with a difference of 8.11 units (t=20.84, p<0.001).

In addition, it is interesting that the students wrote more amounts of writing in PC notebooks than paper notebooks. The results are shown in figure 5.

Media of Note	“Fill in”	“Free”	Difference	*t value* Significance
Paper *n*=136	9.17 (1.85)	1.27 (2.80)	7.90	29.82 p<0.001
PC *n*=95	9.71 (1.14)	1.60 (3.73)	8.11	20.84 p<0.001
Total *n*=231	9.39 (1.61)	1.40 (3.21)	7.99	35.81 p<0.001

Numbers indicates amounts of writing, Max=10.00, (Standard deviation)

Table 4. Comparison of the amounts of writing two types of notebooks

The average amount of writing on paper and PC was 9.39 (93.9%)units for the “fill-in” section and 1.40 (14.0%) for the “free” section, with 7.99 unit difference(t=35.81 p<0.001). Therefore, the average writing (and input) amount of the “fill-in” section is 6.7 times that of the “free” section. Figure 2 presents graphs showing the amounts of note-taking on paper and PCs.

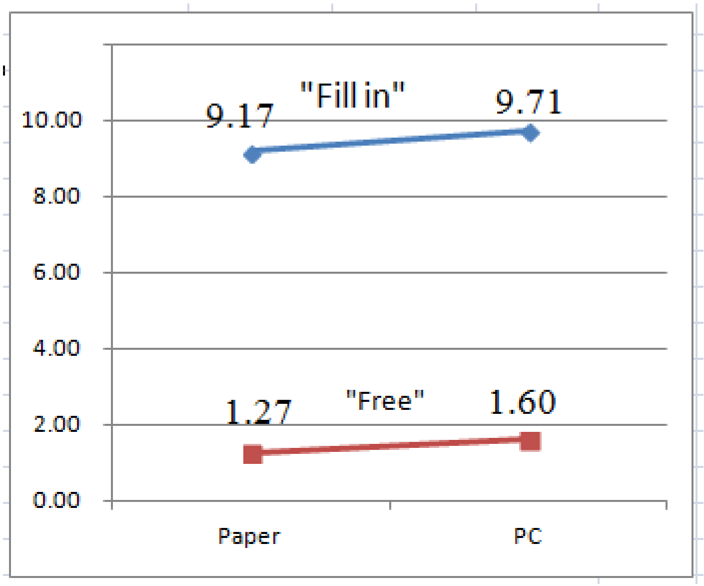

Figure 2. Results: Amount of Writing(Max=10.00)

3.3 Test results

Next, we present the test results in Table 5. As it shows, the students who used paper notebooks earned 6.70 points in the "fill-in" section and 3.88 points in the "free" section, showing a significant difference of 2.82 points(t=13.93, p<0.001).

Media of notebook	"Fill-in"	"Free"	Difference	*t value* Significance
Paper n=137	6.70 (2.61)	3.88 (2.35)	2.82	13.93 p<0.001
PC n=105	6.66 (2.69)	5.02 (2.74)	1.64	6.03 p<0.001
Total n=242	6.68 (2.64)	4.37 (2.58)	2.31	13.71 p<0.001

Numbers indicates test scorers , Full marks=10, (Standard deviation)

Table 5. Test result

The students who used a PC earned 6.66 points in the "fill-in" section and 5.02 points in the "free" section, showing a significant difference of 1.64 points (t=6.03, p<0.001). The combined average of the paper and PC users was 6.68 points for the "fill-in" section and 4.37 points for the "free" section, with 2.31 point difference (t=13.71, p<0.001).

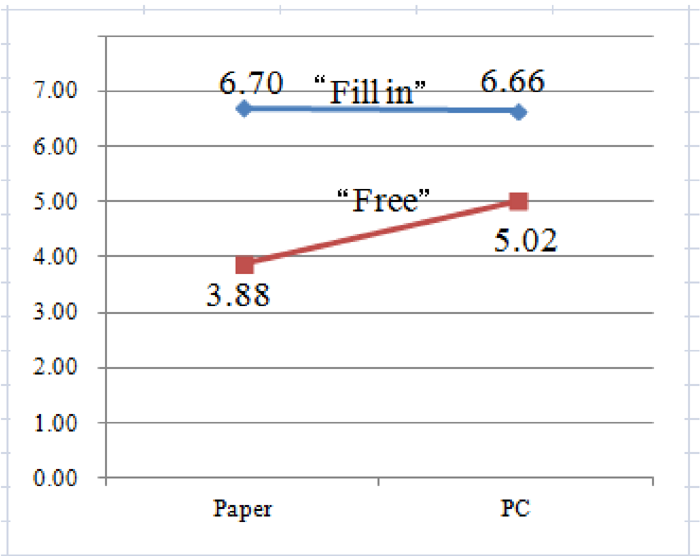

Figure 3. Results of Test Scores(Full Marks=10.00)

As shown above, whether students used paper or PCs, the test scores of the “fill-in” section were significantly higher than that of the “free” section. Therefore, I understood that the “fill-in” section method were very effective when we let the students take the notebooks.

Next, we will analyze interactions. Figure 3 presents the scores grouped into paper and PC using groups, each of which was further divided into “fill-in” and “free”. It shows that for the “free” section, the PC users earned higher scores than the paper users.

Table 6 presents the results of the analysis of variance. It shows that the main effects of both “fill-in” and “free” were significant with less than 1% significance level. For both of the note-taking mediums, paper and PCs, the main effects were found significant with less than 5 % significance levels. As for the “free” section, the PC users showed higher test scores than the paper users. For the interaction term, the significant difference level was less than 5%. I think that the reasons of high scores in “free” section are because the PCs notebooks are color and easy to stay in the impression of the students. About this matter, we think that it is necessary to inspect by the next experiment exactly.

Factor	SS	df	MS	F	P	Judgment
Measure of Note-Taking(A)	591.97	1	591.97	88.54	<.0001	＊＊
Media of Note(B)	35.93	1	35.93	5.37	0.02	＊
A×B	41.86	1	41.86	6.26	0.012	＊
W	3209.24	480	6.69			

Table 6. Analysis of variance ＊＊：1% Level, ＊：5% Level

3.4 Relations between amount of writing and test scores

We analyzed relationship between the amount of writing and test results based on the data summarized in Tables 4 and 5. Figure 4 shows the analysis results. We found “medium-level positive correlation” between the amount of writing and the test score, with the correlation coefficient (r) equaling 0.65(t=9.61, p=1.02E-16). It should be noted that the amounts of writing are concentrated around 20 units because many students wrote in the “fill-in” section, but not in the “free” section.

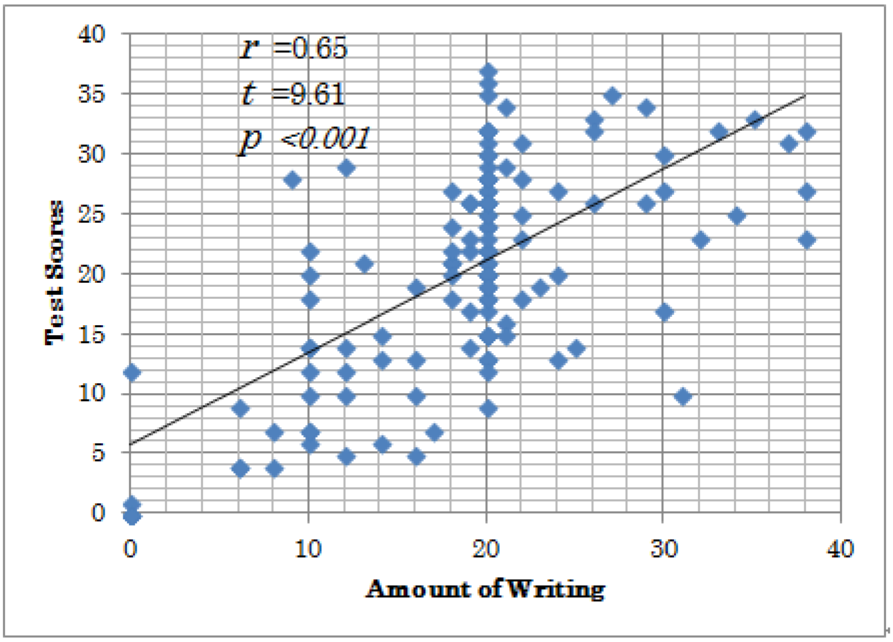

Figure 4. Correlation Between Amount of Writing and Test Scores

4 Conclusion

We analyzed the relationship between the amount of writing and the test score for the “fill-in” and “free” sections. The average amount of writing in the “fill-in” section was 93.9% and that in the “free” section was 14.0%. The amount of writing in the “fill-in” section was 6.7 time that in the “free” section. We found that regardless of the use of paper or PCs, the writing amount in the “fill-in” section is dramatically higher, and that students fill in most of the “fill-in” section. As for the test scores, the average score of the “fill-in” section was 6.68 points (out of 10), while that of the “free” section was 4.37 points. The average of “fill-in” scores was 1.6 times larger than that of “free” scores.

Examination of relationship between the writing amount on paper and input amount in PCs revealed that in terms of writing in the “free” section, the use of PC notebooks led to a higher score than writing on paper.

The correlation (r) between the amount of notes taken and the test score was 0.65(t=9.61, p=1.02E-16).

Our future challenge is to come up with ways to motivate students to take more notes on matters they thought important in class, not just fill in blanks, and to show that test scores of essay questions can be improved.

Acknowledgment

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COMPUTER-ASSISTED PROBLEM-BASED LEARNING FOR WORD-BASED MATHEMATICAL PROBLEM SOLVING

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Abstract

A focus on mathematical understanding and problem solving in math education has developed a need to implement alternate ways of testing to better assess the students' understanding and problem solving skills. Furthermore, previous computer-assisted problem-solving systems designed for elementary school mathematical education have focused mainly on developing students' cognitive skills and less interest is dedicated to related procedural skills. However, procedural and conceptual knowledge are highly correlated. This study proposes a computer-assisted system, whose design is based on Polya's problem-solving model. The system is designed to help low-achieving second graders in mathematics with word-based addition and subtraction questions. The emphasis of using the specific model was on dividing the problem solving procedure into stages and the concentration on the students' cognitive and procedural processes at each stage. In order to help students overcome procedural obstacles, we developed an agent oriented evaluation so as to give them a meaningful feedback to better monitor and support students learning performance.

Keywords: Problem based learning, Cognitive and procedural skills evaluation, Addition and subtraction word problems resolution, Polya's strategy.

1 Introduction

Descriptive evaluation is recognized as an effective method that requires students to write down the problem solving process so that teachers could analyze what the students do not understand and help improve their understanding. During the past 30 years, there has been an increasing emphasis on assessing problem solving by examining the cognitive processes that students use while engaged in problem solving. The multidimensionality of the problem-solving process is certainly made evident as attempts are made to look at all thinking done to solve a problem.

Descriptive assessment does not ask simple questions that could be answered with a fact. Instead, they ask students to describe their problem solving process and evaluate the students' advanced thinking skills such as reasoning skills in mathematics. Whang (Whang, 2004) suggested that descriptive assessment is one of the most effective evaluation methods because it allows teachers to know explicitly the thought process of the students.

Furthermore, computer-assisted mathematical problem solving systems are rapidly growing in educational usage. These systems help students to better cope with difficulties encountered in solving problems and give them immediate feedback. Some of these systems are based on the four problem-solving stages mentioned by Polya (Polya, 1945): (1) understanding the problem, (2) making a plan, (3) executing the plan and (4) reviewing the solution. However, these computer-assisted problem-solving systems have incorporated all the problem-solving steps within a single stage, making it difficult to diagnose stages at which errors occurred when a student encounters difficulties and imposing a too-high cognitive load on students in their problem solving (Chang et al., 2006). Moreover, these systems focus more on cognitive thinking process, as well as abstract mathematical concepts and little interest is devoted to procedural skills. However, procedural and conceptual knowledge are highly correlated (Hallet et al., 2010) (Rittle-Johnson et al., 2001). Competence in domains such as mathematics rests on children developing and linking their knowledge of concepts and procedures (Silver, 1986), therefore we propose to develop a computer-assisted problem solving system that rules on both students' conceptual and procedural skills.

