



## **eL&mL 2012**

The Fourth International Conference on Mobile, Hybrid, and On-line Learning

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# eL&mL 2012

## Forward

The fourth edition of the International Conference on Mobile, Hybrid, and On-line Learning (eL&mL 2012), held in Valencia, Spain, on January 30<sup>th</sup> – February 4<sup>th</sup>, 2012, focused on the latest trends in e-learning and also on the latest IT technology alternatives that are poised to become mainstream strategies in the near future and will influence the e-learning environment.

eLearning refers to on-line learning delivered over the World Wide Web via the public Internet or the private, corporate intranet. The goal of the eL&mL 2012 conference was to provide an overview of technologies, approaches, and trends that are happening right now. The constraints of e-learning are diminishing and options are increasing as the Web becomes increasingly easy to use and the technology becomes better and less expensive.

eL&mL 2012 provided a forum where researchers were able to present recent research results and new research problems and directions related to them. The topics covered aspects related to tools and platforms, on-line learning, mobile learning, and hybrid learning.

We take this opportunity to thank all the members of the eL&mL 2012 Technical Program Committee as well as the numerous reviewers. The creation of such a broad and high-quality conference program would not have been possible without their involvement. We also kindly thank all the authors who dedicated much of their time and efforts to contribute to the eL&mL 2012. We truly believe that, thanks to all these efforts, the final conference program consists of top quality contributions.

This event could also not have been a reality without the support of many individuals, organizations, and sponsors. We are grateful to the members of the eL&mL 2012 organizing committee for their help in handling the logistics and for their work to make this professional meeting a success.

We hope that eL&mL 2012 was a successful international forum for the exchange of ideas and results between academia and industry and for the promotion of progress in eLearning research.

We also hope the attendees enjoyed the beautiful surroundings of Valencia, Spain.

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## Evaluation of a Blended Learning Approach Used in an Anatomy and Physiology Module for Pre-registration Healthcare Students

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**Abstract**—This paper presents evaluation data following the revision of the delivery method for an anatomy and physiology module for pre-registration healthcare practitioners, into a blended (hybrid) model. This subject is recognized as problematic when delivered by traditional methods, therefore change was instigated to introduce stimulating, interactive material; this was presented through use of e-learning tools to supplement the face-to-face sessions. The evaluation data consists of student outcomes from the hybrid mode of delivery compared with previous cohorts using the traditional methods, plus student satisfaction surveys from the students undertaking the module by blended learning. Results of the evaluation have identified that student outcomes for the new delivery method are demonstrating a trend for improvement for a multiple-choice exam, with no significant difference noted for a seen exam. The survey determined that the majority of students indicated satisfaction with the overall quality of the module, with the teaching methods, with the content and with the support provided to them. Therefore, this study suggests that a well designed blended learning system, with good academic content and interactive exercises are motivating for learning and yields as good, if not better, outcomes as a lecture. The module delivery will continue to be enhanced through the addition of synchronous chat facilities and online social network tools.

**Keywords** - *Blended learning; Hybrid learning; Anatomy; Physiology; Pre-registration; ODP.*

### I. BACKGROUND

This paper focuses on a significant change to the delivery method of an anatomy and physiology module in the first year of an undergraduate pre-registration course for Operating Department Practitioners (ODPs), a healthcare discipline regulated by the Health Professions Council, in the United Kingdom (UK).

Literature indicates that anatomy and physiology are amongst the subjects that many healthcare students find hardest [1,2], but this knowledge is vital as it underpins clinical practice.

Delivery of the material had traditionally been by lecture, with drawings and anatomical models, and more recently digital images and video, being used in support. Cadaver prosection and dissection have also been employed within medic (doctor) education [3], but this is not usual practice in the courses of other healthcare disciplines.

Evidence suggests that the traditional lecture-based

model of delivery may be a contributory factor in the problems encountered by students [4-8]. Also, Government policies related to higher education in the UK have indicated that effective use of technology-assisted student-focused learning is essential for the future [9-12].

In consideration of both of these factors, the module delivery was reviewed and a blended (hybrid) model was adopted, which utilizes both face-to-face and e-learning delivery of content. The theoretical foundation upon which this revision is based is constructivism and cognitive learning theory, with the 5E enquiry model [13] being applied in development of the online tools.

This change aimed to provide fresh stimuli to the delivery, in order to promote students' learning of anatomy and physiology through questioning, investigating, challenging, seeking feedback, and learning to consider interactions with other team members [14].

This paper begins by presenting evidence that supports the need for change, and offers an overview of the potential benefits and issues that may be encountered when using e-learning; this aims to explain why the hybrid system was adopted. The revised delivery structure is described, and the paper then progresses to discuss data collection and analysis of an evaluation that was undertaken on the students' outcomes and their views on the delivery. The data is analysed and then discussed in relation to current literature, and finally future developmental plans are presented.

### II. RATIONALE FOR CHANGE

This study is based on a module where the students are taught normal and altered anatomy and physiology of eleven human body systems such as the Cardiovascular, Muscular, Respiratory, and Skeletal Systems, underpinned by the concept of homeostasis. The anatomy element of the content requires students to identify component parts and structure of the body systems, whereas the physiology requires them to understand the function. Homeostasis is the process of maintaining a balance across the body systems, supporting both physical and psychological function. Safe and competent clinical practice is founded upon an accurate knowledge and understanding of this material, and the variations that do occur [15].

In healthcare education literature the subjects of anatomy and physiology have been clearly identified as problematic [16, 17], as there is a strong indication that students find the

subject very difficult [1,18,19], which is almost certainly a contributory factor to the reports that students fear the subject [19-21], are dissatisfied with the teaching [4-8], have high fail rates in assessments [2], and have difficulty in applying the theory to clinical practice [4,5,22]. There is general agreement that these subjects require educators to explore, and where possible implement, innovative approaches to ensure quality learning of these important topics [2,8,23].

### III. DELIVERY METHODS

Lectures have traditionally been viewed as a very inexpensive way of presenting new ideas and concepts to a large group of students. However, lecturing has been described as an ineffective tool for promoting theoretical understanding of concepts [24], and lectures rarely stimulate student thinking and get information beyond the students' short-term memory [25,26]. In lectures students usually assume passive roles as listeners while the tutor imparts the information. Educating in this way is too focused on what is being delivered, rather than the learners and their needs [27]. But, teaching the same content can be made more interesting, and students can become active, independent learners, if different delivery methods are used [28].

However, just as an effective educator should consider individual differences among students and adjust teaching strategies accordingly [29], the selection of appropriate technological tools needs the same consideration [30], and their use should be integral to the process of learning, not obviously an addition [31].

An evaluation of technology-enhanced learning (also commonly referred to as e-learning) used in healthcare education identified that the different tools that are available span from instructivist to constructivist approaches, as set out in the e-Learning Ladder [32, adapted by 33] (Figure 1). Instructivist learning theory is teacher-focused where

knowledge is transferred from the 'instructor' to the passive recipient (the student). Whereas in Constructivist theory it is the student, rather than teacher, who is the focus and 'constructs' new knowledge through analysis, experience and understanding. The latter describes the approach that is needed in order to move away from the traditional delivery of anatomy and physiology, and the Ladder identifies that opportunities for learners to be active in creating their own knowledge and understanding can be offered through Web 2.0 technologies, such as discussion boards. These Web 2.0 applications allow students to not only retrieve information but also provide a platform to create and own the data within them [34]. These tools can be used as an alternative or in addition to traditional lectures; either way results in more learner-centred teaching [35].

When used appropriately in education, interactive technological strategies have been identified as enriching student learning [36,37], and this occurs through decentralizing the teaching process, and in doing so facilitating learner independence [38] and through active engagement in the learning process [39]. The potential of e-learning to deliver innovative approaches specifically in healthcare education is recognized [40,41], and interactive multimedia e-learning systems have been highlighted as working particularly well when used in biological science courses [33,42,43].

One determination of effectiveness can be student satisfaction, and the last decade has produced clear empirical evidence of positive attitudes by healthcare students toward e-learning [44-50].

Another, equally as important consideration, is the effect that this mode of delivery has on student outcomes, and evidence supports the supposition that technology-enhanced teaching used in the fields of health and science positively influences students' learning outcomes [51-55]. Indeed, in a study of a blended learning course [56], students had higher final grades compared to students studying the same course in a traditional manner. Also, another group of students studying a Cardiovascular element of a course demonstrated significant improvement in their performance after using the technological tools that were made available to them via a website [37]. Similar improvements in performance by both on-campus and distance-learning students undertaking e-learning anatomy courses suggests that this method can be used successfully to teach this subject [57, 58].

There are also indirect benefits in using technology-enhanced learning, such as the development of students' computer skills [59]. However, this is directly relevant to one problem commonly associated with e-learning, because just as with any genre of course, learners need to have the appropriate resources in order to be successful. These resources in an e-learning context can be classified as 'External' to the learner, such as slow Internet connections or older computers, and 'Internal' to the learner, which may be a lack of the necessary computer skills. Without these resources, accessing the course materials can be difficult and

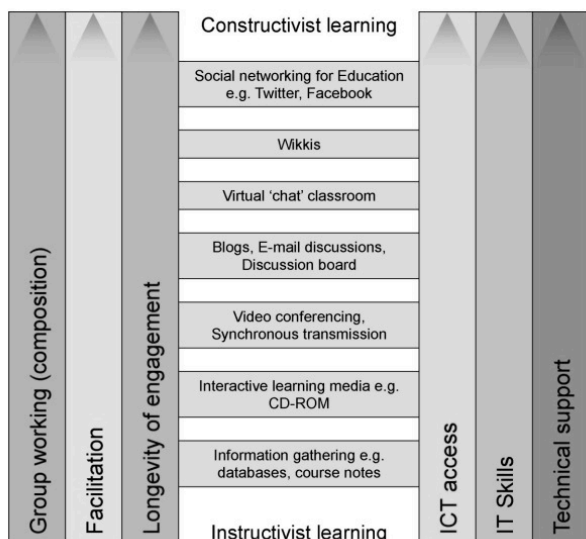


Figure 1. E-learning ladder [33]

the learners' performance can be hindered [60], and it can also cause anxiety [61], which can lead to lack of motivation [44,62,63], which may ultimately result in students becoming frustrated and giving up [64-66], or could even cause them to avoid enrolling on e-learning courses [67,68]. So although, as indicated previously, the students' information technology (IT) skills may unintentionally be enhanced through this mode of learning, the very fact that improvement in these skills may be needed, could in itself adversely affect students' uptake and progress on an e-learning course. However, it has also been identified that an initial lack of confidence can be replaced by positive excitement once the initial experience of e-learning has taken place [69-74].

A lack of computer skills may also result in students on an e-learning course feeling isolated from the tutor, due to them struggling to use the online communication methods; this has resulted in them indicating a preference for face-to-face teacher-centred learning [75,76]. Also, younger students who had just recently finished years of compulsory education, with its requirement for attendance in class, felt that they too were more comfortable face-to-face with a tutor [77]. So, for the tutor using any form of technology-enhanced learning, there is a clear requirement that human-to-human interactions must take place, for teaching, support, and to build a sense of community amongst those undertaking the course [62].

#### IV. PROGRAMME STRUCTURE

The theoretical foundation of the module delivery is constructivism, however cognitive learning theory is also considered [78], which suggests that if students are active in their learning, they will achieve more, through assimilation of the knowledge, leading to better comprehension. Alongside this, the online elements were developed using the '5E enquiry cycle' [13], as indicated in Table I. The 5E inquiry process is recommended as an effective means to help students to understand science-related subjects, and to

TABLE I. APPLICATION OF THE 5E INQUIRY PROCESS

Engagement
Within the forums, the students are asked questions to stimulate response and maintain interest
Exploration
The students have to study the material in order to be prepared for the discussions in the forum
Explanation
The sequence of the systems and their related questions require the students to find answers to the virtual patients' daily updates
Elaboration
The tutor facilitates discussion in the forum to focus the direction, to ensure the students consider what has gone before, to promote retention of information and to move the learner toward possible application in practice
Evaluation
The weekly testing determines learning progress, providing immediate and timely feedback.

apply theory to authentic situations needed for the real world [79].

The delivery pattern for the module includes both face-to-face and e-learning sessions, the latter through use of the University's virtual learning environment (VLE). VLEs provide a repository function and allow space for online interactions between students and staff; they are reported as being widely used in subjects such as nursing and social sciences [80-82]. The rationale for using this blended (hybrid) delivery was to utilize a variety of systems that would potentially appeal to a range of students' preferred styles of learning, to promote interactions, both face-to-face and online, and to foster a sense of community.

The module is timetabled for delivery over a three-week period, and the division of the delivery methods is split 30:70 in favour of e-learning. The first day of the module takes place on campus, where the required logistical and administrative activities are initially carried out, followed by team building exercises, which are designed to introduce the students to each other and to facilitate the creation of social networks. The students are then placed into groups, which relate to how they will be distributed within the VLE, and a further team-based activity takes place, this time online, using the computers in the lab. This introduces the students to the virtual learning environment and aims to provide a guided tour through the system. During this activity the tutor demonstrates what is required via projection of their own computer onto a large screen in the lab, which gives real-time assistance and support; whilst reviewing progress during the activity, the tutor also takes this opportunity to identify any students who appear to lack basic computing skills, and discreet guidance is provided on the appropriate student support mechanisms that are available within the institution.

The remainder of the first day, and each of the face-to-face sessions that follow, consist of 'traditional' lectures and some active-learning methods that encourage student learning [83-85]. All of the material that is delivered during the on-campus sessions is also provided within the VLE, alongside the resources for the e-learning activities.

The second day of the module is an e-learning day, with the third being on-campus again; the latter provides the tutor with an early opportunity to address any computing issues that the students may have encountered during the second day's activities. The remainder of the programme is allocated across the days that are left, ensuring that the virtual learning is interspersed by face-to-face sessions on regular intervals.

On days designated for e-learning, the students are not required to attend campus, providing they have access to appropriate computing equipment. If they do not, or if they just choose to come onto the campus, then the resources are available within the computing labs. The activities for each day are in the VLE, within folders labeled by date, providing a structured plan for the students, setting the pace of learning within the framework of the time available; this strategy

aims to encourage the students to develop basic time management techniques [86-87].

Within each activity folder, the students are presented with various resources, including podcasts, videos, and links to online resources outside of the institution. Having reviewed the materials, the students then access their group discussion board, where they aim to address questions relative to their virtual patient.

This virtual patient is first introduced to the groups during the VLE activity on day one, where they are given an image of the patient (created by the tutor using an avatar building tool), and a brief pen picture giving information such as age, height, and weight; each group has a slightly different character. As the programme progresses, the tutor adds information to the patient profile, relevant to the body systems the students have studied that day, either on-campus or via e-learning. At the same time as building the profile, the tutor challenges the students' understanding by setting questions relevant to their particular patient and the body systems being discussed. For example, on the day where the endocrine system is studied, the virtual patients' blood sugar levels might be made available, and the students then need to determine if they are within normal parameters, and if not, what might be the cause, how it might be managed and the long-term effect on the patient. This patient-based approach allows students to look for solutions by engaging in independent study, reviewing data, and reflecting on their own learning experience. Learning anatomy through a clinical perspective is said to result in better recall and understanding amongst students [88].