The purpose of this paper is to propose a new system that is based on the four problem-solving stages mentioned by Polya. The system assists in achieving addition and subtraction problems for second grade students by assessing cognitive reasoning at each stage and related procedural skills. Moreover, a multi agent system is used to grade students' answers and displays feedback after the problem solving completion.

The paper is organized as follows: In section 2, we discuss the goals of problem based learning strategy and its merits to enhance learning, such as creative thinking, problem solving, logical thinking and decision making. Section 3 focuses mainly on the influence of computer-assisted environments on mathematics instruction and their positive impact on students' problem-solving. In section 4, we present the proposed problem solving process and we describe student-machine interfaces that are used in each stage besides embedded techniques to assist in achieving a successful outcome at each stage. Section 5 presents the student assessment approach and depicts the role of each agent in the assessment process. In section 6, we conclude on adopted strategy, and future work.

2 Problem Based Learning

A focus on mathematical understanding and problem solving in math education has developed a need to implement alternate ways of testing to better assess the students' understanding and problem solving skills. The purpose of education has shifted from simply delivering knowledge and information to student-centered education that focuses on fostering creativity and enhancing problem solving skills.

In Algeria, evaluation in new mathematics curriculum now focuses more on assessing problem solving skills and advanced mathematical thinking skills such as reasoning, communications and mathematical connection skills.

In traditional teaching, assessment of whether students had understood a mathematical problem was based on whether they could describe the correct arithmetic procedure. However, it was not enough to evaluate students' mathematics concepts and abilities of solving math problems merely depending on their writing.

Several researches also pointed out that good problem solving skills are the key to acquiring a successful solution in learning mathematics (Gagne, 1985) (Mayer, 1992).

Obviously, if a student could successfully solve a math problem by arithmetic calculation, that did not mean the student really understood it. It has been maintained in the literature that PBL positively influence learning outcomes along with learners' higher order thinking skills such as creative thinking, problem solving, logical thinking and decision making. For instance, Elshafei (Elshafei, 1999) compared the Calculus achievement levels of second graders in five different high schools and 15 different classes where PBL and traditional instructional methods were implemented. Findings indicated that students in PBL settings did prefer this method and had higher levels of achievement. In addition, it was revealed that students in PBL settings had better solutions for given problems in comparison to those who were in traditional classroom settings. Kaptan and Korkmaz (Kaptan and Korkmaz, 2000) investigated the influence of PBL on problem solving skills and self-efficacy levels of in-service teachers. Findings revealed that the experimental group which was exposed to fundamental science activities through PBL had higher self-efficacy and logical thinking scores than the control group.

The goal of PBL-based cognitive strategy instruction is to teach learners multiple cognitive and metacognitive processes and strategies to facilitate and enhance performance in academic domains (e.g., mathematical problem solving). The processes and strategies range from simple to complex depending on task difficulty and context of the task (Montague and Van Garderen, 2008). Polya's Mathematics Problem-Solving Process is one of these PBL instructional strategies. He was the first to introduce the concept of problem-solving model believing that mathematics is not all about the result.

According to Polya's problem-solving model, the proposed system is designed to guide low-achievers through the parts of the problem-solving process that they often ignore. Furthermore, the system adopts schema representations strategy (Reusser, 1996) in the "Making a plan" stage to enable students describe the solution steps in detail by ordering operands of the problem (see figure 3).

3 Relevant Research Work

Arithmetic word problems play an important role in the elementary school mathematics curricula in terms of developing general problem-solving skills (Verschaffel et al., 2007). Studies of children's solutions of addition and subtraction problems date to the early part of the last century (Arnet, 1905) (Browne, 1906). Since that time a number of researchers have investigated how children solve addition and subtraction problems. (For example, see (Carpenter et al., 1981) (Groen and Parkman, 1972) (Svenson, 1975)). With technological advancement and the arrival of the multimedia computer instruction era, the attention of more and more studies has been fastened on interactive learning methods through multimedia computers. The use of computers to implement findings from qualitative research related to problem-solving teaching strategies can furnish more effective learning opportunities for learners.

Over the last years there has been an increased research studies about the influence of computer-assisted environments on mathematics instruction (see (Huang and Ke, 2009)). We present below some of them that are interested in enhancing cognitive problem solving ability.

Chang et al. (Chang et al., 2006) proposed a computer-assisted system named MathCAL, the design of which was based on the four polya's problem-solving stages. A sample of 130 fifth-grade students (average 11 years old) completed a range of elementary school mathematical problems. The result showed that MathCAL was effective in improving the performance of students with lower problem solving ability. These assistances improved students' problem solving skills in each stage.

Huang et al. (Huang et al., 2012) developed a computer-assisted mathematical problem-solving system in the form of a network instruction website to help low-achieving second- and third-graders in mathematics with word-based addition and subtraction questions. According to Polya's problem-solving model, the proposed system was designed to guide these low-achievers through the parts of the problem-solving process. They found that the mathematical problem solving ability of experiment group students was significantly superior to that of control group students. Most of the participants were able to continue the practice of solving word-based mathematical questions, and their willingness to use the system was high. Their findings indicate that the computer-assisted mathematical problem solving system can serve effectively as a tool for teachers engaged in remedial education.

Panaoura (Panaoura, 2012)] investigated the improvement of students' mathematical performance by using a mathematical model through a computerized approach. He developed an intervention program and 11 years students worked independently on a mathematical model in order to improve their self-representation in mathematics, to self-regulate their performance and consequently to improve their problem solving ability. The emphasis of using the specific model was on dividing the problem solving procedure into stages. The use of the computer offered the opportunity to give students general comments, hints and feedback without the involvement of their teachers. Students had to communicate with a cartoon animation presenting a human being who faced difficulties and cognitive obstacles during problem solving procedure. Experiments involved 255 students (11 years old), who constituted the experimental and the control group. Results confirmed that providing students with the opportunity to self-reflect on their learning behavior when they encounter obstacles in problem solving is one possible way to enhance students' self-regulation and consequently their mathematical performance.

Leh and Jitendra (Leh and Jitendra, 2012) compared the effectiveness of computer-mediated instruction and teacher-mediated instruction on the word problem-solving performance of students struggling in mathematics. Both conditions integrated cognitive modeling that focused on the problem structure using visual representations with critical instructional elements specifically targeting the needs of at-risk students. Participants were 25 third-grade students with mathematics difficulties. But results indicated no statistically significant between-condition differences at posttest and on a 4-week retention test of word problem-solving.

Based on Polya's four problem-solving steps (understanding the problem, devising a plan, carrying out the plan and looking back), Ma and Wu (Ma and Wu, 2000) designed a set of interesting, active learning materials for teaching. Research outcomes indicated both students' learning interest and achievement had improved. Chang (Chang, 2004) incorporated strategies such as key-point marking, diagram illustration and answer review in the problem-solving process and developed a process-oriented, computer-aided mathematics problem solving system. The system was applied mathematical questions (mainly elementary-level arithmetic computation) with fifth graders as the subjects of the empirical study. Results showed that the system was effective in enhancing low-achievers' problem-solving ability.

Summary of the examples cited above evince that computer-assisted mathematics-problem-solving systems have a positive impact on children's problem-solving ability. However all these systems focus on cognitive skills used in problem solving and no interest is devoted to related problem solving procedural skills. Here our focus is mainly on both cognitive and procedural skills training using polya's problem solving strategy and multi agent systems to analyze second grade students' word based problem solving ability. Precisely, we address the problem of how to evaluate the students' skills objectively so as to provide them the best feedback.

4 System Design and Framework Outline

The purpose of this paper is to propose a computer-assisted Learning system that is based on the mathematical problem-solving process proposed by Polya. It guides the second grade students to think and solve the mathematical problems by using a graphical representation in the making plan stage consisting of two operand nodes; one operator node and one result node (see Fig. 3). Each operand and result node comes with two attributes, label and value, representing the meaning of the node and its numerical value, respectively. The values for the two operand nodes and the operator node correspond to the two operands and an operator in the mathematical expression. The value at the result node is the result of the expression.

The schema representation is very helpful for conceptualizing the semantics of the problem [3]. The problems would be divided into four types based on the classification of Vergnaud (Vergnaud, 1982): (1) PUT-TOGETHER, (2) CHANGE-GET-MORE, (3) CHANGE-GET-LESS, and (4) COMPARE (See table 1).

Because all problems involve three quantities and any of these quantities can be unknown, there are three possible problem subtypes within each main problem type. Two of these require subtraction of the two given numbers in the problem and one requires addition of the two givens.

Addition situations	Subtraction situations
Change-Get-More Missing end Ali had 3 marbles. Then Omar gave him 5 more marbles. How many marbles does Ali have now? Missing Change Ali had 3 marbles. Then Omar gave him some more marbles. Now Ali has 8 marbles. How many marbles did Omar give him? Missing start Ali had some marbles. Then Omar gave him 5 more marbles. Now Ali has 8 marbles. How many marbles did Ali have in the beginning?	**Change-Get-Less** Missing end Ali had 8 marbles. Then he gave 5 marbles to Omar. How many marbles does Ali have now? Missing change Ali had 8 marbles. Then he gave some marbles to Omar. Now Ali has 3 marbles. How many marbles did he give to Omar? Missing start Ali had some marbles. Then he gave 5 marbles to Omar. Now Ali has 3 marbles. How many marbles did Ali have in the beginning?
Put-Together Missing all Ali has 3 marbles. Omar has 5 marbles. How many marbles do they have altogether? Missing first part Ali and Omar have 8 marbles altogether. Omar has 3 marbles. How many marbles does Ali have? Missing second part Ali and Omar have 8 marbles altogether. Ali has 3 marbles. How many marbles does Omar have?	**Compare** Missing difference Ali has 8 marbles. Omar has 5 marbles. How many more marbles does Ali have than Omar? Missing big Ali has 3 marbles. Omar has 5 more marbles than Ali. How many marbles does Omar have? Missing small Ali has 8 marbles. He has 5 more marbles than Omar. How many marbles does Omar have?

Table 1. Classification of word problems.

4.1 Students' problem solving process

Students' problem-solving guidance process is shown in Figure 1. Firstly, the adequate problem is provided by the system among other problems stored in the problem solving information database. In stage 1, the assessing module for understanding the problem proposes responses to be tagged by the student and other techniques allowing to rule about comprehension of the problem. The plan making stage enables the student to build a schema representation of his solution. Stage 3offers, according to the operation type, a calculation interface and finally a multi questionnaire is proposed to the student to validate his solution. Problem information is provided at each stage of the problem solving process and assessment of each stage is recorded in the student tracking database. The system displays feedback messages after the whole problem solving completion.

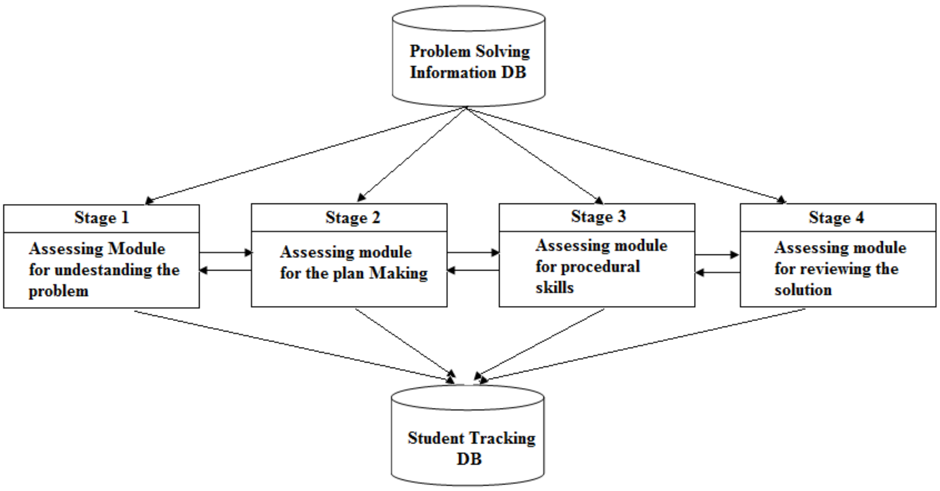

Figure 3. Students' problem solving Process.

4.2 The stage of understanding the problem

In this stage, the system offers to students the possibility to circle important words in the problem. Furthermore, students have to distinguish between what is known and what is requested in the problem by selecting adequate responses. For illustration, figure 2 displays the problem in the problem frame and check boxes for needed answers.

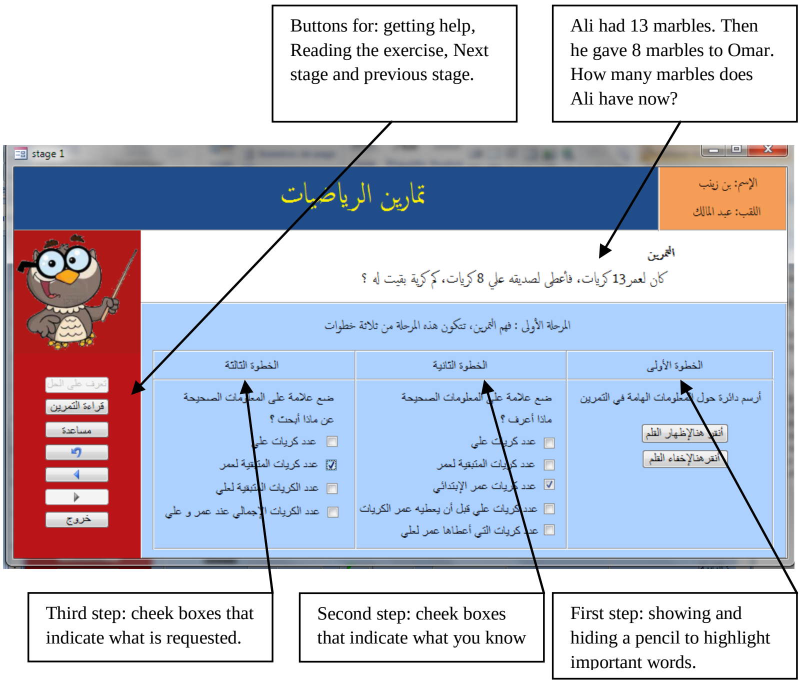

Figure 2. The screenshot of the first stage (Understanding the problem)

4.3 The stage of making the plan

The guiding process of plan elaboration is divided in four steps as illustrated in figure 3 so as to help students express graphically the problem solving. The first step consists of identifying the first operand and its value among a list of operands; the student selects the appropriate one and enters its value. The second step proposes an operator choice between addition and subtraction. In the third step, the student selects the second operand and its value and finally the fourth step requires only a result label. According to the problem missing part a result label may either be requested in first or third step.

In the example of figure 3, the student has chosen the second label for the first operand and enters the value 13, for the second operand he chosen also the second label with a value of 8 and tries subtraction between these two operands. Labels are presented so as to know if student understands the meaning of the operator.

After the student has pressed the ‘‘next’’ button, the system compares the solution plan made by the student with the solution plan built into the system, the suggestions regarding the student’s problem solving are stored in the student tracking database and displayed after the student completes the problem solving.

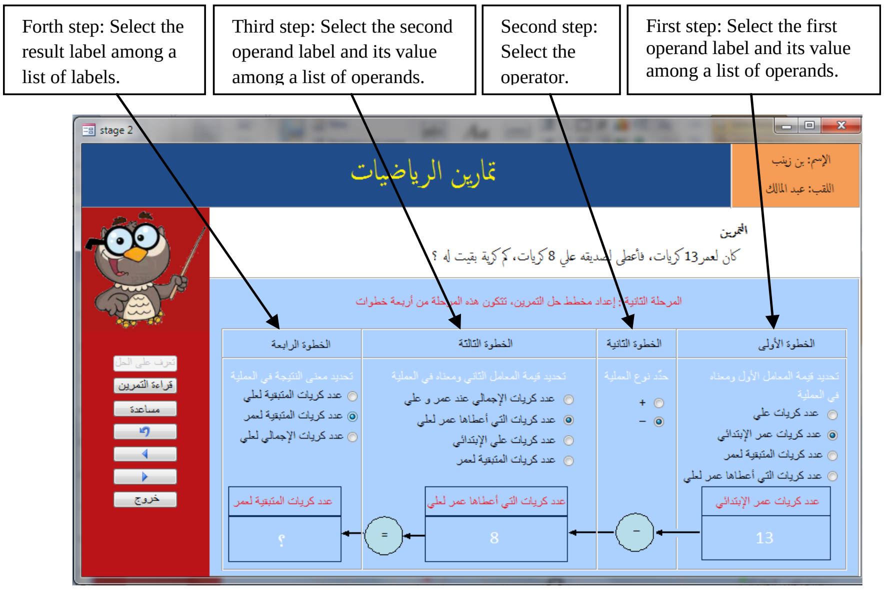

Figure 3. *The screenshot of the second stage (Making the plan)*

4.4 The stage of plan execution

As shown in figure 4, the system provides a graphic preview for all of the addition and subtraction worksheets in a vertical problem format where large cases are reserved for digits of operands and little cases are used if regrouping is required for subtraction (exchanging one of the tens for 10 units or one of the hundreds for 10 tens) or for addition when process involved a carryover number. In this stage, the system evaluates student's procedural knowledge and uses a multi agent evaluation approach. Three steps are required at most to complete this stage, each step aims at manipulate ones, tens and hundreds. The student has to fill in the large cases (ones, tens and hundreds) of result and little cases if regrouping is required for subtraction or if addition needs carrying over. After finishing calculation of all columns, the system assesses student's answer and feedback is stored. A last stage is needed to validate student's problem solution.

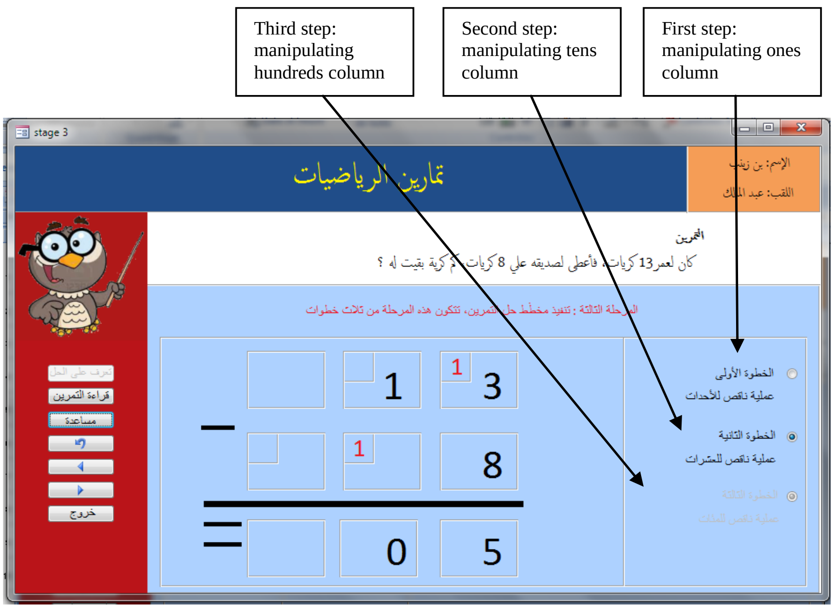

Figure 4. *The screenshot of the third stage (Executing the plan)*

4.5 The stage of reviewing the solution

In this stage the student answers questions as shown in figure 5. In order to validate the solution given at previous stage, the system proposes some questions that are related to the problem and student must answer by true or false. After completing this stage, the student presses the Evaluation button which triggers the system to evaluate the results, and messages appear that indicate whether any mistake was made. Also, the correct problem-solving steps are displayed simultaneously on the same stage interface of student’s answers.

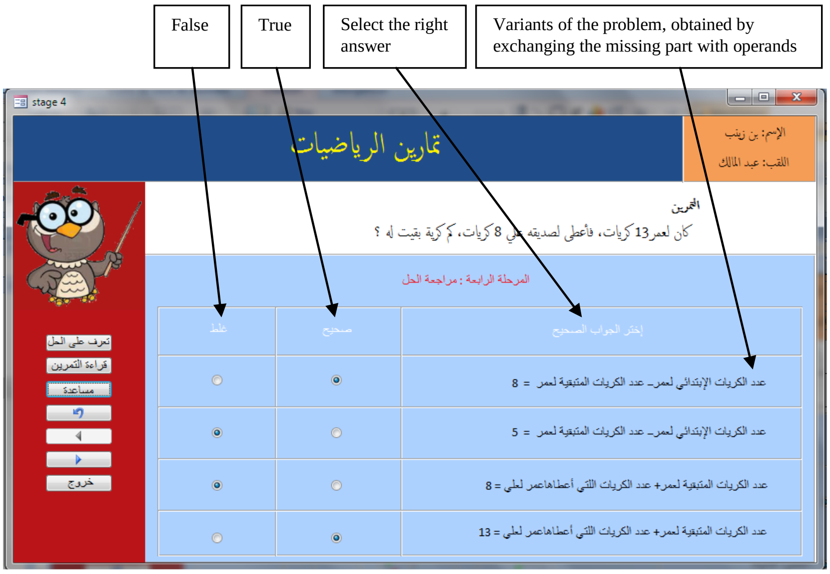

Figure 5. The screenshot of the fourth stage (Reviewing the solution)

5 Student Assessment

One of the most common strategies for studying the problem-solving process involves the use of an analytic scoring scale. Analytic scoring is an evaluation method that assigns point values to various dimensions of the problem-solving episode (Charles et al., 1987).

The grading rubric graded the solutions in 4 specific areas. A total of 10 maximum possible points were awarded to each problem by assigning 2 maximum possible points for understanding the problem, 3 maximum possible points for making a plan stage, 3 maximum possible points for procedural skills and finally 2 maximum possible points for reviewing the solution. Detail of stages’ scoring is given in table 2.

Furthermore, one of interesting research issue in Computer-Assisted Instruction Systems is Intelligent Agents. Some Intelligent Agents are used for helping students doing science experiments in Virtual Experiment Environment (Huang et al., 1999) (Kuo et al., 2001); the others are used to help student solving problems with a kind of knowledge structure and Knowledge Map (Kuo et al., 2002). In this paper, intelligent agents are designed to diagnose students' learning status in problem solving system.

Stage	***Understanding the problem***	***Making a plan***	***Executing the plan***	***Reviewing the solution***
Criteria	Complete understanding of the problem with recognition of what is given and what is requested in the problem with correct identification of important words in the problem.	Accuracy of setting the plan and degree of describing and interpreting the operands and their values, the operation and the missing value.	Accuracy of computation with correct manipulation of numbers (adding/subtracting of units, tens and hundreds) and right use of regrouping and carrying over concepts.	Correct validation of problem solution by selecting the correct problem solution variants. Variants are obtained by Combining addition and subtraction of problem operands and missing part.
Rubrics and scores	• What is known: 0.7 pt • What is requested: 0.7 pt • Identifying the important words: 0.6 pt	• First operand label identification: 0.5 • First operand value: 0.5 • Second operand label identification: 0.5 • Second operand value: 0.5 • Identification of the operator: 0.5 • Identification of label of missing: 0.5	• Manipulation of units: 1pt • Manipulation of tens: 1pt • Manipulation of hundreds: 1pt In case of manipulating numbers without hundreds, the rating score of this category is affected equally to units and tens manipulations.	• First problem solution variant: 0.5 pt. • Second problem solution variant: 0.5 pt. • Third problem solution variant: 0.5 pt. • Fourth problem solution variant: 0.5 pt.

Table 4. Assessment grading rubric

5.1 Stage assessor agents

At the end of each problem solving stage, and when the student presses the next stage button the stage assessor agent is started. The evaluations for stages: understanding the problem, making a plan and reviewing the solution is the same and consists of some operations to be designed in an Intelligent Agent: *1. Load stage solution of the problem*; *2. Evaluate student's answers*: comparing student's answers with stage solution; *3.generate feedback and calculate stage score*: feedback is generated according to mastered concepts and developed skills and score is awarded. All stage solving informations are stored in the student tracking database.