All of this takes place within asynchronous discussion forums, with both the students and the tutor contributing to the content. The tutor's role is that of e-facilitator, or e-moderator, ensuring that the appropriate learning takes place in the discussions and that all members of the group make contributions. To promote this, all group members are given an identifier, a number 1 to 6, and the tutor targets the questions to a particular member of the group, by number. Once this person has satisfactorily responded to the question, the tutor opens it for contributions by the other members of the group. This aims to mimic the control that the tutor has in the traditional classroom, and prevents any enthusiastic members of the group from contributing more than their less eager classmates [33]. This method of control also addresses the issue of lurkers, namely those who access and benefit from others' contributions without interacting themselves [44,89].

Small group learning was implemented as it has emerged as being well suited to developing anatomical understanding, as has peer assisted learning [23]. The group process enables students to develop problem solving skills fundamental to developing their understanding; in doing so they learn to search for knowledge using the available resources, and to work in teams. Based on the contributions to the forum, the tutor evaluates progress based on the students' knowledge building, problem solving and development of their

interpersonal skills [90].

Formative testing takes place once a week during one of the on-campus days, and it is based on all of the body systems that have been covered up to that point. The testing is carried out in the computer labs using the computer-based examination tools that are used for the summative assessment for the module. This not only provides both the tutor and the students with feedback on the students' progress with their studies [91], but also allows the students to practice with the interface and process prior to the final assessment, which has been shown to improve student performance [92-94].

The final day of the module delivery is on-campus. Here the students are presented with a new virtual patient, one not previously used by any of the groups, and the same type of question and answer process that the students have experienced within the discussion forums takes place in the classroom, but based on this new patient's parameters. The activity takes place within a quiz format with the groups competing against each other, and points being awarded for correct answers; a token prize is awarded to the winning group. Presenting the material in this way acknowledges the importance of the cognitive component of the activity (e.g., selecting, organizing, and integrating knowledge) to promote meaningful learning [95].

The two summative examinations take place several weeks later, following a period of time where the students undertake self-directed study and have tutorial support, as requested.

## V. DATA COLLECTION

The module is delivered twice per academic year, September and March, with approximately 32 and 24 students per cohort respectively; the revised programme was implemented two years ago.

Overall student performance in the module was measured by outcomes in the two computer-based summative assessments; data is presented for two cohorts prior to the implementation of the revised programme (the control group), and four cohorts since. Assessment one is a multiple-choice exam, which is divided into the body systems that have been covered in the teaching, with ten questions per system. Assessment two is a seen exam that includes fill-in-the-blank items, diagram labeling, and two or three short-answer essay questions.

The grading scale used is the standard institutional system for Foundation-level modules, where grades 40% and above are awarded a Pass; 39% and below are Referred. (N.B. students are given their actual grades in the feedback, to inform their development).

Students' perceptions of the module were also measured using the institution's end-of-semester online student evaluation system. This comprises twelve statements divided into two sections, plus a free-text area for qualitative responses. All statements were linked to a 5-part Likert-scaled data collection tool: strongly agree – agree – neutral –

disagree – strongly disagree [96]. All statements were worded positively; in other words, a higher score indicated a more favorable response. The online evaluation system was only recently introduced, so data is only available for the four cohorts who have undertaken the revised module structure.

VI. DATA ANALYSIS AND DISCUSSION

As indicated previously, four cohorts have undertaken the revised module structure. The assessment results indicate a trend of improvement in exam one with the multiple-choice questions, and no significant difference in exam two, the seen exam, among the study group (cohorts 3 to 6) as compared with the control group (cohorts 1 and 2); see Figure 2.

The outcomes for exam one reflect previous findings that students experiencing computer-enhanced delivery have significantly higher post-test scores than groups receiving the same content by lecture; indicating that a higher level of cognition was achieved by these groups [97,98]. This is in contrast to a report where no significant differences was found in a multiple-choice test that compared lectures and e-learning groups [99], and disagrees with recent evidence which found that students being taught by traditional methods achieved better performance in multiple-choice examinations when compared with e-learning students [100].

In comparison, the results for the seen exam (exam two) agreed with reports of no statistically significant difference in the post-test scores between a group on a technology-enhanced course and a lecture group [75,101,102]. These findings appear to indicate no significant difference in the retention of material, as has been reported between groups who learned by e-learning and by traditional methods [103,104]. This is in contrast with findings that traditionally taught students have demonstrated slightly better performance in examinations in comparison with online students [105].

Similar to other findings [106,107], the majority of students in all four of the groups that have experienced the blended delivery model indicated satisfaction with the overall quality of the module within their evaluations. The responses to the Likert-scale evaluation significantly reflected positive views that the majority of the students

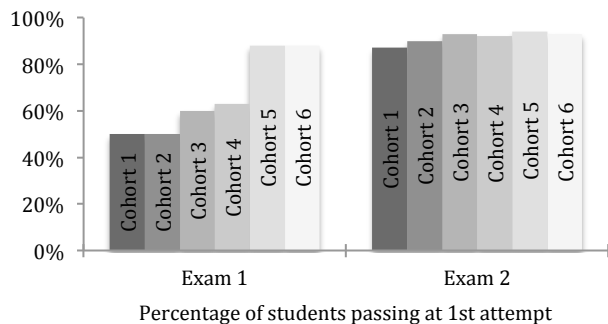


Figure 2. Assessment results

TABLE II. PERCENTAGE OF POSITIVE RESPONSES TO EVALUATION QUESTIONS

	Cohort 1	Cohort 2	Cohort 3	Cohort 4
<b>Quality Assurance</b>				
The teaching methods used in this module were effective in helping me learn.	89%	86%	89%	92%
This module has improved my knowledge and understanding of the subject.	86%	84%	85%	92%
The assessment criteria specified for the module were clear.	93%	95%	96%	100%
The module is well structured and the workload, including assessment, is appropriate.	98%	93%	93%	94%
Feedback on my work, in relation to this module, has been useful and prompt.	93%	94%	88%	94%
The availability and quality of support in relation to this module have been good.	93%	94%	100%	97%
I am satisfied with the overall quality of this module.	96%	98%	98%	97%
<b>Module Specific Questions</b>				
There are sufficient opportunities for student participation in lectures/tutorials/seminars.	100%	98%	100%	97%
This module is intellectually stimulating.	96%	95%	97%	100%
The rooms for lectures/tutorials/seminars are of a suitable quality.	93%	94%	98%	97%
The Virtual Learning Environment has made a valuable contribution to my learning on this module.	93%	94%	97%	97%
This module has been relevant to my course/pathway and career aspirations.	96%	95%	98%	97%

found the module to be well sequenced and stimulating, the discussion forum format clear and simple to follow, and that there was good quality feedback and support available to them when needed, (Table II). This is in accordance with other studies where students positively rated technology-enhanced courses [101,108-110], and would recommend it to other students [109].

Many students also utilized the ‘Any other comments’ free-text box to provide further responses; one common theme being that the weekly formative tests were helpful, motivating, and deepened their understanding of the material.

Some students commented on computer problems; they reported a few ‘teething problems’ during the early stages that could have become more serious, but the students positively mentioned how these were discussed and addressed by the tutor during the face-to-face sessions. This supports earlier findings that a frequently experienced negative comment related to e-learning programs was students’ early frustration with the use of the computer itself [111]; in this study it was the access to the tutor that prevented possible escalation of what were initially perceived as minor issues.

Comments were also made regarding the use of the

discussion forum. Some students indicated that they felt able to think more deeply and carefully about the subject before writing a response, as compared to giving verbal responses; this has previously been reported [112,113]. They particularly favoured the opportunity to review literature and prepare informed evidence-based responses, although at times this was felt to slow the discussions somewhat.

A number of students also made comment on the positive interactions they had experienced with the tutor within the virtual environment, and how there appeared to be a continuous tutor presence. The tutor, obviously, was not online 24/7, but by using the subscription facility within the VLE, the tutor was able to receive email notification of student participation in the forum, which promoted timely review and contributions as appropriate. This provided the students with the perception that the tutor was constantly checking the discussion board, which in turn produced the positive feedback. These comments suggest that the tutor was able to overcome one area of support commonly receiving negative feedback; participants in an earlier study [112] reported that they felt a lack of immediacy in responses in the online element of their course, in comparison to what they expected from a face-to-face class discussion. This appears to be especially obvious in asynchronous interactions taking place within discussion boards, where students have reported frustration due to delays in getting responses [113,114].

The regular face-to-face sessions also received positive comment, with the students indicating that these enabled members of the group to 'make connections' with the tutor and other classmates. These connections could be interpreted as the building blocks associated with forming a community, which would continue within the virtual learning environment. This is significant, as a relationship between students' perceived feelings of community and apparent cognitive learning has been indicated [115]; the stronger the online learners' sense of community, the less isolated they felt. Continuous support and feedback as noted in the literature [44,61,106,116] appear to be essential in facilitating effective e-learning; this would support suggestions that technological tools alone cannot completely replace traditional teaching methods [117] as they both have their own advantages and disadvantages. Therefore, delivering anatomy and physiology using traditional methods along with technological methods could benefit various learners to achieve the course objectives [37].

## VII. LIMITATIONS

This is a small-scale study and the data was drawn from a specific module with a limited number of participants. The study may have been influenced by factors specific to the student groups, which are not immediately evident from the findings. Also, experiences external to the module content and delivery may have contributed to student outcomes and opinions. Finally, the student satisfaction data is only gathered from those who have undertaken the revised

module structure, so no comparison in this area can be made with students who have undertaken this module in the traditional mode of delivery.

## VIII. CONCLUSION AND FUTURE WORK

In this module, the application of constructivist learning theory means following a pedagogy that provides learners with the opportunity to interact with sensory data, and build their own understanding; whilst cognitive learning theory requires students to be active in their learning, leading to further understanding. Integration of the 5Es enquiry process further allows this to be applied by giving students the opportunity to review their prior knowledge and construct new comprehension that arises from solving problems. The revised programme evaluated in this paper aims to combine these principles through enhancing the traditional content delivery with technological tools in a blended mode of delivery.

The electronic resources not only enhance the traditional methods of teaching but also offer new and exciting ways of presenting the material to the students. However, in designing the programme it was acknowledged that the benefits of using technology are accompanied by challenges, which were best overcome by not totally moving away from some elements of traditional delivery. Whilst teaching and learning are no longer confined to the classroom, spending some time in this environment would appear to positively contribute to the overall experience of the learner. Technology is not a solution for all learning environments, but through careful determination as to which interventions can be used to effectively teach content, the optimum conditions may be achieved.

In addition it is important to acknowledge that students require the necessary resources to make optimum use of the materials, therefore the responsibility of educators is to appropriately support programmes to ensure learners are not disadvantaged, through provision of adequate hardware, and evaluation of student abilities. Finally, there is a need to promote the creation of a community or feelings of connection in virtual learning environments; including strategies for community building into the design of the course, particularly in the role of the tutor to facilitate such, appears to assist with this.

Future work will include continual evaluation of the module to ensure the students continue to demonstrate satisfaction with it. Also, a synchronous (chat) discussion tool will be added to the e-learning component of the structure, and an in-house social network environment, similar to Facebook, will be produced, both are in consideration of furthering the constructivism foundation of the module.

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# (Learning $\cap$ Information Technologies) Cartography

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**Abstract**—Nowadays, many researches focus their efforts in studies and applications on the Learning area. However, there is a lack of a reference system that permits to know the positioning and the existing links between Learning and Information Technologies. This paper proposes a Cartography where explains the relationships between the elements that compose the Learning Theories and Information Technologies, considering the own features of the learner and the Information Technologies Properties. This intersection will allow us to know what Information Technologies Properties promote Learning Futures.

**Keywords**—*Learning Theories; Learning Features; Information Technologies; IT Properties.*

## I. INTRODUCTION

Recently, there is a considerable increase of works based on educational software as evidenced by the multiple conferences and workshops about it. However, it has also been evidenced the lack of a reference system, map or cartography to facilitate the location of such works, establish relationships between them and between the existing links among learning theories applied. Given the scope of the study area, this paper proposes a Cartography defined by the intersection between the most important *Learning Theories* and *Information Technologies*, exposing the common elements and the relationships between both sets. The main goal of this paper is to provide some criteria of order in an emerging area.

The proposed Cartography is a reference system consisting of four dimensions arranged symmetrically. On the one hand, there are the *Learning Theories* and the *Learning Features* and on the other hand, as a reflection, there are the *Information Technologies* and their properties – *IT Properties*. The article defines each dimension and the relationships between them, in order to establish a final Cartography. The Cartography shows the intersection between the two sets, *Learning Theories* and *Information Technologies*. Consequently, this intersection will answer the question: What *IT Properties* promote *Learning Features*?

The rest of this paper is organized as follows. Learning Theories and Learning Features are defined in Section

II. The most relevant Information Technologies Properties are gathered in Section III. In Sections IV and V, the Cartography proposed and its implementation is mentioned respectively. In Section VI the results of implementation are analyzed. Finally, Section VII concludes the paper.

## II. LEARNING THEORIES AND LEARNING FEATURES

*Learning* is defined as the relative change of the permanent behavior that reflects knowledge acquisition or skills through experience that can include study, observation and practice. Behavioral changes are relatively objectives and therefore can be measured [1].

### A. Learning Theories

In the Cartography, a group of relevant theories about learning was considered. Some theories construct their approaches based in other theory's approaches.

**Behavioral Theory** [2] focuses on the observable behavior of an individual. The behavior is described from the stimulus-response relationship and considers that learning takes place when there is an appropriate response to a specific stimulus.

**Cognitive Theory** [3] tries to find out how the mind interprets, processes and stores information. The contribution related to learning is the concept of meaningful learning, which tries to establish a relationship between prior learning and the new knowledge obtained.

**Constructivist Theory** [2] describes the knowledge acquisition as a dynamic and interactive process. Through it the external information is interpreted and reinterpreted by the mind that builds explanatory models each time more complex and powerful.

**Social Constructivist Theory** [4] clarifies that human development and learning can be explained in terms of social interaction. Among the proposals of social constructivism there is the cooperative learning, which emphasizes the role of social relationships to learn.

**Constructionist Theory** [5] states that learning emerges in a better way when the mind is committed to build a significant product. It emphasizes the importance of the tangible.

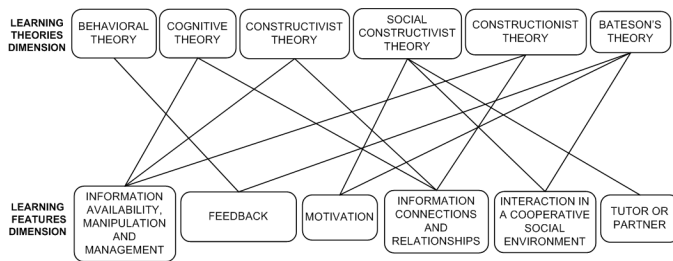


Figure 1. Relationships between *Learning Theories* and *Learning Features* dimensions

**Bateson's Theory** [6] was considered in this study because of focusing more on the student expectation and participation than in the stages of human development. This theory makes special emphasis on the dynamic relationships and individual interactions inside and outside the educational context.

**B. Learning Features**

*Learning Features* are defined as those features that allow students to learn in a better way, which means that student learns better if he/she has [7], [8]: 1) Feedback, 2) Information availability, manipulation and management, 3) Information connections and relationships, 4) Motivation, 5) Interaction in a cooperative social environment and 6) Tutor or Partner. For the development of the Cartography, *Learning Theories* and *Learning Features* were defined as dimensions.

The relationships between these two dimensions were established after extracting the main focus of each theory and mapping it with the *Learning Feature* that reinforced better the principles of each theory. These relationships are shown in Figure 1.

**III. INFORMATION TECHNOLOGIES FOR LEARNING**

The use of computers in education began in the 60's. Several relevant features of these devices were exploited, such as versatility, calculation and specially the ability to interact with them. Students should find answers to the stimulus received. This first approach was called Computer Assisted Instruction (CAI) [9].

The development and diffusion of *Information Technologies* had greatly increased the qualities of computers that support learning. From several studies on works related to the areas of *Learning* with *Information Technologies* it has been concluded that the most relevant *IT Properties* are [10]–[12]: 1) Creation, transmission and dissemination of information, 2) Simulation and training, 3) Customized content and multimedia, 4) Play, 5) Mobility and 6) Social and cooperative processes. This set of properties represents the third dimension of the Cartography.

Finally, the last dimension of the Cartography is formed by *Information Technologies*. For this first design the technologies chosen were [13]–[15]: 1) E-learning, 2) Web2.0-social networks, 3) M-learning and 4) Muve's-games.

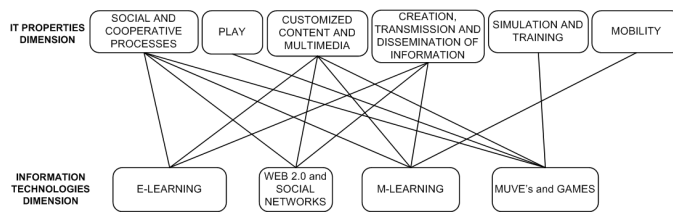


Figure 2. Relationships between *IT Properties* and *Information Technologies* dimensions

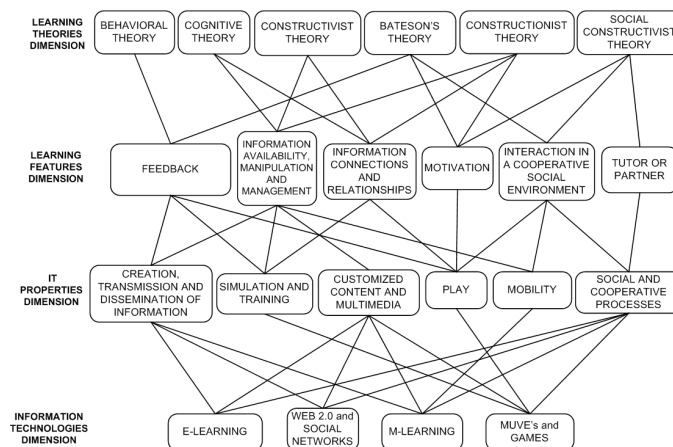


Figure 3. *Learning* and *Information Technologies* Cartography

The relationships between *IT Properties* and *Information Technologies* were established under the premise of what technologies offer or use these properties. These relationships are shown in Figure 2.

**IV. LEARNING AND INFORMATION TECHNOLOGIES CARTOGRAPHY**

The Cartography includes the four dimensions previously studied and the relationships among them. The symmetry that exists in the Cartography is delimited by the areas of *Learning* and *Information Technologies*. The intersection between these two areas is reflected in the relationships that bind them. They answer the question of what *IT Properties* promote *Learning Features*. The final Cartography is shown in Figure 3.

**V. CARTOGRAPHY IMPLEMENTATION**

In addition to the intrinsic value of the Cartography as a methodological or orientation resource, we studied its usefulness as an analytical tool. In particular, a small study was made based on the state of the art.

**A. Methodology**

For this analysis, we chose seventeen works related to the areas of *Learning* and *Information Technologies* [3], [6]–[8], [10]–[13], [15]–[23] that fulfilled the criteria of being directly related to this two areas, and coming from reliable

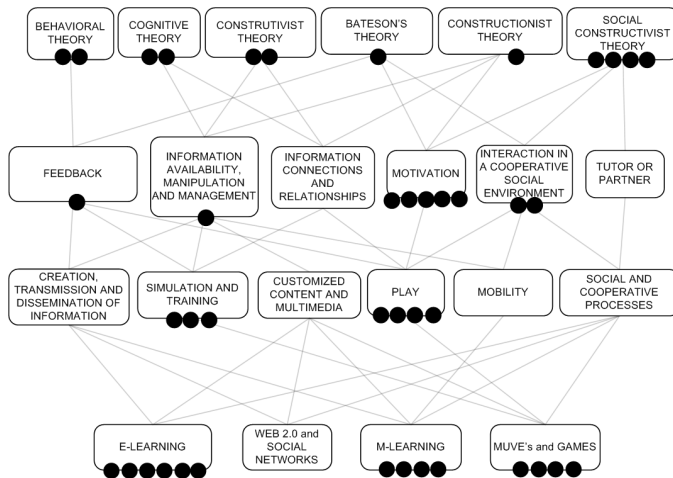


Figure 4. Density of works per attributes

sources. Each work was studied to determine its position in the Cartography, it means with who or whom is related and the use of the dimensions of the Cartography.

**B. Results**

In order to explain the results obtained in this work, the elements belonging to each dimension were defined as attributes. According to the study, two results were obtained.

The first one shows the density of works per attributes in each dimension of the Cartography (Figure 4). Every point shows the relationship of the work with that attribute. There were works related to several attributes.

The second result (Figure 5) is a complement that shows the presence of the dimensions in each work, being represented by a circle with four sections. Every section shows a dimension of the Cartography that was defined by a different plot in order to distinguish them.

**VI. ANALYSIS OF RESULTS**

From the representation of the density of works per attributes:

- Two attributes were highlighted with a higher density: E-learning and Motivation. E-learning, defined as learning and teaching activities via the Internet [15], is focused directly on the two study areas of this research. Therefore a higher density is reflected in this attribute. The high density in Motivation suggests that nowadays the emotions are being considered as an influential factor in the learning area.
- There is a notable absence of density on the dimension *IT Properties*. This is mainly due to the special attention of researchers into educational software applications rather than *Learning Theories* that support them.

From the dimensions per work the following analysis can be done:

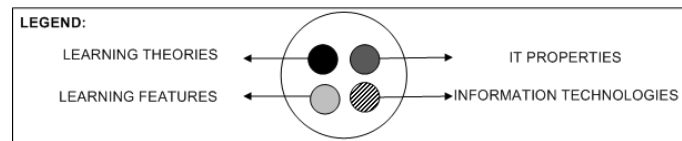
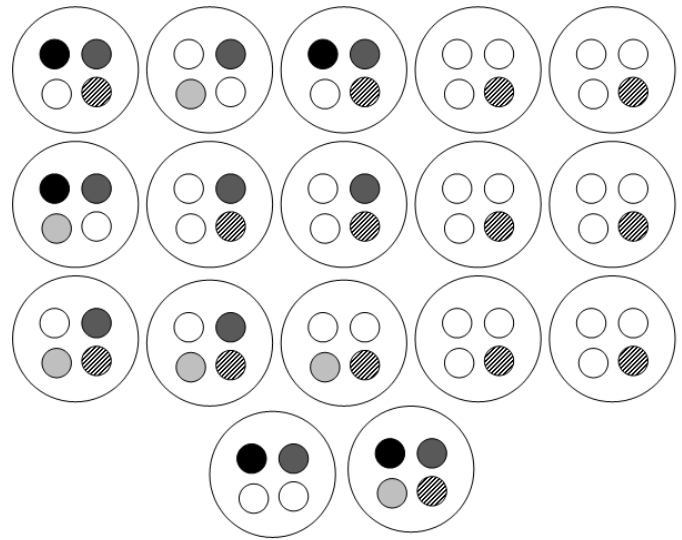


Figure 5. Dimensions per works

- Approximately 80% of the works have in mind the dimension of *Information Technologies*, and almost half of them include one or more dimensions in their investigations. This means that most of the works focus their efforts on the development of technologies.
- The second largest dimension is *Learning Features*. Many of these studies are connected with the dimension of *Information Technologies*. This shows that some works include one or more *Learning Features* for the development of *Information Technologies*.
- There is a low density in the dimensions of *IT Properties* and *Learning Theories*. This indicates that few *IT Properties* are used when developing technology related with learning, which can make us believe that research about *Information Technologies* and *Learning* are made with a poor theoretical basis.

In general, from both representations we can conclude that there is a lack of cohesion between the areas of *Learning* and *Information Technologies*, hence the importance of relating both areas to link them in a better way. Moreover, the study also shows that today there are some works on IT applications addressed in a superficial way, which means that this field is in early stages of research.

**VII. CONCLUSIONS**

First of all, the research work developed in this document represents the entire set of links among the elements involved in the sets of *Learning* and *Information Technologies*. The reviewed literature does not have any similar work,

being this current study a contribution to this area that is just beginning. Moreover, the Cartography has proved to be a powerful tool for the analysis of "Learning-Information Technologies" set, facilitating its understanding and study. It was also a prospection instrument, allowing the exploration of future possibilities based on present evidence.

Particularly, the Cartography determines a reference system where information layers are placed for study, like shown in Section V. This let us to analyze a case study from the dissection of several works previously studied.

The research leaves several areas to be explored and future guidelines where the authors are still working.

#### ACKNOWLEDGMENT

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## Defining a Metadata Schema for Serious Games as Learning Objects

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**Abstract**— Games are increasingly recognized for their educational potential. However, when used as a learning resource, games can differ substantially from other educational media. They often combine high-fidelity audio and video content with experiential, social, or exploratory pedagogy. As educators increasingly turn to technology to support the delivery and management of content, the capability to describe and package serious games effectively as reusable learning objects (LOs) is increasingly vital. Doing so requires developing the capability to express games not in terms of technical boundaries, but as coherent and discrete LOs, which can be reused and combined. Enabling this requires metadata be attached to games, whilst making the metadata schema explicit to allow the use of the metadata beyond its original scope. Furthermore, standardisation of metadata schema means that systems are able to work together and use data interchangeably. However, current standards for describing educational content cannot directly be utilized to describe these serious games as educational resources. This makes it difficult to include serious games in repositories of learning objects and to describe them in a coherent way in the various online repositories. This paper introduces a metadata schema for describing serious games as educational resources, based on existing standards, so that serious games content can be described within online repositories.

**Keywords**— *Serious Games; Game-based learning; Metadata; Repurposing; Rating; Web2.0*

### I. INTRODUCTION

Experts are increasingly recognizing the educational potential of serious games [1] and their use has been growing over recent years. Serious games can provide learning environments, which studies have shown can enhance efficacy over traditional learning [2]. According to Norman and Spohrer [3] a learner's motivation makes more difference to the learning outcome than any other factor. An advantage of computer-based instruction is that it can engage learners, particularly though its support of high-frequency feedback in novel forms [4]. Serious games often combine high fidelity audio or video with elements of game play, in order to offer a more immersive learning experience that provides even higher levels of engagement and direct

feedback than more traditional computer-based learning materials.

The potential of computer-based education has been well established [3] and indeed various standard metadata schemas have been developed [5] to describe digital educational resources in a coherent way. The use of standards means that materials can be used and re-used across platforms and systems. However these standards are not capable of capturing serious games fully, missing out important aspects, such as the context a particular game can be used in, and what type of learner and age group it is suitable for. The most important aspect is pedagogic; particularly as serious games are often shown to work most effectively when blended with other instructional techniques and resources [6], [7] and the same may fit in different blended scenarios. Whilst standards exist, there are no general and complete standards for describing serious games as educational resources. Developing games is a complex and costly affair; games have been shown to work best in a blended approach and repurposing games is complicated as there is not always a one to one relationship between serious games and learning goals [8]. Therefore, it is essential to have the interoperability between different learning platforms and metadata standards. Torrente and colleagues [9] attempted to export games to self-contained Learning Objects (LO), which could be easily distributed through any Learning Management System (LMS) compliant with the current interoperability standards.

However, when attempting to create descriptions of serious games in a comprehensive interoperable manner, a standard is required. As such a standard does not currently exist, the authors of this paper propose a metadata schema for describing serious games as educational resources, based on existing metadata standards and a comprehensive four dimensional framework for evaluating serious games proposed in [10], [11]. The work is based on work around creating an educational metadata schema and repurposing of serious games in the mEducator project and, defining a rating tool for serious games in the EduGameLab project.

The rest of this paper is organized as follows. While it is beyond the scope of this paper to list all existing educational standards, Section II introduces a few related metadata

standards. Framework for evaluating serious games as well as categorisations and classifications of games and their learning experience are briefly reviewed in section III, section IV describes standards for managing and describing competencies, section V introduces the proposed metadata schema and finally section VI outlines our plans for testing the proposed schema.

## II. METADATA STANDARDS

In this section, we briefly review established Metadata Standards from the field of Technology Enhanced Learning, to identify possible candidates to base our metadata schema on.

### A. IEEE LOM

When attempting to create a metadata schema for comprehensive descriptions of serious games in an interoperable manner, the starting point must be existing metadata standards. A well-known standard for educational resources, called learning objects, is the IEEE Learning Object Metadata (LOM) [12], [13] specification. LOM defines a number of vocabularies for describing pedagogical attributes of resources. It includes, for example, attributes like resource type, level of interactivity, semantic density, difficulty and description. In addition, LOM encapsulates the Dublin Core [14] elements. Dublin Core is a cross-disciplinary standard for describing a wide range of networked resources [15]. It consists of two levels: Simple and Qualified. Simple Dublin Core describes objects using 15 simple elements [14] like the Title, Creator and Subject. Qualified Dublin Core adds a group of element qualifiers and three additional elements: Audience, Provenance and RightsHolder.

Serious games are, however, different from most other educational resources as they often offer a game play delivery using high fidelity audio and media and can use a variety of different pedagogical approaches. LOM does not have the attributes to describe these aspects. However, serious games may be exported into self-contained Learning Objects (LO) that can then be combined into larger units/courses.

### B. Sharable Content Object Reference Model (SCORM)

The Sharable Content Object Reference Model aims to bring together previous e-learning standards in a single distributable package and forms a structured design pattern around the creation of interchangeable educational material. SCORM uses IMS Content Packaging [16] for distributing its content and consists of the following parts.

- A Content Aggregation Model defining the components used to build a learning experience from learning resources, and how they are aggregated and organised in units of instruction.
- Assets representing a collection of media. This collection is called a Sharable Content Object (SCO) if it represents a single learning resource.
- An activity, which is a unit of learning, may provide an asset or be composed of sub-activities.

While games can be included in a SCORM package, there are no separate facilities for describing serious games. Therefore there is no particular standard way of including them.

### C. IMS Learning Design (IMS-LD)

IMS Learning Design (IMS LD) [17] was developed by the Open University of the Netherlands and released as a standard by the IMS consortium in 2003. IMS LD is a meta language that evolved from the Educational Modeling Language (EML). There are various activities called acts and people can have different roles. Activities and are conducted in an environment that is composed of several learning objects called Units of Learning. There are three levels (A, B and C), in increasing complexity and several players have been developed, such as CopperCore [18] and .LRN [19]. .LRN is integrated into a learning management system. However there is no native support for serious games. The XML-based format can describe a game only in general learning object terms.

## III. EVALUATION FRAMEWORKS AND CLASSIFICATIONS OF SERIOUS GAMES

In this section, we briefly review established frameworks and classification methods for serious games. Our proposed metadata scheme is based on the elements used in the evaluation and classification in these frameworks.

### A. Four Dimensional Framework

The four dimensional framework, which emerged from user studies, has been proposed previously in [10], [11] and its value has been shown in a number of studies since [20][18], [21]. The framework for evaluating serious games proposes four dimensions: the learner, the pedagogic models used, the representation used and the context, in which the learning takes place. The table below shows the framework schematically. Since the framework is an established framework for evaluating serious games, the metadata schema proposed in Section V should be able to express this evaluation.