5.2 Procedural skills assessment agents

Assessment of plan execution stage is different from the other stages assessment and requires a multi agent assessment to diagnose student's addition and subtraction skills. For this purpose, four agents are needed: ones agent, tens agent, hundreds agent and assessment agent, each of the first three agents is responsible of evaluating one column operation and skills related to both addition and subtraction (if regrouping is required for subtraction or if addition needs carrying over). The assessment agent consults the problem solving information database to know the number of columns (units, tens and hundreds) used in the problem solution, afterward he creates the agents needed for evaluation. After evaluating his column, each agent sends a report to the assessment agent which assesses the whole student's procedural skills (see figure 6). The motivation for applying this assessment method is to understand all computing details used by the student to complete addition and subtraction operations.

5.2.1 The ones agent

The ones assessment agent checks the digits' computation of the ones column and verifies if techniques related to operator type are used.

If needed operation is addition, the agent carries out the following operations:

- Calculates the sum of digits of the ones column,
- Verifies if the result units digit is correct,
- Checks if the student has not miss the carry over number if the operation requires so, and sends a message to tens agent to inform him that carrying over is required after computing ones column.
- Generates a report according to results and sends it as evaluation grid to assessment agent.

If the problem solution requires a subtraction operation, the agent completes the following actions:

- Calculates the difference between digits of the ones column,
- Verifies if the result units digit is correct,
- Checks if the student has used the regrouping technique if the subtraction requires so, and sends a message to tens agent to inform him that regrouping is used to compute ones column.
- Generates the feedback according to results and sends it as evaluation grid (See tables 3 and 4) to assessment agent. The 3 maximum possible points that can be awarded in this stage are divided depending on whether the solution of the problem requires one, two or three columns.

5.2.2 The tens/hundreds agent

This agent performs the same operations as the previous agent and makes sure that student adds the carry over number to the sum of digits in tens (hundreds) column if needed operation is addition. In the subtraction case, the agent checks up if the student adds the regrouping number to the subtracted number of tens (hundreds) column. Finally, he sends details of evaluation to the assessment agent.

5.2.3 The assessment agent

After receiving reports from the three other agents, the assessment agent proceeds to the assessment of the student's procedural skills. The scores are awarded according to previous agents' evaluation grids. Results of assessment are displayed and stored in the student tracking database.

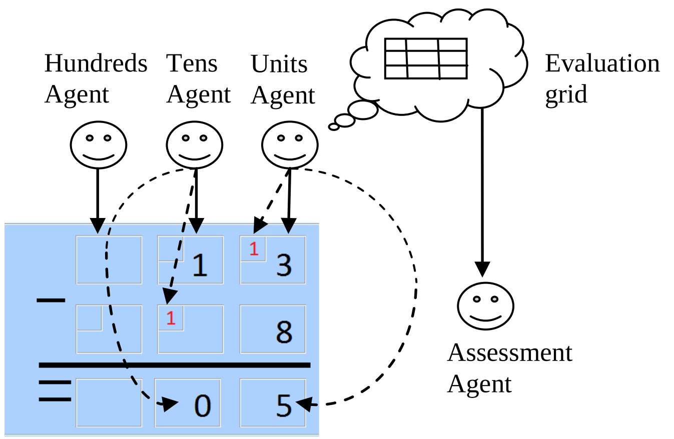

Figure 6. Agent oriented assessment of procedural skills.

Skill	*Needed in computation?*	*Performed?*	*Awarded score*
Alignment of digits on worksheet	Yes	Yes	0.1
Arrangement of numbers on subtraction worksheet	Yes	Yes	0.1
Subtracting numbers less than 10	No	No	
Subtracting numbers greater than 10	Yes	No	0
Management of regrouping technique	Yes	No	0

Table 3. Example of the ones agent's evaluation grid (case of subtraction).

Skill	*Needed in computation?*	*Performed?*	*Awarded score*
Alignment of digits on worksheet	Yes	Yes	0.1
Subtracting numbers less than 10	Yes	Yes	0.2
Subtracting numbers greater than 10	Yes	No	0
Increment by 1 the value of tens to subtract	Yes	No	0
Management of regrouping technique	No	No	

Table 4. Example of the tens agent's evaluation grid (case of subtraction).

6 Conclusion

Mathematics education in Algeria lacked practical and effective descriptive methods that could be readily used in the schools and students who experienced mathematical learning difficulties became unable to attend expanded mathematical curricula. Our study was designed to offer one possible solution to the problem. We developed a Computer-assisted problem-based learning system to help low-achieving elementary students improve their ability to solve basic word-based addition and subtractions questions, and enhance their willingness to continue the learning. Our system is based on Polya's four problem-solving steps; the emphasis of using this model was on dividing the problem solving procedure into stages so as to diagnose stages at which errors occurred when a student encounters difficulties. Furthermore, we focus on remedial computation of addition and subtraction operations by developing an agent based evaluation approach that can furnish a meaningful feedback to be effective in improving the performance of students with lower problem solving ability. Many researches proposed problem-solving assistance to help students with their problem solving, and one of the most suggested problem-solving assistances is visualization. As far as that goes this study continues the convention of using such assistance, it included a few major differences from previous studies. The first is the use of multiple-choice question in the *"Understanding the problem*" stage where student have to identify what is known and what is requested in the problem. The second is using of schema representations strategy in the ”Making a plan“ stage to enable students describe the solution steps in detail by ordering operands of the problem. The third is the graphic presentation of addition and subtraction worksheets so as to enable students to perform regrouping if subtraction is needed to solve the problem or carrying over if addition is requested. These improvements allowed us to objectively evaluate students' cognitive and procedural skills.

Future research is planned to empirically demonstrate the effectiveness of our system on elementary school mathematical problems that involve the operations of addition and subtraction. Another improvement concerns student modeling so as to better monitor and support his learning.

In summary, this study improves assistance used in previous computer-assisted systems to help low-achieving second-graders in mathematics by combining schema representation, graphical worksheets, and other assistance in the problem-solving procedure.

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FROM SILOS TO MASHUPS

CONFORMANCE THROUGH WIDGET-BASED MASHUP APPROACHES TO LEARNING ENVIRONMENTS

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Abstract

Different types of digital learning environments have evolved over the years and there is an ongoing evolvement of different concepts and technology. During the last 10-15 years Learning Management Systems have dominated. In recent years there has been a development of concepts like Personal Learning Environments using mashup technology. This paper presents a study of a mashup approach to the digital learning environment using web widgets. A prototype was developed and tested, covering some technological aspects such as modularity, integration and adaptability as well as pedagogical aspects, such as pedagogical flexibility, technological responsiveness and pedagogues roles and attitudes. The study shows that widgets and mashup technology can be used to construct digital learning environments that have the potential to replace traditional LMSes and that pedagogues are positive to the adaptive learning environments and flexibility that they represent.

Keywords: LMS, MUPPLE, web widgets, mashup, VLE, PLE, e-learning

1 Introduction

Different types of *Digital Learning Environments (DLE)* have evolved over the years and there is a strong momentum and an ongoing progression of different ideas and concepts for the DLE. During the last 15 years a lot has revolved around the idea of Learning Platforms, such as *Learning Management Systems (LMS)*. These systems are commonly set forth as a common solution for a range of educational needs – much like a “Business System” for learning and education. However, LMSes have been criticized for being inflexible and hard to adapt to different pedagogical contexts and needs (see, e.g., (Paulsson, 2008), (Paulsson & Naeve, 2006b) and (Atwell, 2007)). LMSes are also commonly criticized for being too much about the administrative aspects of learning and education and only little about pedagogical activities and pedagogical processes. Hence, having a strong focus on *Learning Management* rather than on the actual learning activities and pedagogical processes per se - as the term also suggests. From a system perspective LMSes are often criticized for being designed and implemented in a silo-like fashion, contributing to lock-in effects of information and processes, preserving old-fashioned system borders. The criticism is actually similar to the critique often heard about business systems in general. There is also a built-in conflict between the development and implementation of systems like LMSes on the one hand and the development and implementation of social software and Web 2.0 on the other hand. While many LMSes currently in use try to create a well-defined kind of “shielded community” for learning, web 2.0 is associated with open communities, global social interaction and open information services that can be used as building blocks for new services[1] - such as for a *Personal Learning Environment* (PLE), as described in (Atwell, 2007), (Jones, 2008) and (Wilson et al., 2006).

[1] Observe that the notion of services for Web 2.0 refer to services that target users and are not equivalent to services as in *Service Oriented Architectures (SOA)*, which is a software design paradigm (Erl, 2007). While the technology platform underlying Web 2.0 services may very well be a SOA platform, there is an unfortunate mix-up of those two rather different notions of services when discussing Web 2.0.

In order for such web services to be used as building blocks in mashups (i.e. a composition of services) the building blocks need to be well defined and with well-defined interfaces. Many web 2.0 services use proprietary interfaces such as the Twitter API, the Facebook API or APIs from Google and/or they use lightweight interfaces and protocols, such as RSS or Atom. This works well in many cases, but in order to build more sophisticated mashups there is a need for more standardized and sophisticated interfaces and concepts for interaction that can be generalized as exemplified in (Paulsson & Berglund, 2008), (Paulsson, 2008), (Wilson, Blinco, & Rehak, 2004) and (Mulligan, 2009). This can obviously be accomplished by using advanced proprietary APIs, as illustrated in (Paulsson & Berglund, 2006), but from a wider perspective, common open standards are preferable, and in the long run a necessity for mashed-up learning environments to be practical. This is also one of the issues the study discussed in this paper was set out to examine, addressing the question: "What are the possibilities for constructing mashed up learning environments based on available open standards?" The study also briefly evaluates and the relationship between mashup approaches and adaptability/responsiveness to pedagogical requirements.

The next section briefly describes the state of art, followed by a discussion on some central concepts and ideas, followed by a presentation of the study and the prototype implementation of a mashup learning environment. Finally the results of the study are discussed in the light of the ongoing progress and previous research in the field.

1.1.1 LMSes and PLEs

Simply put, a *Personal Learning Environment (PLE)* can be described as a learning environment where the learner is in focus as well as in control of the learning environment. However, the main objective of the PLE is to put the learner in control of his own learning rather than in control of the learning environment, even though these two are obviously related. Learning is regarded as a constant, ongoing process, as is the evolvement and change of the learning environment. The learning environment needs to be responsive and adapted to different contexts, needs and pedagogical requirements. There is also a focus on social interaction and the use of Web 2.o technologies in general. These are qualities that are commonly emphasized, such as in (Paulsson, 2008), (Atwell, 2007), (Wilson et al., 2006) and)(Jones, 2008

While LMS-like system are typically implemented by most educational institutions, the movement within the teaching community as well in the research community is towards more adaptive and responsive learning environments, similar to PLEs, see e.g., (Atwell, 2007) (Wilson et al., 2006) (Jones, 2008) (Severance, Hanss, & Hardin, 2010) and (Palmér, Sire, Bogdanov, Gillet, & Wild, 2009). However, while pedagogical concepts like responsive learning environments are attractive, the technology currently in use doesn't support it very well. At the same time, education need specialized services for dealing with pedagogical requirements, such as Personal Development Plans (PDP), digital portfolio, services for discovery and integration of digital learning resources, and so forth, which are resulting in several good and useful tools for learning, but they are not well integrated with the rest of the VLE (Paulsson, 2008) (Sultan, 2010) (Severance et al., 2010). These and similar issues are often addressed through different approaches to system integration on a per system basis, such as by using proprietary APIs or more general integration by Web Service technology, such as described in (Paulsson, 2008) (Erl, 2007) (Paulsson, 2006) (Ogrinz, 2009) and (Gonzalez, Penalvo, Guerrero, & Forment, 2009). However, such approaches to building the learning infrastructure has turned out to be problematic for several reasons. Firstly, it becomes expensive to integrate "per system", using proprietary APIs. API integration tends to make the systems hard coupled, which supresses flexibility, as described in (Paulsson, 2008) and (Brereton & Budgen, 2000). Secondly, using (commonly SOAP-based) Web Service technology tend to become very complex as well as expensive, adding an cost, as well as technical, overhead (Paulsson, 2008) (Brereton & Budgen, 2000) and (Preciado, Comai, & Sánchez-Figueroa, 2005) and not really suitable for the kind of integration needed for adaptive and responsive learning environments controlled by the user. And thirdly, by mixing a monolithic concept, like the LMS with a modular service based approach some of the technical flexibility needed for dealing with some of the pedagogical requirements is lost, as illustrated in (Paulsson, 2008) (Atwell, 2007) (Wilson et al., 2006) and (Palmér et al., 2009).