TABLE I. FOUR DIMENSIONAL FRAMEWORK

Four Dimensional Framework	
<b>Learner Specifics</b>	<b>Pedagogy</b>
Profile	Associative
Role	Cognitive
Competences	Social / situative
<b>Representation</b>	<b>Context</b>
Fidelity	Environment
Interactivity	Access to learning
Immersion	Supporting resources
	Topic being studied

The learner specifics dimension involves profiling and modelling the learner to ensure a close match between learning activities and the required outcomes. The second dimension analyses the pedagogic perspective of the learning activities in the serious games such as the kinds of learning and teaching models. The third dimension is the representation, how active the learning experience needs to

be, what levels of fidelity are required and how immersive the experience needs to be. Finally, the context describes where the learning is taking place, what resources the learner has access to but also the topic being studied. The context the game is used in can vary and different evaluators may evaluate the game differently depending on their own experiences. Therefore, one game can have multiple evaluations.

### B. Different Types and Styles of Games

Mark Prensky proposes a classification of games [22] based on diverse content perspectives, shown in Table II. While his work is controversial and this classification does not provide a comprehensive evaluation framework, it does show how games can be classified in terms of the different types of content. The learning activities are related to the pedagogy dimension and the game styles are related to the representation dimension. The classification of games does not take into account any specifics of the learner, as it does not seek to evaluate its use with particular learners but is merely intended to group games in categories.

Sawyer and Smith [23] have created taxonomy of serious games by distinguishing into 6 categories, Games for Health, Advergaming (games for advertising), Games for Training, Games for Education, Games for Science and Research, Production Games as Work. However, they noted that this is work in progress and it can continuously be modified. This taxonomy again is focusing more on the content of the games and does not focus on the learning needs of the user/learner. However, they are associating these categories with the areas of application such as Government and NGO, Defence, Healthcare, Marketing and Communication, Education, Corporate and Industry creating a matrix like taxonomy.

Similarly, Alvarez and Rampnoux [24] have attempted to classify serious games in 5 main categories: Advergaming, Edutainment, Edumarket game, Diverted game and Simulation game.

### C. Learning Objectives Based Game Classification

Educational games can be produced as self-contained distributable Learning Objects (LO) [9] in support for the principles of the LO model [12], [13] that deploys the learning contents as small self-contained objects that can then be combined into larger units/courses. However, particular challenges exist when considering games, which might address multiple learning objectives, and therefore by definition encapsulate multiple LOs, or games, which are blended with other materials, and therefore to function as a repurposable LO require these materials to be included. Standardized formats should be used to store and distribute learning objects, allowing the content to be reused across platforms and contexts. Pivec and Moretti [25] have introduced a Learning Objectives-based classification for serious games. The classification describes a definition of the game, the features required, the typology and number of players. The Learning Objectives can be classified in the following groups.

- Memory/Repetition/Retention (factual knowledge)
- Dexterity/Spread/Precision (sensorial/dexterous knowledge)
- Applying Concepts/Rules (translate knowledge into new context; use information, methods, concepts, theories in new situations)
- Decision-making (strategy & problem-solving)
- Social Interaction/values/cultures (understanding the social environment of others)
- Ability to learn/self-assessment (evaluation)

Below we see an example describing John Smith, who wants to find a learning resource that extends his skills in web editing and is a president at learnNR.

```
<PersonName>
  <GivenName>John</GivenName>
  <FamilyName>Smith</FamilyName>
  <Objective>Find a learning resource that
extends his skills in web editing </Objective>
<EmploymentHistory>
  <EmployerOrg>
    <EmployerOrgName>learnNR</EmployerOrgName>
  <PositionHistory>
    <Title> President</Title>
    <OrgName>
      <OrganizationName>Paper
</OrganizationName>
    </OrgName>
    <Description>Key Player</Description>
    <StartDate>
      <AnyDate>2002-02-01</AnyDate>
    </StartDate>
  </PositionHistory>
</EmployerOrg>
</EmploymentHistory>
</PersonName>
```

As we can see in Table II most of these groups have been covered in the four dimensional framework and the existing classifications and taxonomies. Our classification of game styles in Table II is not intended to imply the game style will necessarily include a given content type; rather, that these game styles are amongst the most common and relevant when attempting to categorise serious games.

## IV. COMPETENCIES

The learner will have a certain set of competences, as suggested in the Learner Specifics dimension of the four dimensional framework. The learner will also be acquiring new competencies. Describing and managing competences is a well researched topic and is very relevant for serious games. Various different standards for describing competencies have been proposed [26], most notably the IMS Reusable Definition of Competency or Educational Objective (RDCEO) [27], IEEE Reusable Competency Definitions (RCD) [28] and HR-XML [29] competencies. Both IMS RDCEO and HR-XML identify the following.

- An identification of the competency
- A title for the competency
- A description
- A definition
- A taxonomy of the competency
- Personal information



TABLE II. PRENSKY'S CLASSIFICATION OF GAMES [22]

"Content"	Learning activities	Possible Game Styles
Facts	Questions, memorization, association, drill	Game show, competitions flashcard type games mnemonics action, sports games
Skills	Imitation, feedback coaching, continuous practice, increasing challenge	Persistent state games, role-play games, adventure games, detective games
Judgment	Reviewing cases, asking questions, making choices (practice), feedback coaching	Role play games, detective games, multiplayer interaction, adventure games, strategy games
Behaviours	Imitation, feedback coaching, practice	Role playing games
Theories	Logic, experimentation, questioning	Open ended simulation games, building games, constructing games, reality testing games
Reasoning	Problems, examples	Puzzles
Process	System analysis and Deconstruction, practice	Strategy games, adventure games
Procedures	Imitation practice	Timed games, reflex games
Creativity	Play	Puzzles, invention games
Language	Imitation, continuous practice, immersion	Role playing games, reflex games, flashcard games
Systems	Understanding principles, graduated tasks, playing in micro worlds	Simulation games
Observation	Observing, feedback	Concentration games, adventure games
Communication	Imitation, practice	Role playing games, reflex games

In addition to this some European countries have developed their own set of standards to describe competencies, e.g., France is implementing ScoLOMfr [30], which extends LOM with vocabularies to classify learning objects used by teachers and students in secondary education.

- HR-XML also has measurable weights and importance levels. The European Union established various standards in the Lisbon treaty [31], which define what should be acquired through education, is based on this. However its focus is very narrow and mainly on the competences that must be acquired through formal school education and therefore the standard exists of the following seven blocks of competences. Mother tongue knowledge
- Practice of a foreign language
- Math, scientific and technological culture
- Visual information and communication's techniques
- Humanities culture
- Social and civic competences
- Autonomy, initiative

#### V. SERIOUS GAMES METADATA

As the IEEE LOM standard is widely used for describing learning objects, the metadata schema we propose for serious games is an extension to IEEE LOM. When describing serious games, we face a challenge not dissimilar to the challenge standards such as IMS-LD and Dublin Core faced when they were being developed. A human can read and write full-text with ease but can be confused by complex compound structures. However, free-text is difficult to process automatically and a more complex compound structure using complex data types can make automatic processing more feasible. Therefore our proposed metadata

schema, which adds a number of fields to IEEE LOM, will have two different levels. The first level that focuses on human readability and the second level that focuses on machine processability. The elements are the same, but the types are stricter in Level 2. Our proposed schema mainly focuses on descriptive and review elements of serious games. In Tables III and IV, we describe the fields that we propose to add to IEEE LOM. We show the type for Level 1 and Level 2. The proposed metadata schema allows for a number of reviews in addition to technical and descriptive fields, therefore, we make a distinction between these technical and descriptive fields on the one hand and the set of review fields on the other hand.

#### VI. CONCLUSION AND FURTHER WORK

Existing standards for describing learning resources are incomplete when it comes to describing serious games. Any automated system that stores and retrieves serious games as objects, needs a metadata schema to describe them. Hence, a general metadata standard for describing serious games is needed. In this paper, we introduced our proposed metadata schema, based on existing technology enhanced learning and standards and metadata standards, also taking into account existing frameworks for evaluating serious games.

We plan to test our metadata schema, which was inspired by previous work in the mEducator project, by integrating it into a rating tool for serious games. The rating tool is being developed in the course of the EduGameLab project, which is aimed at parents and teachers. The rating tool will enable rating and sharing of experiences with individual games. For this purpose the metadata schema will be used to describe the games.

TABLE III. ADDITIONAL TECHNICAL AND DESCRIPTIVE FIELDS FOR SERIOUS GAMES

Field	L1 type	L2 type	Contents	Multiplicity
Game_developer	Text	Text	Name of the developer/publisher of the game	1
Producer	Text	Text	Name of the producer/ promoter if not the same as developer	1
Sponsor	Text	Text	Name of the institution who commissioned or sponsored the development (if any)	*
Age_group	Enum <sup>a</sup>	Enum	Intended age group: 0-3, 4-7, 8-12, 13-16, 17-18, 18+	+
Content_type	Text	Enum	One of the types described in Section III C.	+ <sup>b</sup>
Game_genre	Text	Enum	The genre of games: (Action shooter, action-adventure, adventure, role-playing, construction and management simulation, life simulation, vehicle simulation, simulation, strategy, music, exercise/ training, sports game)	+
Type_of_game	Text	Enum	Type of game (Entertainment, education, edutainment, other)	+
Representation	Text	Enum	Virtual world, 3 <sup>rd</sup> person, 1 <sup>st</sup> person, board game, turn-based, card, other	1
Technical_platform	Text	Enum	E.g., PC, Mac, iPhone, Android, Playstation3, Wii etc	+
Platform_type	Enum	Enum	(Pc, Console, Mobile, Other)	+
Multi_player	Enum	Enum	(No, on same device, online)	+
Subject	Text	DBpedia category	General Subject	1
Performance_indicators	Text	Enum	E.g., In game score, time, completion, appreciation, success, failures	+
PEGI_rating	Enum	Enum	PEGI rating, only if official rating is available: (3,7,12,16,18)	[0..1]
PEGI_reasoning	Enum	Enum	PEGI rating, only if official rating is available: (Bad Language, Discrimination, Drugs, Fear, Gambling, Sex, Violence, Online game play)	* <sup>c</sup>
Review	Complex	Complex	See below	*

It will be tested in user-panels that are due to be set up within the project.

Significant future challenges surrounding the use of serious games within LMS and LCMS systems include the capacity to define and extract multiple LOs from single games, as well as support fully games, which function as part of blended learning activities, and therefore can represent an element of content within a larger LO. Our schema has addressed, on a technical level, some key considerations, which are essential to allow functional repurposing of game-based learning content. Future work must couple this with a full pedagogic consideration of how this technical capacity may be used to support the implementation of serious games into LMS and LCMS systems.

a. Enumeration, i.e., a choice out of a given list of values

b. \* = any number, += 1 or more

c. If there is a PEGI rating other than 3 than the multiplicity is + otherwise 0

Achieving this is particularly challenging, as game-based learning is frequently deployed in blended contexts; and can be difficult to define independently from its given context. not in terms of the boundaries arbitrarily placed by the interface between game engine and LMS, but instead in pedagogic terms, thus allowing them to adhere to best practices for LO definition, as well as best practices for the implementation of game-based learning approaches.

TABLE IV. ELEMENTS CONTAINED IN A REVIEW ENTRY

Field	L1 type	L2 type	Contents	Multiplicity
Learner Specifics	Complex	Complex	Composed of each of the following sub-fields: Age Occupation (e.g., In full-time education, unemployed or one of the items of the Standard Occupational Classification 2010 [32]) Subject area if in full-time higher and further education, e.g., one of the topics from Wikipedia for easy translation (0 or more) competences using either HR-XML, IEEE RCD or IMS RDCEO	+
Pedagogy	Enum	Enum	Point on Kolb's learning cycle [33], or other pedagogical models such as Boolms taxonomy [34], or Gees Learning Principles [35]	[0..1]
Context	Complex	Complex	Context the game is used in (by the reviewer) composed of each of the following sub-fields: Place (one of school, home, museum, mobile, other) Subject (free text / Wikipedia topic for easy translation) Time of the pedagogical activity involving the game (0 or more) supporting resources	+
Star rating	Enum	Enum	(0,1,2,3,4,5) indicating the subjective pedagogical quality, based on the distance between the aim and the result of the evaluator, compared to their usual approach	1

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## RESTful Service Oriented Architecture for Querying and Publishing Learning Objects in Repositories

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**Abstract**—This paper presents a service oriented architecture for querying and publishing learning objects in distributed repositories. The architecture is based on RESTful web services and proposes the adaptation of A Simple Query Interface Specification (SQI) and The Simple Publishing Interface Specification (SPI) specifications for supporting this technology.

**Keywords**—component; Learning object; learning repository; querying; publishing; web service.

### I. INTRODUCTION

A repository or digital storage of educative elements is a collection of resources (learning objects) accessible through a communication network. It is not necessary having previous knowledge about the collection, it is only needed a reference to locate it [1].

Most repositories are usually autonomous, i.e., they work as websites that can be accessed through a Web-based interface, providing a search mechanism and a list of categories for conducting the search. However, the possibility of carrying out federated searches in distributed repositories is becoming increasingly important [2].

### II. STATE OF THE ART

There are federated repositories engines oriented towards sharing and reusing learning content, e.g., Multimedia Educational Resource for Learning and Online Teaching (MERLOT) [3], but the content stored usually does not contain the associated metadata instances inside the resources. Storing metadata packaged with the learning contents increase flexibility and interoperability between learning systems.

Another federations as Alliance of Remote Instructional Authoring and Distribution Network of Europe (ARIADNE) [4] allow sharing full learning objects with its metadata across heterogeneous repositories, using publishing and query interfaces such as SPI [5] and SQI [6], but the current implementations are based on Simple Object Access Protocol (SOAP) [7].

There are several repositories that do not support SQI because it is SOAP based, so it is necessary to adapt the existing publishing and query mechanisms to a modern RESTful approach, in order to support new bridges for communication between repositories and federations of repositories. The main advantages of this new model are:

- Those repositories, which have discontinued SOAP support, can take advantage of SQI benefits.
- The background technology has already been used in some systems.
- The repositories of the federation store learning objects packages with their metadata.

### III. STANDARDS AND SPECIFICATIONS

This paper is focused on two main specifications: A Simple Query Interface Specification for Learning Repositories (SQI) and The Simple Publishing Interface Specification (SPI). Both of them have been developed by a public initiative known as the CEN/ISSS Learning Technologies Workshop, whose commitment is to guarantee interoperability between learning object repositories.

#### A. Simple Query Interface

SQI specification consists in a definition of a set of methods that a repository should provide, so that remote systems (clients) can query for learning objects stored within the repository. Figure 1 shows how repository A (source) makes a data request from repository B (target). For this communication being possible it is necessary to use a common query language (based on SQI) which both repositories understand. However, the query language may differ inside the repository. In this case, a layer (an SQI component) is responsible for making the conversions needed.

SQI identifies thirteen methods to be provided by such systems, these methods are classified in three categories: configuration methods, session management methods and query methods (synchronous and asynchronous).

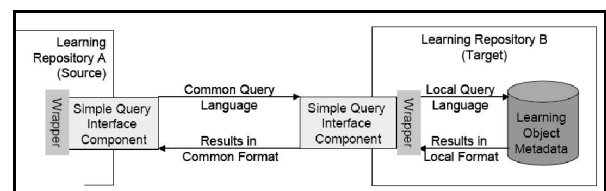


Figure 1. Communication between two SQI repositories

### B. Simple Publishing Interface

SPI makes a distinction between semantic and syntactic interoperability. Syntactic interoperability is the ability of applications to deal with the structure and format of data (for example XML documents). Semantic interoperability refers to the ability of two parties to agree on the meaning of data or methods. In an exchanging data process, semantic interoperability is achieved when data is interpreted in the same way by all the applications involved.

In a typical SPI scenario, two approaches enable data transmission from a source to a target: “by value” or “by reference”. “By value” publishing embeds a learning object, after encoding, into the message that is sent to a target. “By reference” publishing embeds a reference (e.g., a Uniform Resource Locator, URL) to a learning object to publish into the message that is sent to a target.

The model for SPI builds on a separation between data and metadata: data is a resource (e.g., a learning object) while metadata is the description of the resource (e.g., using Learning Object Metadata, LOM [8], to describe the learning object) (Figure 2). Every resource can be described by zero, one, or more metadata instances. A metadata instance must have a metadata identifier that identifies the metadata instance itself, and must have a resource identifier that matches to the identifier of the resource. The metadata identifier enables distinguishing between multiple metadata instances referring to the same resource. In this model, a metadata instance must be connected to a resource; however the resource may be hosted externally.

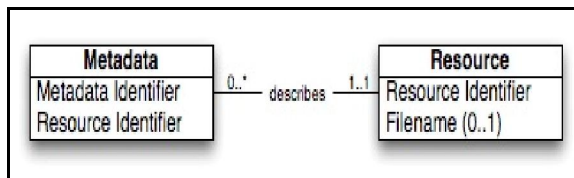


Figure 2. Resources and metadata instances in SPI.

The SPI model defines several classes of messages and functional units in a publishing architecture. When binding the specification to a given technology, these concepts are mapped into a concrete specification that can be implemented in a repository so that conformance can also be tested.

SPI defines the following methods:

- Submit/Delete Metadata Record: These are methods for inserting or deleting object descriptions respectively.
- Submit/Delete Resource by value / by reference: These are methods for inserting or deleting resources respectively.
- The SPI model does not include explicit methods for updating resources or metadata instances.

#### IV. RESTFUL WEB SERVICES

Roy Fielding introduces in his doctoral dissertation [9] the concept of Representational State Transfer (REST)

defined as an abstraction of the architectural elements within a distributed hypermedia system.

REST takes advantage of Hypertext Transfer Protocol (HTTP) [10] [11] for building distributed applications. Components that participate in REST architecture are called resources. These resources are identified by an URL, so they can be accessed and identified in an easy way. The architecture also defines a resource representation as the data found behind the resource URL, e.g., an image file or a web page.

Once these concepts are established, a new web service-based architecture, different of Simple Object Access Protocol (SOAP) web services, has been developed. RESTful web services are those web services based on REST architecture. The operations of the web services are implemented as resources called using HTTP protocol and the results returned by services are resources representations. Operation parameters can be passed using HTTP request parameter mechanism.

This architecture is faster and simpler than SOAP because it is not necessary to build heavy clients from Web Service Definition Language (WSDL) files for accessing to the services anymore, just URLs identifying resources are required. Network traffic is also reduced as is not necessary to transmit loud SOAP messages, but lightweight HTTP requests and responses are used instead.

#### Accessing Resources

HTTP protocol defines an operation set. Some of these operations are used to provide access to RESTful web services:

- GET: Typically used to invoke query operations.
- PUT: This operation is normally used to create new data elements.
- POST: This message should be used for edit data elements.
- DELETE: The common operation for deleting data elements.

Data elements are represented as REST resources. For instance, a web service for managing songs data could be define as a REST resource with an URL to identify it, as <http://service.org/songs>. If clients need to access to a concrete song, e.g., the song with id 576, they can do that using the URL <http://service.org/songs/576>. Once the resource is defined, users could perform Create, Read, Update and Delete (CRUD) operations with song data, as the following:

- Create a new song (with ID 576): POST request at <http://service.org/songs/576>.
- Read song data: GET request at <http://service.org/songs/576>.
- Update song data: PUT request at <http://service.org/songs/576>.
- Delete song data: DELETE request <http://service.org/songs/576>.

Also, if clients need to get a list of data items, they can retrieve it by sending a GET request to

http://service.org/songs. So data can be accessed easily with RESTful web services.

In learning repositories context, the CRUD operations are needed for publishing and querying learning objects and its metadata. POST and PUT requests solve the publishing problem and GET requests enable querying operations. Removing objects and its metadata can be done with DELETE requests. Publishing and querying issues can be adapted to RESTful architectures taking all its advantages, i.e., simplicity, performance and an easy way to build clients that comply with the interfaces.

### V. PROPOSED ARCHITECTURE

With the idea of adapting the SQI and SPI specifications to RESTful a new architecture is proposed (Figure 3). It is composed by layers, whose main characteristics are:

- Layer 1 comprises all RESTful web services associated to each repository. RESTful web services enable accessing learning objects described by their metadata. With the GET method the RESTful web service allows the system to access to the stored learning data (by its metadata). This method replaces the query SQI methods. With the PUT and DELETE methods, we comply with the SPI specification.
- Layer 2 comprises the federated search services. They use the RESTful web services provided by layer 1 to get and handle the data provided by them. For carrying out a federated search we only need the URL of each repository, and then we use the GET method (with the search criteria of metadata) in the RESTful web service in each repository and handle

all information provided by the repositories. With the results of each repository the system must classify and filter this information.

- Layer 3 corresponds to the presentation layer of the system. All the interfaces that offer access to the system will be found here. The system has two primary functions: searching learning objects in the federated repositories and adding a new repository. If we want comply with the SPI specification we must add two new operations, namely publish and delete a learning object.

The first step in the design of a system that uses RESTful is to define the data it handles. In the case of repositories of learning objects data will be as follows. Learning objects are composed of internal elements (resources according to SPI) and metadata describing them. We recommend that the metadata is described using the LOM standard. For transferring a resource by reference, its URL must be specified, so the repository will access the address where the resource is in order to include it to the repository.

To adapt the SQI specification so that RESTful can perform federated searches in various repositories of learning objects, we only need the URL of the repository in which we want to launch queries. When the user queries a repository, the search is extended to the repositories are associated. Because we use RESTful, our repository has the role of a client that searches in other repositories. This operation is transparent to the user.

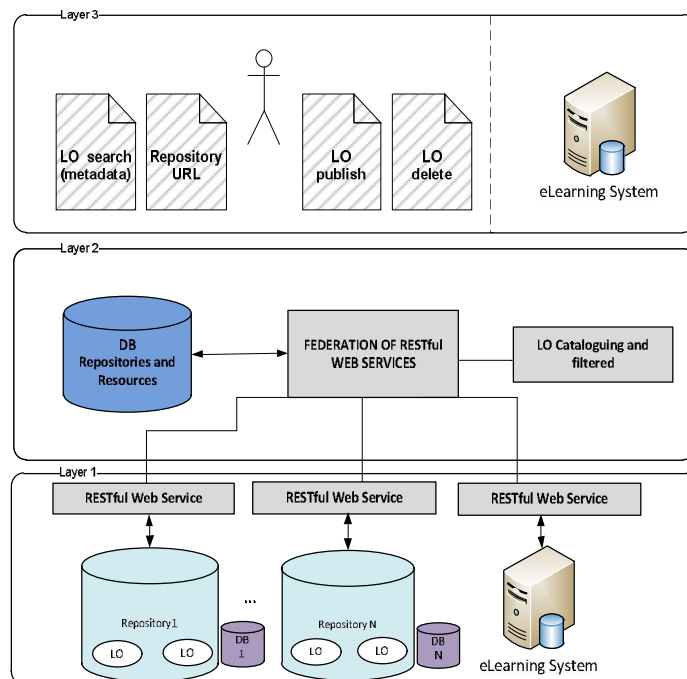


Figure 3. A RESTful Service Oriented Architecture

## VI. CONCLUSIONS

If we want to build a federated repository of learning objects the SQI and SPI specifications can provide a considerably interoperability because it is no longer necessary to implement different search / publish mechanisms for different repositories.

The problem with the SQI specification is that a lot of repositories that previously supported it are no longer doing so [12]. We believe that this occurred because the SQI specification is based on out-dated technology (SOAP and WSDL) and therefore the main conclusion is that SQI must upgrade and evolve from traditional web services to RESTful.

RESTful web services are especially suitable for the implementation of SQI and SPI specifications because both are based on the management of the data stored in repositories of learning objects, so their use to define these specifications would ease their interoperability via HTTP.

The architecture proposed can help developers of federated repositories of learning objects in their developments using two of the most important specifications to ensure interoperability.

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# Virtual Reality Using Stereoscopic Vision for Teaching/Learning of Descriptive Geometry

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**Abstract** — This paper addresses one of the main difficulties observed in some theoretical courses of spatial geometry, which refers to the requirement of abstract spatial visualization skills. The study also shows the demand for computer graphic resources to support teaching and learning of these disciplines. Finally, it is submitted to a virtual system, animated, by using stereoscopic anaglyph vision, covering the basic contents of Descriptive Geometry. This system has already been developed and implemented.

**Keywords**—computer graphics; descriptive geometry; virtual reality; spatial stereoscopic visualization

## I. INTRODUCTION

The major developments in computing and electronics bring the opportunity to apply new technological resources for teaching/learning courses in graphics. Therefore, we can find in the related literature some studies that have been developed in search for computational solutions within the teaching subjects such as Descriptive Geometry (DG), Technical Drawing, etc..

Valente and Santos [1] proposed an intelligent computing environment, accessed via Internet, which operates according to the profile of each student. The system presents a database of exercises that must be registered by teachers. The virtual environment has not been tested yet.

In [2], Harris presents a proposal to restructure the Drawing Technique discipline. It involves the use of graphical applications on-line in support of teaching. The first results reveal a greater motivation among students that uses the new system.

Also, we found studies that indicate the potential for stereoscopic computer graphic systems for the development of spatial visualization skills [3] and virtual reality techniques have to be employed. It is suggested to use a stereoscopic display system using polarized projections, where students would attend classes using passive polarized glasses. However, the system was not implemented.

Another work of the area has a graphical tutorial system, available on the Internet for teaching Descriptive Geometry. The system consists of written content, accompanied by illustrative animations. The system, however, is not intended for use in classroom, and does not explore stereoscopic capabilities or real-time interactivity [4]. In a more recent study, the author has been making use of augmented reality

techniques for visualizing and learning of conical surfaces [5].

The Descriptive Geometry software [6], developed at the University of Lisboa, can be freely downloaded from the website. The program is interactive and has offices in both epure and space representation. The system interface is somewhat overwhelmed by too much information windows and not very suitable for beginning students.

Since the program AEIOU Geometria Descritiva [7] has many graphics and a clear and friendly interface, it is a commercial software.

We observed that the most articles published in technical and scientific events in the area are still at the level of academic research and is not therefore available for use. On the other hand, we find some commercial products available, though expensive and not always perfectly suited to our educational needs.

Therefore, this paper seeks to fill this gap by developing a system using virtual reality techniques, able to support teachers and pupils learning Descriptive Geometry.

Section II presents Descriptive Geometry basic concepts and the problem of spatial visualization disability; Section III proposes the use of virtual reality with stereoscope vision applied for teaching/learning of Descriptive Geometry; Section IV shows the VirtualGD system, which has been developed and implemented in an undergraduate educational institution in Brazil; Section V presents an assessment of the VirtualGD system and Section VI the conclusion and proposes to future work.

## II. DESCRIPTIVE GEOMETRY

It is the branch of geometry that intends to represent spatial figures in a plane, so that, in this plane all problems relating to these figures can be solved.

It was created in the late eighteenth century by the french mathematician Gaspard Monge [8].

### A. Basic Concepts

Descriptive Geometry is an early discipline, especially for engineering and architecture courses. It addresses to the representation and solution of problems involving spatial mathematical entities such as points, lines, planes, polyhedrons, etc., through its cylindrical orthogonal projections in two planes, perpendicular to each other, in which one is rotated over the other, with the aid of plane



geometry properties, as shown in Figure 1. The figure obtained after this revolution is called Epure.

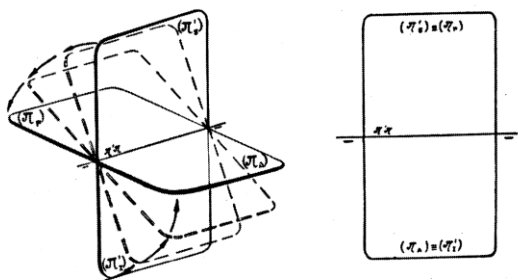


Figure 1. Revolution of the vertical plane on the horizontal plane – Epure.

The distance from one point to the horizontal plane is called quota. The quota coordinate is conventionally represented in Epure by the distance from the vertical point projection to the intersection planes line.

The distance from one point to the vertical plane is called afastamento. This coordinate is represented in Epure by the distance from the horizontal point projection to the intersection planes line, according to Figure 2.

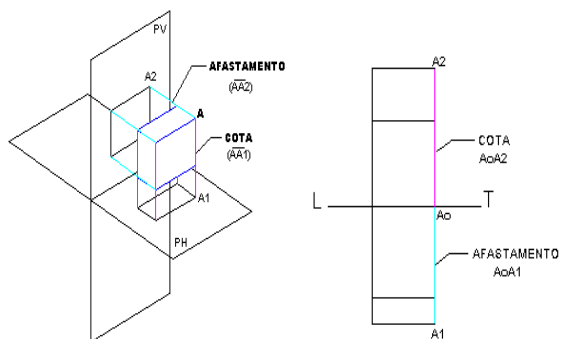


Figure 2. Afastamento and cota's point located in first dihedral. Spatial representation and Epure.

The Geometry studies the projections of objects that can be located in any of the four dihedral. In terms of technical design, the Brazilian Association of Technical Standards (ABNT) admits representations in both first and third, being the first dihedral representation the most used one.

### B. The spatial visualization problem

Disciplines involving planar representations (views, perspectives and projections) are an essential part of courses like engineering, architecture, industrial design, etc. Much of the work of these professionals involves the design of objects, from small parts to large buildings, which need to be represented and analyzed in the paper or computer screen. The need for representation of such projects in two dimensional media is what makes these essential disciplines, arising also the importance of Descriptive Geometry, as a suitable tool manipulation of these representations.

The Descriptive Geometry is given in general by lecture, using the blackboard, where the teacher makes the designs that are copied by students with the help of specific traditional materials (ruler, set squares, compass, real models, etc.). However, with this practice, it has been observed that a large number of students have serious difficulties in relation to spatial visualization ability, and this is one of the main factors for failure in learning this discipline.

References [9], [10] points to the reduced workload, the lack of a prior contact with the basic concepts of the discipline and the use of traditional teaching techniques are some of the factors that contribute to worsen this situation. The non-development of spatial reasoning during the school results in students, newcomers to undergraduate courses with recognized difficulties to understand the concepts treated in disciplines like Descriptive Geometry and Technical Drawing. Allied to this factor, there is a lack of alternative learning resources that can minimize these difficulties and support the mental abstraction processes necessary for the development of spatial visualization skills. The real models are most often used to facilitate three dimensional understanding.

Thus, we see the need to seek the use of modern techniques that can minimize this problem. In recent years, the use of visualization techniques related to computer graphics is becoming more frequent, so that we can find such applications being developed in several knowledge areas.

Within this context, this project proposes the creation of a virtual environment involving computational techniques such as computer graphics, virtual reality, multimedia, animations, etc., which can be used in Descriptive Geometry courses, aiming to improve the students spatial visualization ability and give teachers a new approach to teach the discipline. The system can be used both by the teacher, as a tool to support classroom, and by the students individually, as a way to strengthen the contents studied. The proposed virtual environment will be seen by students through stereoscopic vision glasses, aiming the better assimilation of the graphical space involved.