1.1.2 Widgets and Mashups

In recent years there has been a general development on the Internet towards modularity and an alternative kind of loosely couple services driven by less complex and more web friendly service integration, such as using RESTFul APIs [21] and lightweight APIs and protocols, such RSS and Atom combined with widget and mashup technologies, see e.g. (Yu, Benatallah, Casati, & Daniel, 2008) (Wong & Hong, 2008) and (Hoyer & Fischer, 2008).

In conjunction with this development, a number of standards and specification, dealing especially with issues related to widgets and mashups, have been developed. There are several (but similar) definitions of a mashup. A web-mashup is commonly defined as being a combination of different services on the web in a way that create a new composite application (or service) with an added value. A widget-based mashup obviously uses widget technology and is typically constructed using a mashup environment, such as Netwibes or iGoogle, see e.g. (Casquero, Portillo, Ovelar, Romo, & Benito, 2008), (Godwin-Jones, 2009) and (Hoyer & Fischer, 2008). A mashup can also be created by very simple means, using simple web tools that allow users to combine services on the web by matching and mixing information using lightweight interfaces such as RSS or Atom. However, in such cases it is mainly about mashing up information and not that much about mashing up functionality and services in a way that goes beyond the delivery and consumption of information – even though information mashups can be valuable in many cases as part of a digital learning environment irrespective of type.

Even so, if you are a developer or an experienced user you might want to use one of the more sophisticated approaches that are available for the development of web-based applications, or RIA (Rich Internet Applications) (see (Preciado et al., 2005) and (Fraternali, Rossi, & Sánchez-Figueroa, 2010)), as it is sometimes referred to, that has the potential of moving computing from the desktop to the web.

Standards are a necessity to make Widget-Mashups work in a wider perspective and in symbiosis with the development Widget and Mashup technology, a number of standards and specifications has evolved and most distinguished among those are most likely the Open Social specifications, described in (Mitchell-Wong, Kowalczyk, Roshelova, Joy, & Tsai, 2007) and (Häsel, 2011), and the package from W3C, described in (Wilson, Sharples, & Griffiths, 2008) and (Wilson, Daniel, Jugel, & Soi, 2012).

The Widget and Mashup technology concept stands out as exceedingly suitable for the next generation of learning environments, fulfilling the flexibility requirements for personal and responsive learning environments by providing standardized frameworks for modularity and loose integration on the web. As discussed in (Paulsson, 2008), (Wheeler, 2009), (Verpoorten, Westera, & Specht, 2011) and (Severance et al., 2010), there is a relation between the flexibility provided by modularity and the pedagogical flexibility needed to make the learning environment adaptive and responsive. Hence, using modular approaches for the design and implementation of digital learning environments can address some of the LMS related issues that were described in the previous section.

The terms Widgets and Mashup will from now on referring to W3C or OpenSocial widgets and Widget Mashups in the context of this paper.

The study described in this paper was carried out in a project called WiLearn. Before describing the WiLearn project some brief background will be given in the next section.

1.1.3 Background and context

The WiLearn project is the successor of two previous research projects dealing with modular digital learning environments and the relation between modularity, technical flexibility and pedagogical adaptability and responsiveness. The first project, called the Virtual Workspace Environment (VWE) was started in 1998. The objective of VWE was to implement a modular digital learning environment that also moved the computer desktop to the web. The underlying idea was that teachers and students should be able to construct and change their own, as well as their shared, learning environment by combining building blocks (components) called VWE Tools. The learning environment didn't exist until someone assembled it for a specific pedagogical purpose, using components suitable for supporting that specific pedagogical scenario. VWE was constructed using Java RMI on the server and Java Applets on the client (in the browser) and an important part of the VWE was a collection of server-sider services that kept the environment together by dealing with the internal communication of components, session management and other system stuff. The technical solution and architecture made VWE somewhat proprietary and there were no standard components that could be used out of the box. Everything had to be adapted for VWE. The use of Java RMI and applets created an overhead that made it to scale and it put a lot of demand on the browser, see (Paulsson & Berglund, 2003). Some of those problems were addressed by the use of SOAP web service, but even though this solved some of the problems, it also contributed to new overhead, see (Paulsson & Berglund, 2008).

Taken altogether this made it very hard to make comprehensive field studies with teachers and students. However, in spite of this VWE contributed with some valuable knowledge about the distinct relationship of technical flexibility, provided by modularity and the pedagogical flexibility and adaptability as a result. This was discussed in detail in (Paulsson, 2008). The VWE project also pointed out the importance of standards. General standards as well as Learning Technology Standards (LTSC) that are needed to keep the learning processes and the digital learning content together, something that are discussed in (Paulsson & Naeve, 2006a), (Salmenjoki, Paulsson, & Vainio, 2007), (Nilsson, 2001) and (Varlamis & Apostolakis, 2006).

WiMupple was the name of the second project and the objective of WiMupple was to compare a Widget-based Mashup solution to the Java RMI and SOAP-based approaches of the VWE. A simple prototype was developed and compared to the properties of VWE. Some new conclusions could be drawn about the importance of web friendliness and some of the findings from the VWE-project, such as the importance of standards, could be verified once again. The main differences were less technical complexity and overhead in the implementation and the ability to use standardized components (i.e. widgets) from third-party. The use of the Wookie widget server to implement the W3C widget standards made this possible; see (Wilson et al., 2008). The ability to use widgets developed by others is important as it facilitates reuse and stimulates development. Even though the Wookie server was used, some in-house development was needed in order to make the WiMupple platform usable. This resulted in a couple of REST APIs based on *Yahoo Querying Language* (YQL) (2011) and some proprietary functionality, which actually added some similar problem as VWE. However, this was necessary to develop the same level of functionality as in VWE The WiMupple project was discussed in (Paulsson, 2012).

The next part of this paper presents the WiLearn project the study carried out, followed by a discussion of the results and some ideas for future studies.

2 Objective

The objective of the WiLearn project was to study how teachers approach modular digital learning environments and to study if and how the technical flexibility offered contributes to the view of the pedagogical possibilities. Another objective of the study was to implement a prototype of a generic mashup environment for constructing digital learning environments based on widget and mashup technology, without the limitations of the VWE and the WiMupple environments. The purpose was to use the prototype for the study fulfilling the first objective.

It should be noted that the basic idea is still the same as with the previous studies: that teachers and students should be in control and that the learning environment can be assembled for a specific situation based on pedagogical needs and requirements. Different types of digital learning environments can be constructed, such as PLEs or LMS-like learning environments, depending on the type of widgets and supporting backend systems that are available and used.

3 Methodology

An experimental approach was used for the study in the WiLearn project. The approach was inspired by the design-based research methodology described in (Wang & Hannafin, 2005) and in (Anderson & Shattuck, 2012). The intension was to create a setting that was as similar to a real-life pedagogical scenario as possible by developing a functional prototype that didn't restrict the field part of the study more than necessary.

3.1 Technology settings

An important premiss was to avoid unnecessary development and avoid developing everything from scratch, which was the case in the VWE-project. There is a multitude of ongoing development and projects addressing widgets and mashups and one of the first design decisions were to go as mainstream as possible and existing work has been used whenever possible. The main platform used was the Apache Rave framework. Apache Rave is described by the development team as a *"…web and social mashup engine that aggregates and serves web widgets…*"[2]. The reason for the choice of Apache Rave was mainly that, even though Apache Rave is in an early stage of development, it is based on two solid Widget platforms providing stable widget frameworks. The main components of Apache Rave are the Apache Wookie server, serving W3C widgets, and the Apache Shindig, serving OpenSocial widgets, see (Wilson et al., 2008) and (Häsel, 2011). This also means that WiLearn has the ability to use both W3C widgets and OpenSocial widgets for mashups, which increases the number of available widgets. Another important reason for using Apache Rave is that it takes care of things like session management, management of user workspaces and login/single sign-on (SSO). Especially SSO is a central feature for mashups, as the user will actually be using several systems, even though it may have the look and feel of one integrated system. Besides, Apache Rave can support different ways of handling login, which makes it easier to integrate with existing user management and system legacy. Figure 1 illustrates the components and architecture of Apache Rave.

Using Apache Rave as the basis, the features needed to implement a simple but functional and flexible learning environment were developed. Both OpenSocial widgets and W3C widgets were used and the choice of widget framework mainly depended on two things: whether there were existing widgets that could be used and the type and character of the functionality to be implemented. It turned out that a large part of the needed widgets were already available as widgets developed by others. However, these often needed some adaption in order to be suitable for our purposes and to be suitable for use in a learning environment. Some of the core (administrative) features that are normally found in the LMS were implemented using widgets, but the focus of the widget implementation was on widgets adding pedagogical value. Besides the possibility to use widgets that ere adapted by for the sake of the study, a possibility to search two different "Widget stores" was implemented. In total over 300 000 widgets that could potentially be found and used to add new and/or alternative functionality to the learning environment.

[2] The Apache Rave website. Retrieved from http://rave.apache.org/ 2013-03-01

The technology requirements at the client-side are very low as a consequence of going mainstream. There is no need for software installations or plug-ins. The only demand on the client is a reasonably new browser and a stable Internet connection. This is a distinct difference from both the VWE project and the WiMupple project where certain browser versions and software was a requirement.

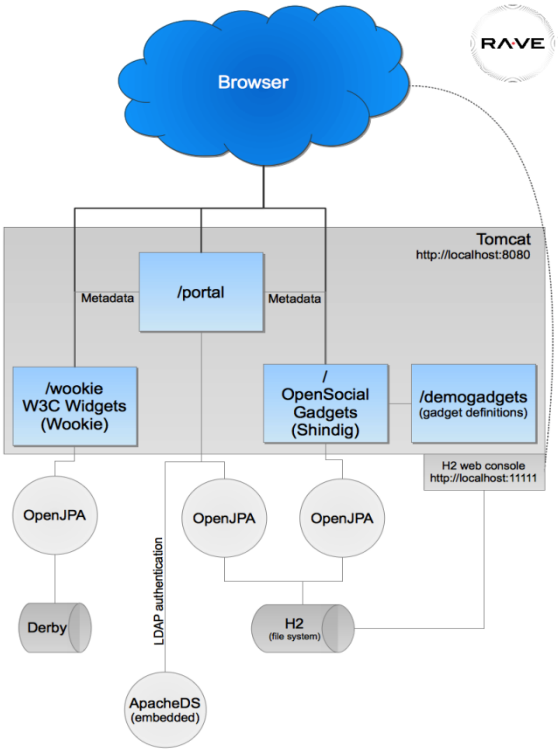

Figure 1. Components and architecture of Apache Rave[3]

[3] The Apache Rave website. Retrieved from http://rave.apache.org/ 2013-03-01

3.2 The field study

The prototype environment that was described in the previous section was used for a field study. The field study involved in total 34 pedagogues from public schools and was carried out as a number of workshops involving 6-12 pedagogues each time. Informal conversations took place during the workshops and from the perspective of the study, these were threated as a form of contextual interviews, even though the form was very informal and the main activity during the workshops was the work with the digital learning environment. The focus of the workshops was on pedagogues composing their own digital learning environment using the WiLearn platform and widgets.

In order to get the most out of the “collective intelligence” of the pedagogues participating in the field study, the pedagogical scenario and the composition of the learning environment was carried out as a collective effort, with support from a developer in order to be able to encounter for issues that may occur from the fact that the WiMupple platform is still in a prototype stage and that problems may occur from time to time.