### III. VIRTUAL REALITY

Virtual reality comes to computer use to bring a new paradigm for interfacing with the man. In this paradigm, human beings will no longer be in front of the monitor, but rather feel it in the interface. In this sense, we can define virtual reality, in a simplified manner, as the most advanced human-computer interface yet available [11].

#### A. A virtual environment applied to teaching/learning of Descriptive Geometry

A virtual environment is a three-dimensional, multisensory, computer generated, which reacts in real time to user activities. User interaction with the virtual environment of the devices is done through multi-sensory input and output. Input devices are responsible for capturing the user actions and feed the system with this information. The output devices will return the user with sensations in the environment, due to their actions, updated in real time [12].

The modeling of virtual environments can be made using languages such as VRML (Virtual Reality Modeling Language) [13] and its successor X3D [14], and other languages, as well as through authoring tools such as Blender [15], or 3DSMax [16], among others, which offer greater details abstraction of development.

In recent years, the use of modern virtual reality technologies has been very promisingly disseminated in the technical and scientific field. We can find applications successfully developed in several areas like education, training, entertainment and medical sciences, among others. Also in the field of teaching graphic disciplines and engineering activities, virtual reality is gradually gaining more space, especially with regard to the potential of this tool for the development of spatial visualization skills and the implementation of virtual labs to support engineering activities [17]-[20], which motivated us to evaluate the possibility of using this technology as a tool to support the teaching/learning of Descriptive Geometry.

Some computational techniques such as multimedia, animation and hypertext have been studied and/or implemented [5], [9] and [21] as a way to support the learning of this discipline. The authors have been investigating the use of virtual reality, and only the non-immersive techniques with flat-screen were explored. However, virtual reality using stereoscopic viewing seems to be the most suitable for improving the spatial visualization ability of Descriptive Geometry students.

**B. Stereoscope vision using anaglyphic glasses**

The design of stereoscopic vision or an object depth occurs when we draw the projections corresponding to the two eyes, left (L) and right (R) as shown in Figure 3.

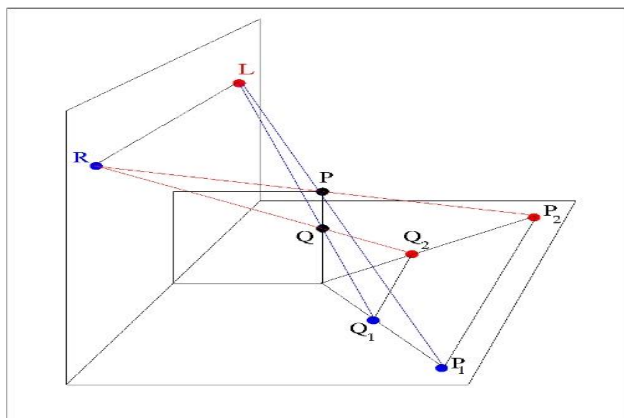


Figure 3. Horizontal plane projections of the P and Q points, according the positions of the left eye (L) and right eye (R).

On P point we have the P1 and P2 projections corresponding to the left and right eye respectively. Notice that the distance between the projections on the horizontal plane is proportional to the height of the point. Thus, P being at a greater height than Q is farthest from its projections which Q projections. So, the perpendicular line projection in a horizontal plane results in two intersecting lines as shown in Figure 4.

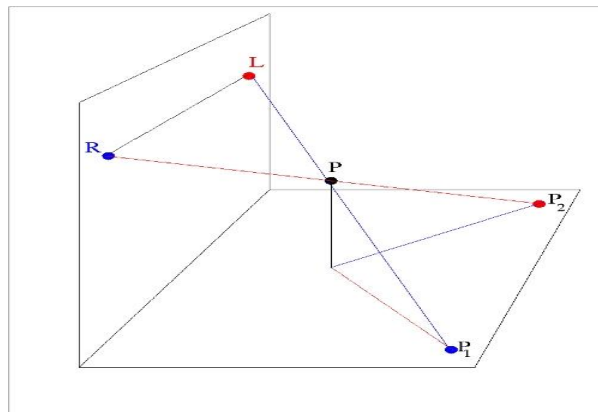


Figure 4. Line projections in a horizontal plane according to positions of the left eye (L) and right eye (R).

To view in stereo the P point, we must separate the left eye (L) projection of the right eye (R) projection. To achieve this, we use glasses called anaglyphic, performing a color filtering, in which the left lens filters out red light leaving only blue light and the right lens filters blue light leaving only red light. So we use the left eye image in blue and right eye image in red. Taking the glasses with the left lens red and blue lens right, we must first calibrate the color of paint so that the left eye does not see the red color (R) and the right eye does not see the blue color (B).

Thus, we can first draw the figure corresponding to the right eye, red (R) and performing a shearing operation, determine the second figure in blue (B), corresponding to the left eye. In the case of drawing stereoscopic projections of a (P) point on the horizontal and vertical planes, the result is shown in Figure 5. Red (R) is shown the right eye image and blue (B) the left eye image.

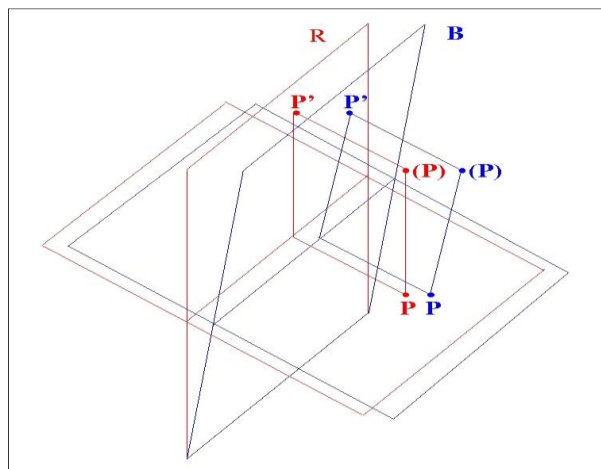


Figure 5. Stereoscopic drawing of (P) point projections on the horizontal and vertical planes.

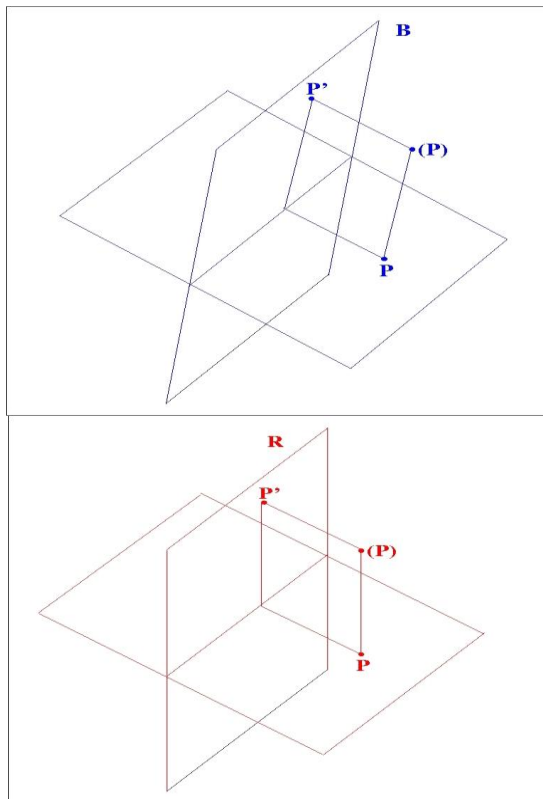


Figure 6. Images of the (P) point projections on the horizontal and vertical planes seen through the left lens (B) and right lens (R) of anaglyphic glasses.

The stereoscopic vision is a natural characteristic of the human visual system, which allows us to see in three dimensions and to perceive the depth of the scenes.

### C. Technologies for stereoscope vision

In order to obtain a stereo computed image, we must generate two images of the same object from a little different view points, and present them separately to each eye, as described above. There are several ways to achieve this effect, with different interfaces [22]:

- **Anaglyphic glasses** (passive glasses) – Anaglyphic stereoscopy is the oldest technique of images separation. The viewing, in this research, initially, will be done with the use of anaglyphic glasses for being less costly and easier to implement. The disciplines of Descriptive Geometry are been offered, usually, for groups with large audience, which would not make the use of stereoscopic projection system expensive and complex.
- **Shutter glasses** (active glasses) – Use electronic shutters made of liquid crystal. The computer quickly and alternately generates two images on the monitor, one for each eye. The glasses, in synchronism with the monitor, plug alternately light that reaches each eye, so that, each eye sees only its image.



Figure 7. Shutter glasses.

- **Polarized glasses** (passive glasses) - The technique is widely used in three dimensional movies. The glasses are formed by two polarized lens, so that, the images from each eye are sent through polarized light emitted by two different projectors, one for each lens.
- **Helmet** (active glasses) - To generate two separate images for each eye, two small monitors, each with their images, are attached to the helmet. In this type of underwater equipment, the user does not need to look at the computer screen because the monitor is on the helmet.



Figure 8. Virtual reality helmet

- **Lenticular display** (without glasses) - The figure is covered with small curved lenses and the lenticular effect allows the viewing of images slightly different, depending on the angle of observation.

### IV. THE VIRTUALGD SYSTEM

The system which is being developed and implemented entitled VirtualGD [20], [21] consists of modules (files) that are independent, each one covering a specific issue. It intends to cover all the course content. Each lesson, the teacher would have the modules that suits it. The modules are all interactive, responding to user requests in real time. The concepts are illustrated graphically and animated through three-dimensional representations. The subjects can be manipulated, providing their better view from different angles.

The VirtualGD was developed in the X3D standard, maintained by WEB3D Consortium (2009). The system is

displayed in the Browser, with the FluxPlayer plug-in that comes with Fluxstudio, with the operating system Windows.

The system will be manipulated by the teacher, projected onto a white screen and seen by students by using stereoscopic vision glasses, in classroom or manipulated by the student, on the screen of any computer, such as support classes. A stereoscopic system will contribute to obtain more realistic representations, providing greater clarity about the scene depth and position of objects in space. Thus, we are encouraging the power of visualization and spatial reasoning of the student, and facilitating the assimilation of relations between the mathematical entities involved.

The following is a small illustration of the module "profile lines" of VirtualGD system. The initial scenario of this module presents the horizontal and vertical planes of projection, and a menu designed with the kinds of the lines. If the user selects, for example, "intersecting lines", it appears in the space and the "project" button is provided in accordance with Figure 9.

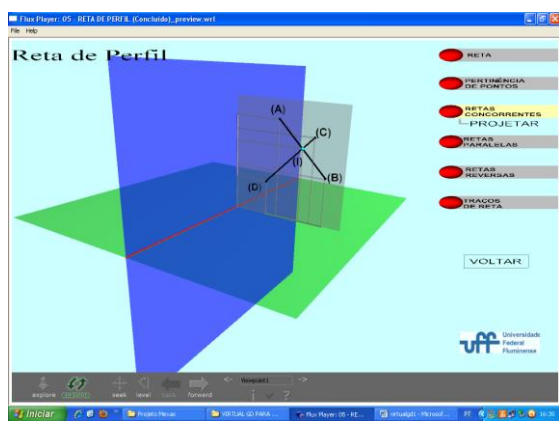


Figure 9. VirtualGD: Spatial representation of the intersecting profile lines.

The user can freely manipulate these projection planes to better understand the position of these lines in space, as shown in Figure 10.

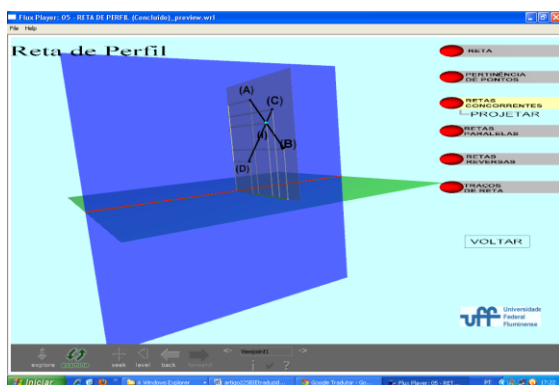


Figure 10. VirtualGD: Study object manipulated by the user.

Selecting the "project" button, the horizontal and vertical projections of the lines are presented in accordance with Figure 11 and the system provides the "Revolution" button.

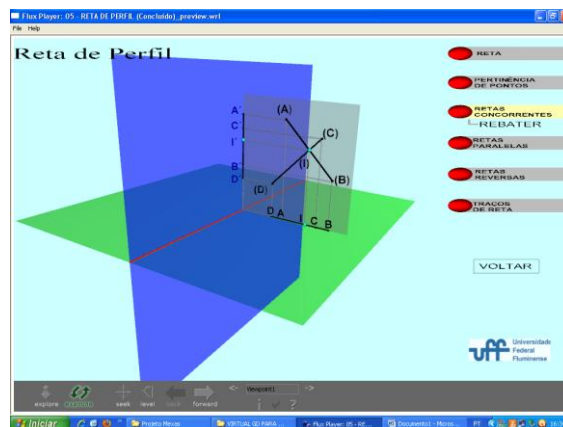


Figure 11. VirtualGD: Horizontal and vertical projections of the lines (A)(B) and (C)(D).

By choosing "Revolution", the system start an animation that illustrates the revolution of the profile plane in the vertical plane, as shown in Figure 12, and provide the "Epura" button.

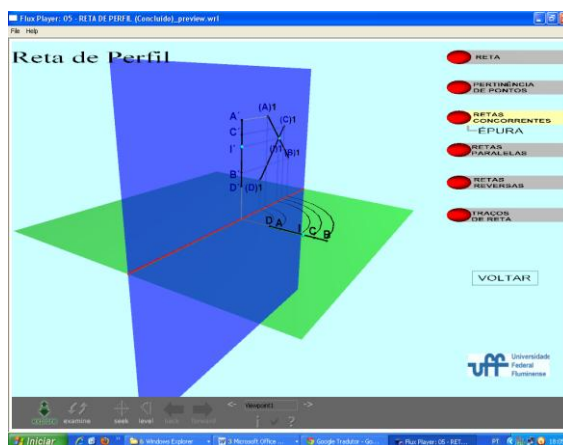


Figure 12. Revolution of the profile plane on the vertical plane.

By choosing "Epura", the system becomes an animation that illustrates the revolution of the horizontal plane or the process of obtaining Epure, as shown in Figure 13.

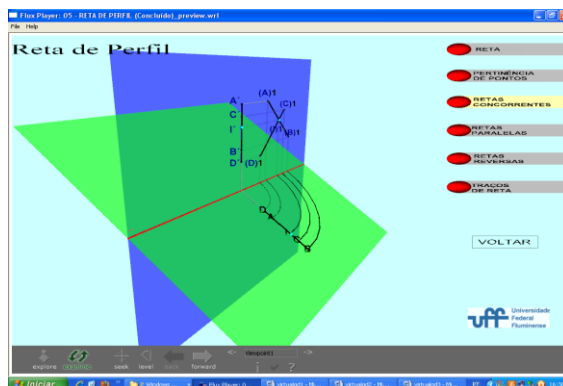


Figure 13. Revolution of the horizontal plane on the vertical plane to obtain the "Epura".

The system is in its developmental stage and has implemented the modules "projections and the point study", "special positions lines", "lines and planes intersections", "special positions planes and lines contained in these planes", "profile lines", "rotation", "revolution" and "change of plane".

V. ASSESSMENT

The VirtualGD was experienced in a Geometry Descriptive class composed of 40 students of Production Engineering at our university. All contents were presented by the teacher in the classroom, with the support of VirtualGD system, which was designed in flat screen, inside the classroom. The VirtualGD was also made available for students to use it outside the classroom. The evaluation criterion was based on scores in the first test performed by the students, since the VirtualGD in its current version only covers this stage to the course content. These scores were compared with the students' first test of the previous year which did not work with VirtualGD, and was called "control group".