4 Results and discussion

First of all, it is obvious that a lot has happened technology wise since the first attempt towards a modular digital learning environment that was made in the VWE project. The fact that there is now a common concept a framework for modularity on the web is probably one of the most important single factors that may change the way the construction of digital learning environments are viewed and constructed. In the first attempt made in the VWE project, there was no other way than making the environment proprietary. Even though it was possible to address the problem of information silos (in part) and to work with standards to a certain level, there was still not possible to build a digital learning environment that was completely open and based on standards. In the second attempt, in the WiLearn project, it was possible to work with the common concept of widgets-based mashups and a much more extensive use of standards both general technology standards, standards connected to the widget and mashup field and learning technology standards. Still there was a need to develop some quite extensive parts that could not be solely based on standards and common practise since the widget and mashup frameworks were not developed enough. From that perspective the situation in the WiLearn was a lot better than in the VWE project, but still far from ideal and there was still a need for quite a lot of tweaking and solutions developed by the project team.

From the experiences of the WiLearn project it can be concluded that the concept of widgets and mashups has matured and so has the related standards. The development of frameworks, such as the Wookie and Shindig frameworks have come far and are now fully usable and almost production stable. Even though the Apache Rave platform is still in early development it is reasonably stable. Much due to the fact that both Apache Wookie and Shindig that are used as the basis for Apache Rave are stable products.

From a technology point of view, the study worked well and there were only a few technical problems and some of them could be countered for in the field study as it was carried out in a controlled environment with members of the project team helping out. The problems that arose where mainly due to the prototype nature of the WiLearn platform, with limited and/or missing functionality or related to widgets developed for different versions of the standards. Some widgets found in the external widget stores were simply not able to run on the WiLearn platform. This was an annoying problem, but far from being a showstopper. Another limitation, related to the versioning problem, was the limited support for inter-widget communication. Inter-widget communication is essential for creating the same level of conceived integration as in a traditional LMS-system and for implementing advanced and rich functionality. In a mashup everything is loosely coupled and different widgets are normally completely self-standing and self-contained and not “aware” of the context in which they are used. This makes it harder to maintain the feeling of a well-integrated learning environment. Still, the tight integration of LMS-functionality is often seen as a core problem of the LMS and is also what much of the criticism is targeting. With well-developed mechanisms for inter-widget communication integration can be managed by loose coupling instead, favouring adaptability and openness. There are strategies to deal with this problem and as the widget standards evolve, together with the implementation of html-feature, this problem is slowly being dealt with, se e.g. (Isaksson & Palmer, 2010) and (Sire, Paquier, Vagner, & Bogaerts, 2009) for an in-depth discussion on the inter-widget communication issue.

The WiLearn study, together with the experiences from previous studies, show that it is quite possible to implement all of the core functionality in a modular fashion using widgets and mashup technology. This basically means that mashup environments could potentially replace traditional LMSes. There are no restrictions regarding the type of digital learning environment that can be composed using a mashups. It is possible to create LMS-like learning environments as well as personal learning environments of combinations of the two. Everything depends on the widgets that are used in the mashup and the structure that is implemented. Hence, with the right set of widgets, a complete LMS could be built using as a mashup, even though an LMS may not be what is wanted or needed. The technical development is fast and by choosing modularity and standards in favour of monoliths, it is likely to be much more feasible to keep up with new and emerging technology. In fact, even though educational institutions in general are not among the early adopters of technology, many teachers are and everyone gains from an infrastructure for learning that is designed for change and that can meet with early adopters.

The study also confirms that modular learning environments are better adapted to suit different learning theories and pedagogical approaches as well as to different and changing pedagogical scenarios. Such features are beneficial and even essential in many learning scenarios, especially when working with pedagogical methods and approaches like Problem Based Learning (PLE) or case methodology, where it is hard (if not impossible) to foresee the learning path from start to finish beforehand – and thereby also to foresee the needs of the learning environment. Adaptability is also an essential property as it allows for the learning environment to be distributed (service-wise) over the Internet. At the same time it makes it possible to personalize and adapt the learning environment at the service level for group preferences as well as for personal preferences. The correlation between modular environments and adaptability and responsiveness, as well as technologies ability to match different learning theories, were discussed in detail in (Paulsson, 2008).

Several pedagogues also asked for ways to change the overall structure and look and feel of the WiLearn environment. This is an area that needs to be addressed in future versions.

Many pedagogues feel (and in fact are) restricted by the LMS and they got creative when presented to the mashup environment. Interesting, as well as a bit surprising, was that when pedagogues were given the freedom to influence how the learning environment was designed and what functions that should be available there was still a focus on the administration of learning and education. The difference was that the focus was on the small administrative tasks that is a part of the daily classroom activities and needed for communication with pupils and parent. This kind of support is often quite simple and surprisingly enough often missing in LMSes. Another, but related issue was the ability to create a personal “toolbox” with personal tools needed to facilitate teaching and all that is related. A common requirement was widgets that integrate different cloud services, such as Google Apps, DropBox, Twitter and likewise. There are widgets available that can do this, but the quality is varying and most of them are rather unsophisticated. The quality issue created a problem in general when searching widgets outside the WiLearn widget store. There is a huge amount of widgets available in different widget stores and many of them are of poor quality and they are adapted different versions of the standards, which cause some widgets not to function properly in the WiLearn environment. There is no good way of searching only for widgets intended for learning and education.

Another type of widgets that were asked for by the pedagogues participating in the study was support for specific pedagogical tasks and needs, such as widgets that could replace software for learners with special needs or widgets performing isolated tasks – i.e. replacing pedagogical desktop software. This is interesting and such widgets would in many cases be reasonably straightforward to develop. Unfortunately there are only a few widgets available of this kind and they are often dependent of language and cultural factors. In general, the supply of widgets that are especially developed for learning and education is small and of varying quality. Altogether, this contributes to an interesting business case where market competition is opened up for smaller actors to compete with LMS vendors by providing small and specialized components acting as building blocks in a mashup learning environments. In fact, it makes the learning environment independent of a specific LMS vendor to implement certain functionality. It has proven to be quite straightforward to develop simple widgets that can act as clients to different legacy (as well as to other) systems. The relation of system legacy and WiMupple is a concern that were raised a couple of times during the study and the idea of widgets acting as clients proved to be working, at least for simple cases.

In all, the study presented in this paper has contributed to the research field by providing a better understanding for how modularity and widget-based mashups influence the way that pedagogues approach the use of ICT and digital learning environments.

5 Future research

There are some potentially intriguing developments around the corner that are likely to benefit the development of mashup environments. On the one hand there is the general development, such as the gradual evolvement of html5 and standards for widgets and mashups. On the other hand there are developments within the field of learning technology standards, which at least on paper, look very promising from a modularity point of view. Among the most interesting efforts are the new specifications from IMS and especially the content standard IMS Common Cartridge (IMS CC) (2008) and the IMS Learning Tools Interoperability (IMS LTI) (2010) specifications. We are currently in the process of examining whether IMS CC can be used as a packaging format for WiLearn and furthermore, if IMS LTI can be used as a standard for widget communication and interactions related to pedagogical activities within a widget-based learning environment – as a complement to general standards. Severance et al. describes some experiments in (Severance et al., 2010) where IMS LTI was tested in a mashup environment and the results are promising and could be taken even further in the context of the WiLearn project.

The intention is to develop the WiLearn environment into a “production stable” framework for composing mashed-up digital learning environments that can be implemented and tested in a real-life educational scenario as a substitute to the LMS and to be able to study the use and effects in a real context over a longer period of time.

Another direction, that has already started, is the integration of the *Spider* and the WiLearn environment. The Spider is a national search service for digital learning resources that connects a number of repositories, using either metadata harvesting or federated search. This makes it possible to search for learning resources from several sources from a single point (Paulsson, 2009). The idea is to use the Spider as a widget store as well and by that making it possible to search for widgets and learning content in the same context.

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INTELLIGENT TUTORING IN INFORMAL SETTINGS: EMPIRICAL STUDY

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Abstract

Modeling and realization of an intelligent tutor for informal situations in support of formal education is a new and challenging problem relevant to the learning performance and efficacy. It needs further exploration regarding the factors that distinguish tutoring and learning in a formal classroom and informal places. The paper presents the results from an empirical study identifying the environmental conditions, cognitive states and emotional charge of students that influence learning in informal places like a cafe, a park, home and public transport. The techniques for attention concentration after task breaking and during task performance are determined according to the gathered students' opinion.

Keywords: informal learning, intelligent tutor, environmental conditions, affective state

1 Introduction

One direction for increasing personal effectiveness in learning is applying a strategy of intelligent tutoring. The research society is looking for a computer tutor combining the advantages of the human teachers' capabilities and multi-tasking and multi-modal techniques of machine learning in the form of web-based and mobile applications. Such computer tutor is described not only as a domain expert and instructional designer who guides step-by-step and advises a learner on demand but also as a good psychologist, adapting pedagogies and content to the emotional state. There are several solutions proposing adaptive tutoring according to the personal cognitive and affective charge of a given learner, realized by the integration of facial expression methods, sound recognition, text typing mood, observation of learner's physical characteristics.

Learning occurs not only during the planned classes according to the curriculum but also very often it continues in informal settings in cafe places, libraries, home, etc. in the time between classes and after that. Also, Csanyi et al. found the indicators through empirical study for interface between formal and informal learning. They agree that "informal learning is not only autonomous activity, but also can be influenced by teachers or trainers" and that the power of informal learning could be taken only if it is related to formal learning (Csanyi et al., 2008). Furthermore, Chang et al. report for specially created places for informal learning in the School of engineering at the University of Melbourne where students immediately after formal classes could feel comfortable to continue their learning in a "student-friendly" environment (Chang et al., 2009). The findings after a survey point increase use of the informal places if they are available for students.

Modelling and realization of an intelligent tutor for informal situations in support of formal education is a new and challenging problem relevant to the learning performance and efficacy. A motivated learner is looking for knowledge receiving in informal spaces or outside the university in a time and place suitable for him. The environmental conditions and the specificity of the places for informal learning are different than these for lecture or practice classes. There are many variables for disturbing and interrupting a started learning activity. The conditions and causes for interruptions in an informal learning session and techniques for easy transitions from pauses to learning are still not studied and algorithmized well. The main factor for improving the learning breakdowns is attention concentration on the learning content according to research reports. Also, there is evidence that emotions influence on learner's attention and concentration focusing on a given learning item (Chaffar and Frasson, 2004). Another problem is related to motivation increasing for learning after interruptions and fast returning of attention to the current studying point.

The aim of this paper is to identify the variables important for the realization of an intelligent tutor supporting informal learning through empirical study. The explored variables are grouped in five categories: (1) influence of environmental factors on attention concentration; (2) attention allocation techniques, (3) identification of suitable cognitive level of learning in informal places, (4) influence of emotional charge on learning (5) factors for improvement of motivation for learning.

2 Method

The aim of this empirical study is to identify disturbing and favorable factors that impact on learning in informal places. For this purpose, survey tools are developed to gather the opinion of students. In this exploration 22 male and 7 female students are involved. They are in their third year of bachelor degree study in Computer Science. The survey tools include questions related to:

(1) How the environmental conditions influence on the process of learning? The conditions at four often used places for informal learning are examined: cafe, home, park and public transport vehicles. The used scale for evaluation is ranged from 5 – this factor possesses very high influence on learning to 0 – this factor does not influence on learning.

(2) How the emotional states of a student contribute to the motivation for learning? The emotions are divided in positive and negative and their imprint on the task concentration is identified. Students' vote range from 5 – this emotion is very important for my learning to 0 – this emotion is not important.

(3) How does personality influence on informal learning? The students' personality is classified in 6 different groups: *group1* includes students with intensive social life, who like to be in the centre of attention and who in their activities is influenced by positive emotions; *group 2* collects quiet, reserved, self-controlled students who think intensively before every single step, their attention is concentrated on their inside and specific personal life, they are slightly engaged in social relationships; *group 3* gathers students who are easily affected by the conditions of the environment, they easily can be discouraged, the typical emotions for them are: anxiety, angry, guilty, envy, depression.; *group 4* characterizes very impulsive persons who usually perform risky activities, they do not plan their steps, they are at enmity with each other, they are with spirited mood.; *group 5* are persons who respect social laws and rules and these rules are a base for their activities; *group 6* – it includes students who cannot categorize them-selves in the above mentioned five groups.

(4) What kinds of techniques are suitable for attention concentration when learning occurs in informal settings? The techniques are classified in 3 groups: appropriate techniques for attention returning when a disturbing factor emerges, techniques for attention allocation during the task performance and techniques for motivation to learn in informal situation.

(5) What is the maximal achieved level of cognition when a student learns in a café, at home, in a park, in public transport vehicles? Bloom's taxonomy with its 6 levels: knowledge, comprehension, application, analysis, synthesis and evaluation is used. This will point the level of task complexity suitable for serving to students when they decide to learn informally. It is important for motivation improvement and for induction of positive emotions.

3 Influence of environment

At the foundation of this research the main hypothesis is that: the sound level, light intensity, temperature, dynamics of people stream, furniture comfortableness, weather conditions, GSM ring, food/coffee smell and secondary computer/mobile applications are among the factors that could disturb or support learning when it occurs outside the formal classes. In order to prove or reject this hypothesis the results of students' votes are summarized in Table 1 in the cases when they use mobile computers or smart phones for learning in a cafe, at home, in a park or in public transport. The opinion of male and female students for the interference of the surrounding conditions on a learning process differs. To identify the most disturbing factors the average values of male and female students are calculated. The findings point that in a cafe: the loud talk (4.35) and loud music (3.5), intensive stream of people (3.84), additional computer applications (3.01), GSM ring (2.96), hot room (2.81) and poor light (2.65) are among the interventional factors with the biggest value. When students are at home, they break off their task doing because of influence of the above mentioned factors typical for a cafe plus the feeling of nice sunny weather (2.85), feeling the comfortless of the furniture (table – 2.63, chair – 2.5) and the low temperatures in the room (2.51).

Factor	In a cafe			At home			In a park			In transport		
	score male	score female	score average	score male	score female	score average	score male	score female	score average	score male	score female	score average
Loud music	4.14	2.86	3.5	3.86	3.43	3.65	3.55	2.14	2.85	3.86	3.57	3.72
Quiet music	1.59	1.71	1.61	1.36	2.57	1.97	1.23	1.14	1.19	1.82	2.14	1.98
Loud talk	4.41	4.29	4.35	3.73	4.71	4.22	4.36	4.29	4.33	3.91	4.14	4.03
Quiet talk	2.18	2.71	2.45	2.09	2.57	2.33	1.91	3	2.46	2.18	3.14	2.66
Intense light	2.41	2.29	2.35	2.45	2	2.23	2.41	2.29	2.35	2.5	2.71	2.61
Poor light	2	3.29	2.65	2.14	3.29	2.72	2.23	2.71	2.47	2.23	2	2.12
Hot room/cabin	3.05	2.57	2.81	2.86	2.57	2.72	-	-	-	4.59	3.86	4.23
Cold room/cabin	2	1.58	1.79	2.59	2.43	2.51	-	-	-	3.05	3.43	3.24
Intensive stream of people	3.68	4	3.84	3.36	4.43	3.9	2.86	4.14	3.5	3.64	4.14	3.89
Low stream of people	1.82	2.71	2.27	1.4	3.86	2.63	1.36	3	2.18	1.91	2.86	2.39
Comfortable chair/bench	2.55	1.71	2.13	2.86	2.14	2.5	2.55	2.29	2.42	2.45	1.57	2.01
Comfortable table	2.14	2	2.07	2.68	2.57	2.63	-	-	-	-	-	-
Nice sunny weather	2.14	2.71	2.43	2.41	3.29	2.85	2.91	3.14	3.03	2.36	2.43	2.4
Nasty rainy weather	1.77	2.29	2.03	1.77	1.57	1.67	3.55	4	3.78	2.64	2	2.32
GSM ring	2.91	3	2.96	2.5	3	2.75	2.23	2.86	2.55	2.73	2.71	2.72
Strong food/coffee smell	2.18	1.43	1.81	2.27	2.29	2.28	2.09	1.29	1.69	2.45	1.29	1.87
Week food/coffee smell	1.23	1.14	1.19	1.45	1.14	1.26	1.23	1.14	1.19	1.23	1.86	1.55
Computer/mobile applications	2.73	3.29	3.01	3.36	3.43	3.36	2.41	3.29	2.85	2.5	3.29	2.9
Stops frequency	-	-	-	-	-	-	-	-	-	2.55	3.14	2.85

Table 1. Students' vote about the influence of environmental conditions on their learning

During the time in the park students' attention is drawn aside from the loud sound (talk – 4.33 and music – 2.85), the weather conditions (nasty rainy weather – 3.78 and nice sunny weather – 3.03), intensive stream of people (3.5), additional computer/mobile applications (2.85) and GSM ring (2.55). When students travel via a public transport vehicle they feel intervention of temperatures in the cabin (hot cabin – 4.23 and cold cabin – 3.24), loud sound (loud talk – 4.03 and loud music – 3.71), intensive stream of people (3.89), additional computer applications (2.9), stops frequency (2.85), GSM ring (2.72) and nice sunny weather (2.4). The repeated factors in the four described cases for informal learning: in a café, at home, in a park and in public transport are shown on Figure 1. As it can be seen the students are very sensitive to the loud sound, intensive stream of people, additional computer/mobile applications installed locally on their devices and GSM ring. These factors should be taken into consideration when an intelligent tutor is designed in support of learning in informal situations.

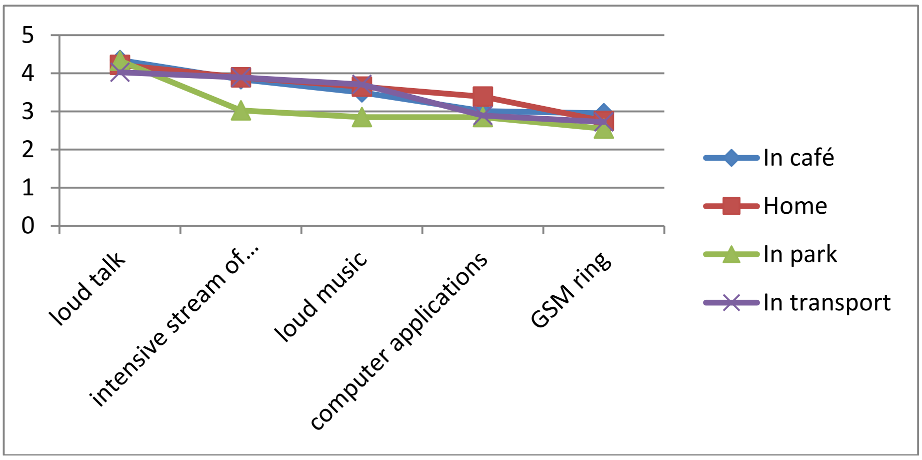

Figure 1.The common factors disturbing learning in a cafe, at home, in a park and in public transport

4 Techniques for attention concentration and motivation

Different interventions could interrupt the students' task doing or problem solving and researchers are looking for suitable techniques that can easily and fast return the students' attention on the working item. Roda and Nabeth discuss four levels for attention focusing in an online learning environment: (1) perceptual level - techniques for facilitating the access to the important parts of a web page, for selection the needed information as well as techniques for attention focusing after interruption; (2) deliberative level - tools for performing control on tasks and tasks priorities, techniques for motivation and attention returning; (3) operational level - techniques and tools for context keeping after interruptions, for information filtering, for reducing the level of complexity, (4) meta-cognitive level - tools for self-diagnostic, techniques for attention allocation (Roda and Nabeth, 2008). Techniques, tools and strategies for attention focusing suitable for an application at the above described four-level model are extracted from the book "Human attention in digital environments" edited by Roda (2011) and this information is analyzed and visualized on Figure 2.

For the purposes of this exploration the techniques for attention concentration are divided to: (1) techniques for attention returning when a task is interrupted and the student gives up to continue at this moment and (2) techniques facilitating task performance and attention allocation. According to the students' opinion when a factor breaks a task it would be very useful for software to remember the last used item and to select it in different color or in another way (77% of all surveyed students). When a student decides to return to this task it will be easy to continue from the selected item. The students also appreciate help (72.5%) and advice receiving (64.5%) how to continue with the problem solving, hint how far it gets last time (58%) and summary describing the work to this moment (53.5%). From the survey it becomes clear that students do not like software interventions in the form of reminder saying that they *must* continue (only 35% of all students give their vote for this technique). Among the techniques enhancing task performance with the highest rate are: availability of instructions for task performance (90.5% of all voted students), structuring the tasks according to different criteria (53.5%), receiving appropriate advice (62.5%) and help (58%), a kind reminder about the goal of this task (60.6%), and decreasing the task's complexity when it is needed (53.5%). The students do not appreciate enough the power of techniques like: tracking of affective states (face and facial expression recognition) (49%), eye tracking (9%), and hands tracking (26%), although there are several developed intelligent tutors reporting promising results. They integrate methods for affective state recognition (Whitehill et al., 2008; Alexander et al., 2006; Ntombikayise and Robinson, 2011) and hand gestures tracking (Bustos et al., 2011; Abbasi et al, 2008).

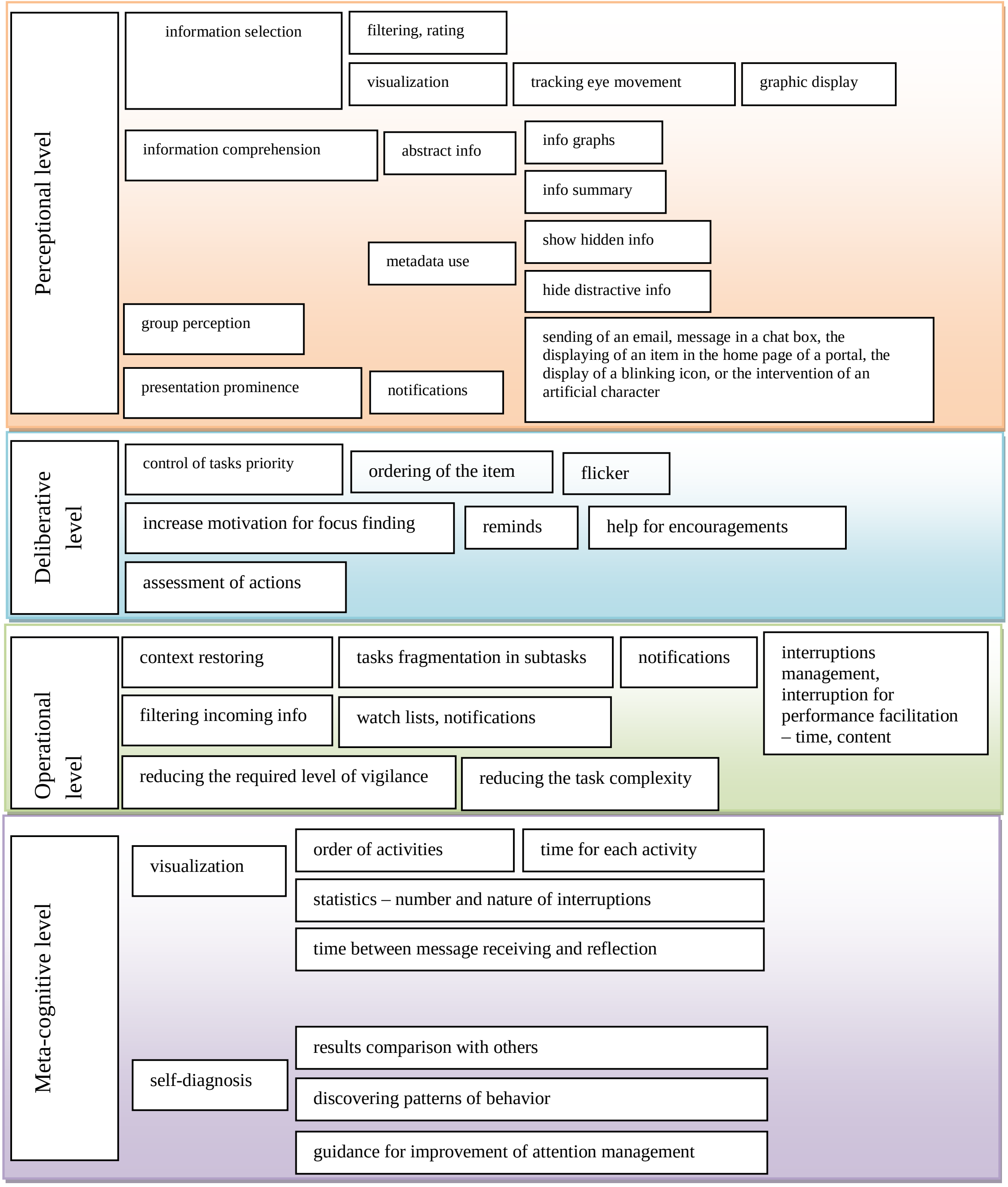

Figure 2. Four levels for attention management in digital environment according to (Roda and Nabeth, 2008) and (Roda, 2011)

The tutoring system M-Ecolab uses a mechanism for adaptation of the learning resources according to the individual student's motivational state (Rebolledo-Mendez et al., 2011). The degree of motivation is identified automatically through measurement of the students' participation in solving problems, the level of tasks difficulties, and according to the requested help during a task doing. The effect of the applied motivational techniques on learning are evaluated through statistical tests that show "significantly higher scores in the domain knowledge" achieved by students.