A. Results

Of the 40 students in the class that used VirtualGD, 33 performed the first test. Of the 40 enrolled in the class above, the control group, only 19 performed the first test. That high level of abstention observed already seems to reflect the greater difficult presented by this group, which did not used the VirtualGD, and the consequent fear of failure in the evaluation.

Table 1 shows the scores, in ascending order, of the students' first test in each class, in addition to the arithmetic averages of the classes.

TABLE I – STUDENTS FIRST TEST SCORES AND CLASS ARITHMETIC AVERAGE.

Students	Classes	
	VirtualGD	Control
1	0.5	0
2	0.5	0
3	0.5	0
4	1	0
5	1	0
6	1.5	0
7	1.5	0.7
8	2.5	0.7
9	4	0.8
10	4	0.9
11	4	2.5
12	4	2.5
13	4.5	2.8
14	5	3.2
15	5	5.7
16	5.5	6
17	6	6.8
18	6	7
19	6	8.5
20	6	-
21	6.2	-
22	6.3	-
23	6.5	-

24	7	-
25	7	-
26	7.2	-
27	7.2	-
28	7.5	-
29	7.5	-
30	7.5	-
31	8	-
32	9	-
33	9.5	-
<b>Average</b>	5.01	2.53

In Table 1, it is observed that the average of the control group was significantly lower (approximately 50%) to the average obtained by the class that used the VirtualGD.

The frequency distribution graph is shown in Figure 14. It shows the percentual of students in each class who took scores at intervals ranging from zero to two, two to four, four to six, six to eight and eight to ten.

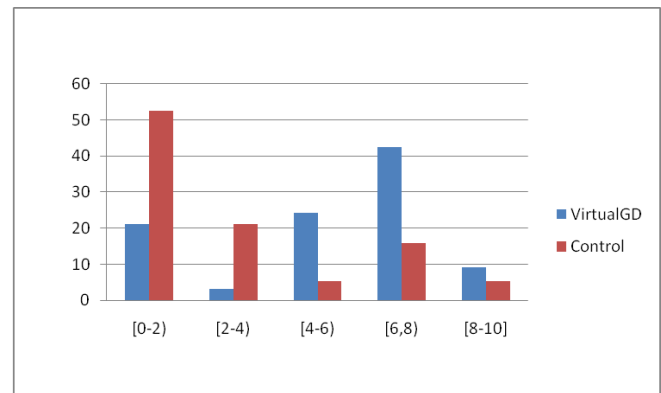


Figure 14. Frequency distribution of students by scores intervals.

According to Figure 14 more than half of the control group (52.63%) received score equal to or less than two in the first test. As for the class that used the VirtualGD system, the more frequently result (42.4%) was observed at the score interval between six and eight.

Figure 15 shows the cumulative frequency distribution for the two classes, considering the same scores intervals.

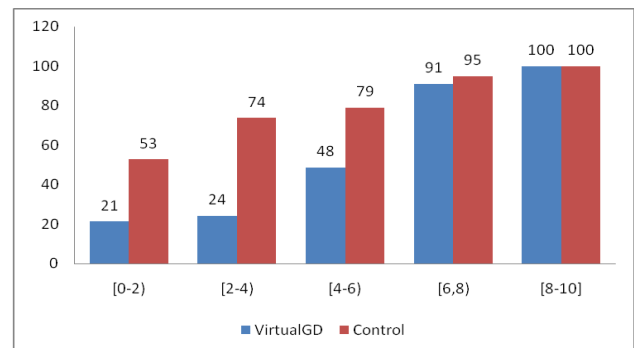


Figure 15. Cumulative frequency distribution of students by scores intervals.

According to Figure 15, 74% of the control group was scored below 4.0 compared with 24% for the class that used the VirtualGD. Considering that at the university the student has to take a final average equal to or greater than 6.0 (six point zero) to be approved in the course, Figure 15 shows that 52% of the class that used VirtualGD managed to stay above this level compared with 21% for the control group.

## VI. CONCLUSION AND FUTURE WORK

This paper presented the VirtualGD, a virtual reality system designed to support the teaching and the learning of Descriptive Geometry. The product includes various contents of this discipline, all dealt with three dimensional graphics, interactive, equipped with animations and using stereoscopic anaglyphics vision to support the mental abstraction process of students spatial visualization.

Initially, the finished modules have been tested by students and teachers in regular classes of Descriptive Geometry of an undergraduate educational institution in Brazil. Preliminary results were quite satisfactory, as the students were able to understand the concepts presented in the system, assimilated the best spatial positioning of entities involved, and were able to answer questions by filling gaps left by the theoretical explanation in the classroom, since they could watch the modules at home. The tutors and teachers, in turn, felt comfortable with the use of modules, which were considered friendly and intuitive. The results suggest that VirtualGD was able to contribute to students' performance because their test scores increased significantly with the use of the system.

The next steps involve the complementation of this work with the development of new modules (covering all course content), the implementation of the proposed system with stereoscopic vision in all modules and increment the statistic study about the best results in teaching/learning of Descriptive Geometry using this new approach.

The future propose is to extend this stereoscopic vision system to other disciplines which involves spatial visualization like Geometries in general and Molecular Chemistry.

The VirtualGD will be available via Internet. The already implemented modules can be seen on YouTube [23]. Thus, the program can be used not only by teachers but also by students and tutors in extracurricular schedules for further review of the contents seen in classroom.

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## Use of Social Media for Health Education: An Example of Online Support Group for Individuals with Atrial Fibrillation

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**Abstract**—Social media is increasingly used by patients for health education, empowerment and support. There is a lack of systematic data on what kind of information is being sought by patients via social medial channels. By analyzing information exchange in an on-line support group we can better understand what information is not provided reliably to patients in a clinical setting. The aim of this study was to analyze a content of messages exchanged between participants in an online support group for people with atrial fibrillation. Using Grounded Theory, we conducted a content analysis of 626 messages, which were grouped into seven categories. We described each category and provided examples of users' citations belonging to each category. In addition, proportion of initial posts and responses to them was analyzed depending on message category. Social media facilitated health education on major topics related to atrial fibrillation. Practical implications of qualitative analysis of messages posted on an online support group are discussed.

**Keywords**-Atrial fibrillation; online support group; qualitative analysis; knowledge gaps; social support

### I. INTRODUCTION

Atrial fibrillation (AF) is the most common cardiac dysrhythmia which affects over 6 million patients in Europe and approximately 2.3 million in the United States. The number of patients with AF continues to grow rapidly due to an expanding elderly population. AF increases the risk of embolic stroke by about 4-5 times [1]. Furthermore, AF is responsible for one-third of all hospitalizations for cardiac dysrhythmia, and the number of hospital admissions for AF increased two to three times from 1985 to 1999 [1].

Despite high hospital admission rates and high prevalence of the disease, even after emergency room and hospital admission, patients with recently detected AF have limited knowledge about AF symptoms, purpose of medication, stroke prevention, and side effects of warfarin [2]. Gaps in knowledge about the disease and its treatment, detection of symptoms and how and when to seek treatment were found in another study in patients visiting emergency room for AF symptoms and 3 months after discharge [3].

AF significantly affects patients' everyday quality of life [4]. It may sometimes limit their everyday and extracurricular activities, such as physical exercise, travel and others. Treatment for AF symptoms has been shown to improve the quality of life [4]. Among treatment options available are prescription of medication, electrical

cardioversion, radiofrequency ablation, implantation of atrial pacemakers, surgery and others.

With wide Internet expansion, individuals affected by AF turn to Internet in search of informational and emotional support from other people who are also affected by the disease by joining disease-specific online support groups. Online support groups help individuals to cope with their disease-related issues by overcoming distance, access, or communication-related challenges [5]. Members can share their experiences anonymously and ask questions that they may be uncomfortable to ask in person when interacting with their peers or a medical professional. Moreover, patients get access to more diverse points of view and information as compared to what they can get through established close relationships [6,7]. Therefore, online group members may obtain diverse information about their condition, treatment and related issues from other members. Such information is based on members' own experience and information from other sources like Internet web sites, books, patients' doctors and others. Thus, active participation in an online support group may help educate patients about their condition by addressing their knowledge gaps.

In addition to sharing information, patients share their emotions and feelings related to their disease. Participation in online groups promotes trust, empathy and emotional integration into a "virtual community" [8]. Higher levels of social support are related to lower psychological distress and better mental health in the sense of coping resources [9]. Social support buffers effect of stressors, like chronic health conditions, negative life events and other long-term conditions. In this case, social support may help a patient to cope better with the disease. Perceived availability of social support serves as a protective factor against psychological distress, depression, and anxiety [10,11].

Qualitative research methods are widely used to gain in-depth understanding of human behavior and the reasons that govern such behavior. The content of messages posted in online support group web sites may be a valuable resource for understanding experiences of group members and the utility of online interactions for the group participants [12]. Content analysis of the messages posted online has been previously successfully applied to investigate moderated and non-moderated online disease-specific support groups [13-14]. However, analysis based on Grounded Theory (GT) has not been applied

systematically to the content of online support groups, particularly in individuals with AF [15].

The goal of the present study was to analyze information content of messages exchanged between participants in an online AF support group using qualitative methodology in order to identify and classify major topics which are being discussed by the group participants. Understanding the everyday concerns and worries in the lives of patients with AF can help health care professionals to better meet their patients' expectations, and address patient-centered values, preferences and needs.

## II. METHODS

A grounded theory approach was followed in the analysis of online posts [16]. Research based on GT employs inductive thinking, aiming to understand a situation from 'inside' rather than stating a hypothesis first. Therefore, no categories were specified in advance of data collection. We analyzed archived messages posted on one of the AF support group web site. The content of 626 messages posted during the period of 1/1 to 1/31 2008 by 144 anonymous users was analyzed using the NVivo 8 software. Messages were analyzed in terms of similarities or differences, which was followed by finding common themes and developing categories. These categories, then, were used as a basis for the creation of a hypothesis.

## III. RESULTS

All messages have been grouped into seven major categories (see Table 1 for details). The most discussed category of messages was related to *medications*. Within this category, group members discussed medications prescribed to alleviate AF symptoms, which medications helped and which did not, and medication side effects. The most frequently mentioned medications were amiodarone and coumodin, e.g., "It (amiodarone) got me very very sick and I did not know it until I had to be hospitalized."

The *procedures* category included postings about effectiveness of such procedures as ablation, cardioversion, and half/full maze procedure, e.g., "My ablation healing seems to be progressing very well. My EKG is fine. I have been AF free except for three post ablation episodes (of decreasing duration) the first week. I understand that is part of the healing process."

The *experiences with AF* category contained messages describing personal experience with AF symptoms, asking how common the symptoms are and how other members cope with them, e.g., "Sometimes I will feel dizzy beforehand, but very often it will come out of the blue (...) My heart does palpitate very strongly several times a day, but this seems to happen independently of other symptoms."

The category named *quality of life* included messages about the impact of AF on quality of life. The members discussed limitations in physical exercise and travel: "AF

was basically ruining my life. I could no longer travel, I could no longer feel free to do simple things like paint a wall, or work in the garden on a hot day." Also, members shared how the disease affects their everyday life activities such as shopping, work, leisure time.

The *diet* category reflected the properties of various foods and drinks, such as green vs. black tea, fruits and vegetables, and how they affect the disease and blood coagulation: "A month ago after reading that green tea can cause palpitations I stopped taking the tea - and my AF has been behaving itself!"

In *helpful links and articles* helpful web sites, links and other sources of information were posted, e.g., "See Medscape, guidelines for the management of AF. Dr. Calkins has some very useful comments on Amiodarone in his interview with editor."

In the last category, *devices*, two devices helping to monitor and regulate the heart rhythm were actively discussed - atrial pacemakers and holter monitors, e.g., "I had a holter a few years ago, but unfortunately wasn't able to catch any of the episodes on it."

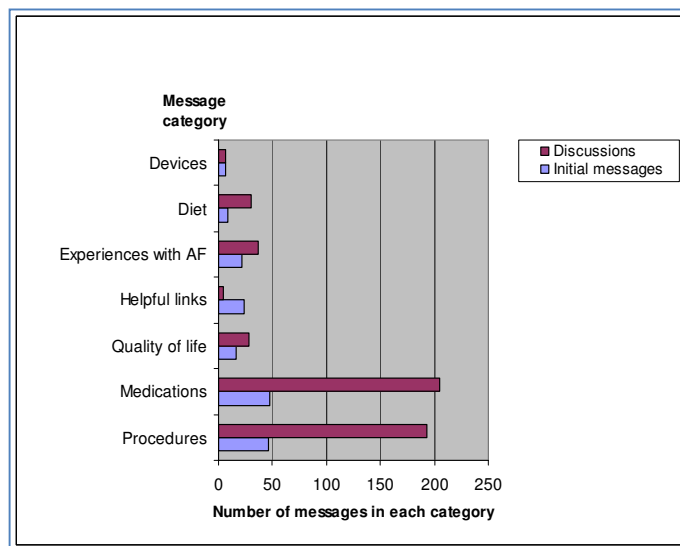


Figure 1. Number of initial messages and their discussions in each message category

As seen in Fig. 1, messages posted in some categories initiated active discussion of a topic, whereas in other categories number of responses was relatively low. For instance, the two most discussed categories were medications and procedures. At the same time, posts related to helpful links and articles were not discussed as actively as other messages.



TABLE I. NUMBER OF MESSAGES IN EACH CATEGORY AND SUBCATEGORY AND THEIR PERCENTAGE VALUES

Message category	Total number of messages in each category and subcategory and their percentage	
	Total number	%
Medications	252	
Antiarrhythmic drugs	79	31.35
Anticoagulants	59	23.41
Beta-blokers	27	10.71
Calcium channel blockers	9	3.57
Calcium and potassium	40	15.87
Side effects	33	13.01
Others	5	1.98
Procedures	239	
Ablation	151	63.18
Cardioversion	26	10.88
Maze	19	7.95
Location	19	7.95
Other	24	10.04
Life with AF	59	
Symptoms	17	28.80
Sleep	7	11.85
Dealing with AF	4	6.77
AF during pregnancy	3	5.05
Other	28	47.44
Quality of life	44	
Exercise	33	75.00
Travel	6	13.64
Influence of AF	2	4.55
Other	3	6.82
Diet	39	
Green tea	15	38.46
Red tea	3	7.69
Other	21	53.84
Helpful links	28	
Devices	18	
Holter	7	38.88
Pacemaker	4	22.22
AfibAlert	2	11.11
Other	5	27.77

## IV. DISCUSSION

We identified seven major categories of messages posted in the AF online support group: medications, procedures, life with AF, quality of life, diet, helpful links, and devices. With exception of helpful links and devices categories, in all other categories the proportion of messages offering support was much bigger than initial messages. This finding supports previous research describing major discussion topics in a disease-specific online support group [18].

We analyzed messages posted on the AF online support group during one month. Messages were content analyzed and grouped into seven major categories. We found that in five out of seven categories AF patients were more inclined to offer support than ask for it. This pattern was especially evident in topics related to AF medications and treatment procedures. At the same time, much less interest was expressed toward objective information related to atrial fibrillation available online, such as articles, web sites and useful links.