Among the directions for motivation improvement the students think that the following techniques could contribute: time limiting for every single task (70.5% of all responders), comparison of learning achievements among all participant in a lesson (62.5%), creation of a report summarizing the students' current progress (56%), usage of messages notifying the current tasks' status and student's progress (53%). The techniques like creation of a rating list (42%) and usage of messages for encouragement (37%) are not rated very high by students.

5 Cognitive states

The Bloom's taxonomy with its six levels for achievement of given cognitive skills is used to determine the types of tasks suitable for serving to students when they are placed in informal settings. According to the learning objectives the tasks are classified into 6 groups: *group A* includes tasks for existing knowledge recalling, *group B* contains tasks for new knowledge understanding, *group C* – tasks that require applying old and new knowledge in problem solving, *group D* – tasks that are connected to the analytical students' skills, *group E* consists of tasks that require skills for knowledge combination and creation of new solution, *group F* includes tasks for evaluation and judgement of knowledge, concepts, solutions. According to the responders the best learning tasks in a cafe should be focused on existing knowledge recalling, comprehension of new concepts and applying this knowledge to solve a problem (tasks from A, B and C groups). In a park and in transport the suitable tasks are not so complex tasks - they require repetition of existing knowledge and understanding new concepts (tasks from groups A and B). Home proposes the best conditions for informal learning and students could solve complex problems including tasks at the levels of analysis, synthesis and evaluation (tasks from all groups).

6 Affective states

Nowadays, ITSs are improved through modules for recognition of the student' affective states and possibilities for the induction of suitable emotions for learning. Several of them can predict the emotional state of a student, dynamics in his behaviour and in this way different strategy for motivation could be applied and the learning path could be optimized.

Rishi (2009) discusses the influence of emotional state on attention in task doing – negative emotions (anger, anxiety, or distress) do not allow focusing on the learning item or moving the attention to the new one and in this way the learning performance is decreased. Positive emotions like joy and pride could facilitate thinking and learning. The author proposes a rule-based dynamic method for ensuring the best emotional conditions for learning, including detection of emotions and provoking suitable affective state for performance improvement.

Chaffar and Frasson (2004) present a system ESTEL (Emotional State towards Efficient Learning system) that has features to predict the optimal emotional state for learning according to the learner's personality. It can induce the appropriate emotions to improve the processes memorization and comprehension through applying different techniques like guided imagery, music and images. The learners' personality is divided into four groups: (1) extraverts are active and communicative persons who could easily be influenced by positive emotions; (2) neuroticism is typical for people who are easily affected by the conditions of the surrounding environment and who are easily discouraged; (3) psychoticism are impulsive and hostile people; (4) lie group includes sociable persons with respect to the societal laws. The authors show the connection between a learner's personality and optimal emotional state. As it can be seen the common affective states that could play a catalizator role for learning are positive emotions like: joy, confident, pride, anxious, self-gratification. The authors propose a six module architecture including: emotion manager - responsible for emotions monitoring, distribution and tasks synchronization; emotion identifier - recognizes and predicts the emotional state of the learner according to his color preferences; personality identifier - identify the personality of a learner through a questionnaire and communicates with the emotion manager module; optimal emotion extractor determines the optimal emotional state according to the learner personality using a set of rules; emotion inducer - induces the suitable emotions for learning; learning appraiser evaluates the learner' s performance in his current affective state through a pre-test and evaluates the performance in his optimal emotional state through a post-test. The Naive Bayes classifier is applied for optimal emotional state prediction in correspondence of the learner's personality.

du Boulay researches the factors that could support the design of motivational modules in ITSs (Boulay, 2011). The author explores three negative emotions: frustration, anxiety and boredom and searches for suitable pedagogical strategies according to the three motivational states: values (personal, social and cultural background of a student that stimulates his participation in a learning process), expectancies (expectations of a student for performing learning) and feelings (the emotion emerging from the previous experience).

Another study addresses the influence of positive emotions on learning performance and facilitation of the cognitive process (Um et al., 2007). The findings show significant impact of positive emotions on cognition and learning. The authors agree that instructional design and instructional learning objects can be used for induction of a positive mood, to improve students' experience, satisfaction and performance.

For the purposes of this study a set of emotions – positive and negative is proposed to students to cast their vote about the influence of emotions on learning in an informal situation. As it can be seen on Figure 3 and Figure 4 the positive as well as the negative emotions have the power to drive learning and to motivate or not the students. The positive emotions with the highest scores that support meaningful learning are: joy, happiness, enthusiasm, and confidence. Among negative emotions that influence learning with the highest scores are: angry, perturbed, anxiety and hopelessness.

The students' personality is explored too according to self-report of responders. 31.9% of male students and 28.6% of female students self-describe as quiet, reserved, self-controlled students; they prefer to learn alone, concentrating all their attention on the learning item. 22.7% of male students and 42.8% of female students are classified in the group of social, active and communicative persons; they are easily influenced from the positive emotions.

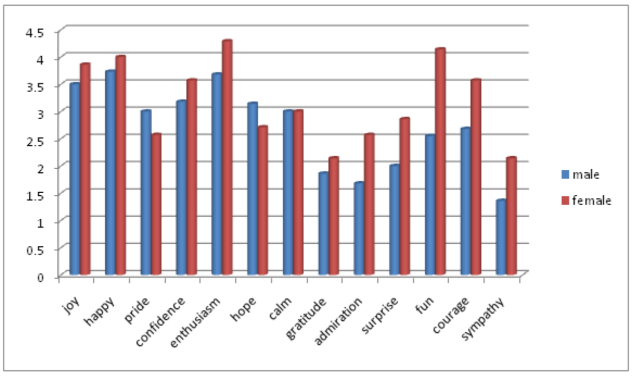

Figure 3. Students' vote about the influence of positive emotions

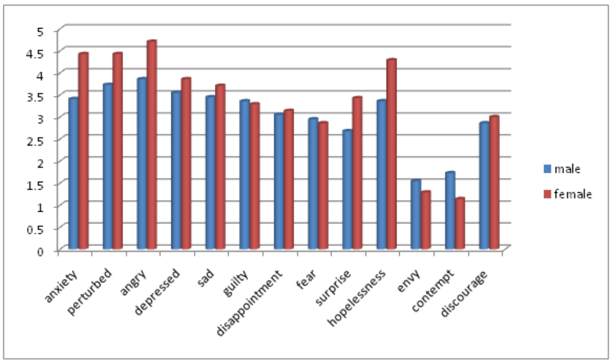

Figure 4. Students' vote about the influence of negative emotions

The rest of the students (the smaller part of the responders) define them-selves as students who are easily affected by the environmental conditions (13.7% of male students and 14.3% of female students); as very impulsive persons who usually perform risky activities (13.7% of male students and 14.3% of female students); as persons who follow social rules in their activities performance (9% of male students) and as students who combine features of the above mentioned personality groups – showing one or other feature according to the conditions and situations (9% of male students).

The results from the empirical study and findings from literature point that an intelligent tutor with an intention to support informal learning has to integrate techniques for induction of suitable emotions predisposing students to continue their work on tasks and achieving the planed outcomes.

7 Conclusions

The paper presents the results from an empirical study with focus on the main factors that impact on learning efficacy when students are placed in informal settings according to their vote. The findings show that there are many different factors that disturb and interrupt learning. Several of them are so strong and they could lead to task breaking for a long time or refusal of further problem solving and task doing. Therefore, suitable techniques for motivation and emotional charge have to be selected very precisely and used for realization of an intelligent tutor. This study stresses strongly the main factors that should be taken into consideration when learning occurs in an informal situation and they are found in environmental conditions, the level of cognition, the emotional state, attention concentration and motivation for learning. A model is developed to summarize variables that influence learning in informal situations (Figure 5).

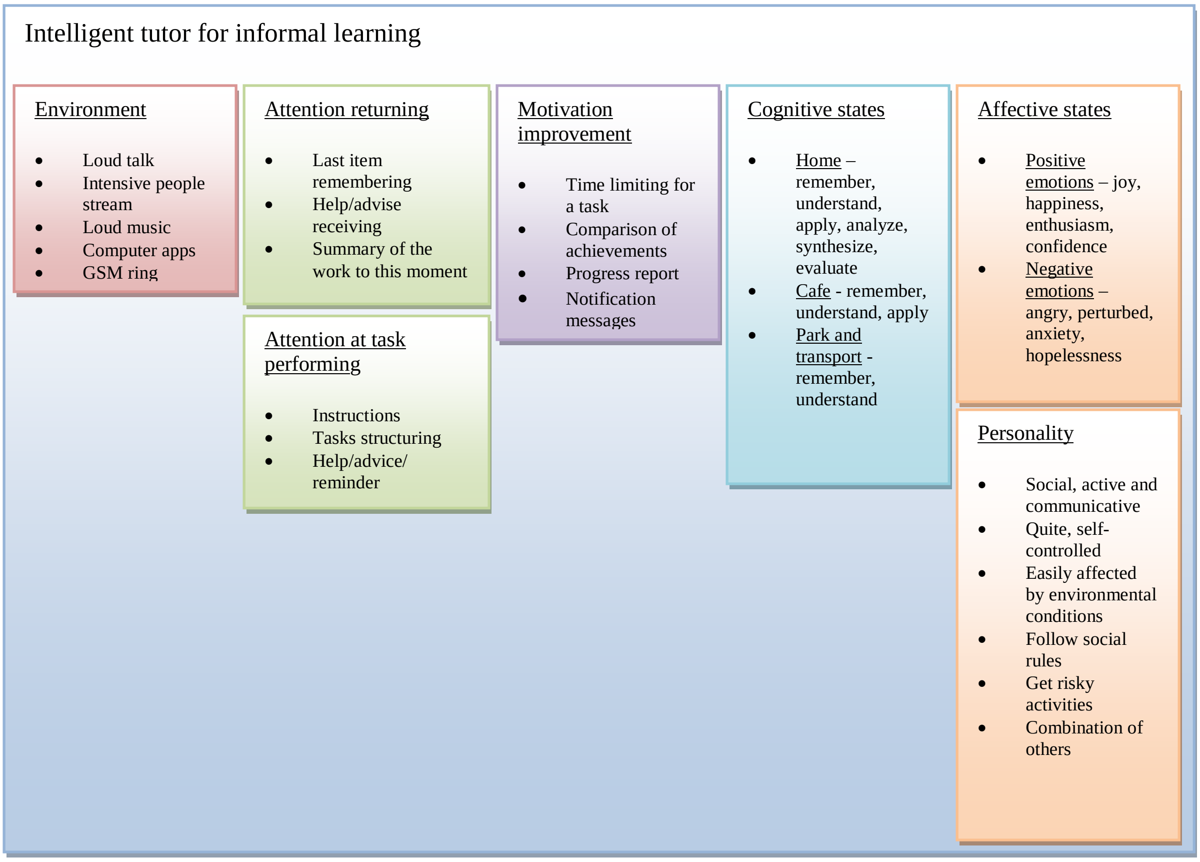

Figure 5. Factors influencing learning in informal situations

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