Messages posted in AF online support group provided insight into the disease-related topics that are the most important for AF patients and which were not addressed otherwise. The most common topics in group members' messages were related to AF medications and treatment procedures. This finding supports previous research demonstrating gaps in AF patients' knowledge about the disease and its treatment [2,3]. It also emphasizes patients' need in opinion from others who have similar condition, not just a medical professional. The number of responses to posts related to medications and treatment procedures was four times greater than the number of initial posts. Therefore, group members sought other members' opinion and advice in addition to their doctor's suggestions, e.g., "I have been advised to increase that (medication dosage) to 400 mg of paceron once a day, 200 in the AM and 200 at night. Anyone else take that large a dose with no side effect?", "I think I am ready to say goodbye to the meds, talk to my Doctor and go for rate control. Anyone have any thoughts or advice?"

Furthermore, AF patients paid much less attention to the discussion of validated sources of factual information related to atrial fibrillation available via online educational resources, such as articles, web sites and useful links, as compared to exchange of personal experiences and opinions. This demonstrates that the primary impetus for joining the online group for the AF patients was the desire to learn more about the disease from other people with the same disease, to understand how other people deal with this condition, and to validate their personal opinions by the group experience. Similar findings were reported in a case study of another online support group [8]. Our findings also correspond to results of a recent survey which demonstrated that patients preferred to discuss medical information online before talking with medical professionals [17].

Analysis of the content topics supported the notion that participation in the AF online group helped patients to cope with life challenges posed by their condition. Sharing emotions related to life with AF and getting understanding from others reduced psychological distress in patients, e.g. “Thanks for the additional information re: other rhythms. It has given me some stress relief from the concerns I had.” Moreover, in response to sharing personal experiences, the patients received information about a wide range of disease coping strategies that may be potentially effective in patient’s situation. The fact that the group participants were more inclined to provide support rather than request it from others underscored previously described phenomena according to which providing social support to others may result in health benefits comparable to—or even greater—than receiving support [19].

Previous studies demonstrated the efficacy of computer-assisted education in delivering knowledge and empowerment for disease prevention and management [20-22]. Social media can be used in conjunction with other tools available on the internet to improve continuous personalized patient education and support [23-25].

#### V. CONCLUSION

Our study provided evidence that an online support group for AF patients can help them to address knowledge gaps about their condition based on others’ personal experience. In addition, by joining such groups, patients can find emotional and informational support and resources that can help them to deal with disease-related stress. Understanding information needs of people with AF can help medical professionals to provide better medical care and improve patient-provider communication.

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# Being There with Bluetooth

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**Abstract**— In this paper, we describe how a multi-purpose Bluetooth communication software could simplify the daily routines of a vocational teacher significantly with virtually no extra cost and without excessive technical requirements. The attendance of the students can be monitored using the system described in this article. This feature was discovered when testing a short-range communication application intended for information distribution. The conclusion is that, with the addition of a tailored report formatting module, this application has significant potential to improve the quality of the everyday work of both the teacher and the students.

**Keywords**—simulation; short-range wireless networks; encounter networks; vocational education.

## I. INTRODUCTION

In this paper, we describe how a simple Bluetooth-based mobile application can support the everyday work of a vocational teacher by providing up-to-date information about the attendance of the students. While significantly reducing the time required for everyday routines, this application also facilitates achieving more accurate results and allows the teacher to concentrate on the students during the critical moments of starting a lesson. The system described here helps both the teacher and the students to stay more focused on the subject of the lesson, which is a good starting point for an effective learning experience. An important part of this is the fact that the utility described here does not require immediate attention from either party. Computers (and various mobile devices) can be very useful for learning purposes in some cases, but according to the common experience of the teacher community, they are also notorious for diverting one's attention from the ongoing process, such as the start of a lecture. Various network games and social media services are often seen to gain the students' full attention instead of the teacher. An information system based on "just being there", allowing the presence of the students being examined later, can hence be very effective in such situations.

This paper is organized as follows: Section II describes the related work in the field. Section III gives the necessary background information for understanding the problem in question. Section IV discusses the solution discovered for the problem. Section V describes the field test performed, and Section VI draws attention to the open questions and challenges in the field. Finally, Section VII sums up the process described in the article.

## II. RELATED WORK

The potential of using different Personal Mobile Information Devices (PMIDs) in Short-Range Wireless Networking (SRWN) has been examined by us with our colleagues. In [3], a generic platform for Bluetooth-based communication is described. The potential applications for such utility is described in [4], while [5] provides more formal approach to this form of communication. These ideas are further developed in [6], which also points out the significance of just detecting a device, without any communication transactions. These papers created the background for the contribution of this paper, observing the potential of the application in detecting the presence of a Bluetooth device users(s).

The basic concept of encounters between mobile devices ([7]) is utilized here in its most pure form: As suggested in [3] and [6], it is the presence of the device that already provides valuable information, not only the (possible) communication between the devices. This is the background that the system described in this paper is based on.

The focus of this research is on technically less demanding, human time frame applications. We consider this approach to be significantly different when compared to more traditional, connection/data transfer oriented approaches. For example, Sundaresan and Sivakumar [1] search for improvement in communication from the antenna technology. Yap et al. [2] in turn take a higher-level approach in requesting open systems, smoother transitions between different network infrastructures. Spyropoulos, Psounis, and Raghavendra [11] apply the most traditional approach, how to improve the network performance via more efficient data distribution methods. These are all important matters and serve well the mobile communication community. However, we feel that there is still another area of work: Applications and services simple enough to provide significant value without any further development on the areas mentioned above. In this paper, we describe one such a case.

## III. THE BEING THERE PROBLEM

Vocational education, from the age of 16 and above, is supposed to provide students with the professional skills of a particular field they have selected ([8]). In Finland, a wide variety of areas is commonly available, although some special subjects may be provided only by a very limited set of educational organizations. The training is organized as three-year vocational studies, divided into courses consisting of lectures (lessons) containing both theoretical and practical

approaches to the subject, supplemented with a certain amount of supportive courses in, e.g., languages and science. These are required since any three-year vocational degree is supposed to provide a sufficient background for continuing one's studies on the (applied) university level.

In most cases, one must be present during the lessons to practice and to show that one can actually perform the vocational tasks being discussed. If the attendance rate of a student is not high enough, the teacher cannot evaluate his or her learning and the student hence cannot pass the course.

For these reasons, the teacher must keep exact track of the students' attendance at each lecture. This information is in most cases entered into the organization-wide web-based information system (such as StarSoft Wilma, [12]), which is used by not only the teachers but also the students and their parents (in case the student is under 18 years of age). If a student is marked absent, he or she must provide a valid reason for missing the class. The parents of a student under 18 years of age should confirm the information given by the student. The group supervisor of each student group monitors the data and, if required, may take necessary measures.

Due to some of the students coming in late (an unfortunate but rather common phenomenon) and the large number of students (sometimes up to 35 in a single group), this is a time-consuming task. For certain workshop environments, the use of a standard classroom desktop computer may not be feasible at all.

This process is time-consuming especially for teachers working with several groups of students (mathematics-physics-chemistry teachers, language teachers, to mention but a few) who may meet four or five different groups during one day. It takes time to learn to know all the students, so for most part of the semester a roll call is the only method which can be used to monitor the attendance of the students. It takes up a lot of precious learning time. Quite often it has also occurred that even if, on a good day, the roll call only takes a minute or so, it still is a time long enough to divert the attention of the students away from the forthcoming lesson. If this could be avoided, the lesson could start with a more concentrated group of students. Furthermore, it is not mandatory to enter the data into the school's system immediately, since data entry will only provide value after the lesson is completed. In most cases it would be sufficient to update the information system after the whole day is complete.

Hence, a problem to be solved appears to be how to quickly and silently but reliably record the attendance of the students and to keep the information available for one or two hours so it could be entered into the official school system.

#### IV. THE SOLUTION

A Bluetooth-based non-communicating network may offer a solution to the problem described above. One can detect the presence of a Bluetooth device owner quite fast and quite reliably. This is not an absolute process, but compares quite well with the standard visual and auditory detection currently used. Such device-detecting application can satisfactorily work on the human time scale (as noted in [5]). The attendance of a student should be recorded with an accuracy of a minute, not a millisecond. The delay in the Bluetooth device detection procedure is therefore quite acceptable for this application.

A student project ("SBSB" for "Simple Broadcast Service/Bluetooth" unofficially called the "BlueInfo", a part of the subject studies of mathematical information technology at the University of Jyväskylä, Finland) related to our research work was carried out during early 2010. The project produced an application which was able to detect Bluetooth devices and pass information to them ([10]). However, it was both recognized and requested that the result of the project be a generic platform allowing different, yet unspecified uses of the software. Being able to detect devices and by request to be able to communicate with them via Bluetooth was the essence of the project. An exhaustive event logging system in the ASCII text file format was implemented in the software, providing the discovery (and discontinuing) times of the devices detected. This already provides sufficient data for the presence detection software.

The fact that virtually every student on this level has a personal mobile phone with Bluetooth support ensures the validity of the scheme suggested here. In addition, since the detection can be based on the MAC ID of the device only, no special features (such as software installation) are required from the students' side. Unlike NFC technology (described in [9], for example), Bluetooth allows the detection within a reasonable distance (classroom-sized spaces).

#### V. TESTING THE SOFTWARE

The idea has been demonstrated as a part of another software test of the SBSB project. It was run on an N810 device and we wanted to know how the application could handle a larger number of devices and to get an impression of its performance outside the labs. In April 2010, the following test was performed. During a scheduled break between the lessons a group of 23 students was asked if they wanted to volunteer for a software experiment. There were no objections; all the students were very interested in the subject (which obviously offered well-deserved variation to the math lessons). They were asked to turn on their mobile devices' Bluetooth feature so the N810 device application could detect them. This was done on a volunteer basis; one could participate in the test if one wished. At most there were 19 Bluetooth devices recorded being present within the same classroom. The application, not yet being the release version, eventually crashed, but during those approximately 10 minutes it was working it became clear that such a system would be valuable in tracking the presence of other devices. The logging feature of the application allows the presence of other devices being examined later. It would be a reasonable coding task to create a post-processor for formatting the log information into a suitable format for the particular use described above.

The N810, even though obsolete in many ways, is very well suited for this kind of task. WLAN and USB connections allow the transfer of information to other devices. Furthermore, the relatively large display allows manual entry of the data being viewed into other systems (even low-tech, still quite a common option and cannot be ignored in this scenario).

One should note that in the group of 23 students everyone did have a mobile phone. One student had a phone without Bluetooth support. This observation suggests that restrictions in usability of the service remain rare (e.g., less than 10 %), and the application can still make a significant contribution.

## VI. OPEN QUESTIONS

The most obvious (technical) question is that since the range and reachability of Bluetooth devices may vary, especially indoors, one could receive inappropriate signals from the adjacent classroom, for example. This could be avoided by using device IDs containing two parts which identify the student group and the student within the group. This could also be done on the server side (during the data analysis phase) by assigning certain MAC addresses to a certain group, i.e., no action would be required from the student's side. However, a permission of the participants (most likely in written form) should be received.

It is highly unlikely that a device within the same area, e.g., within the same open space and less than 20 meters away, is not detected within a couple of minutes. Again, if such cases fit within the 10 % residual, this should not be a problem.

It is clear that this system cannot be made mandatory considering the rights of the students. There is potential for legal problems, concerning the storing of the data. In principle, similar data has been recorded manually for decades, but one cannot guarantee that all the parties involved (teachers, administration, students, their parents) will immediately accept this more advanced version. On the other hand, it would be possible to use nicknames and/or code numbers. As already noted above, the Bluetooth MAC address would be sufficient. A connection between it and the user could be made in the teacher's system, where the information is already present.

The reliability of the software should no longer be a problem. After the test described above (which led to the crash of the software), there were several critical errors which were corrected before the end of the project (June 2010).

## VII. CONCLUSION AND FUTURE WORK

In this paper, we presented a small but frequently occurring everyday problem which may be solved quite comprehensively with a very simple information system, which, for the most part, has already been created. A network without communication can still provide information about the devices' presence and the time of arrival (and departure), which, in this case, is what the problem to be solved is all about. Immediate recording combined with the possibility of analyzing the data later is the essential part of the solution.

Based on the brief test made in a real classroom environment, the solution appears to be valid. The creation of suitable parser software for providing more readable output of the particular data required could be executed as another student project. Meanwhile, it is possible to continue field testing on a volunteer basis.

The original purpose of delivering SMS-sized messages to the clients could also be used in a classroom environment, for "silent communication". Such needs may occur when, for example, a student needs to go to the dentist during the following lesson. However, this is an extension to the system which requires a separate development cycle of its own.

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# Experiences in use Tablet PC to Support Student's Activities:

## Five Years of an Exploratory Study

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**Abstract**— Since 2006 we are studying the use of Tablet PCs in academic environment to support learning activities in and out classrooms. This article resume a five years of Tablet PC use in many learning activities, since 2006 until 2011, describing how this device was used. In the exploratory study, the student deals with some interaction problems that are described here. One conclusion is the difficult to find software for Tablet PC that offer functions to support the broad of student's activities, but the main contribution is the perception of the usability decrease when use software designed to desktop PC in Tablet PCs.

**Keywords**—Hardware/software systems for mobile communications, computing support learning activities, usability, pen-computing.

### I. INTRODUCTION

The recent technology forwards minimize part of the commons problems in the mobile computing: connectivity, length and processor capacity. This possibility brings a broad of new applications made to support many areas, inside this areas we can highlight the education. One of the mobile devices that are gained repercussion in this scenario is the Tablet PC, a device with height is similar to a notebook and have an input device similar a pen.

The paper and pen metaphor implies that tasks performed before in paper, like draw or manuscript writing, can be more natural in the Tablet PC than in the another computing devices. So, educational applications for contexts where paper and pen usually are presents can benefits from this new interaction style and from pen-computing, it offers better use experiences for teachers and students.

Backon [1] says that the keyboard allows a rapid typewriting and do texts structured by topics, but only pen can allow a creativity increment, better flexibility and a natural record of the think development process and rationale in all stages (ideal requirements for the educational environment), aging like a direct hand extension. For example in the resolution of complex problems with a large calculus solution, by using applications is possible to record all the steps and draw diagrams that explain the problem resolution, step by step.

When move the pen in the screen, the pen trace should result in electronic ink that must be treated by the application to be rendered and stored. But desktop applications, that running in the Tablet PCs, do not treat electronic ink, so it is

necessary special applications, applications that treat electronic ink, to have benefices of the pen interaction style.

But more than treat electronic ink, witch more attributes differs desktop applications and Tablet PCs applications? Which design issues can be extracted from these attributes and used in the design of good usability applications for Tablet PCs?

To answer these questions, it is necessary collect and analyze the use of Tablet PC applications that support the user in the educational context, a student. So, the initial question is which available applications can be used in the student's day a day activities? Which functions are important to support these activities? Intrigued by these questions, we started to do an exploratory study with real use the Tablet PC and some applications to support students activities. The main objective of this paper is brings some answers to these questions describing this exploratory studies until 2011 that began in the December 2006.

Section II shows the adopted methodology for the exploratory student and its context, and Section III presents the Tablet PCs models used in the study, and Section IV describes the used applications in this period. Section V presents a resume of the use and the main problems the u dealt. Section VI brings some design issues based on the related problems. The conclusions are presented in Section VII.

### II. METHODOLOGY

The exploratory study goal is observing and describing how the Tablet PC can be used to support students day a day activities. So we used the following methodology:

- Identification of student activities in and out classrooms;
- Identification of Tablet PCs applications that support the identified activities;
- Use the collected applications for Tablet PC in the activities;
- Analyze the use and collect the student opinion;
- Extract interaction problems.

The study is related with the winning project [2] submitted for the 'Higher Education HP Technology for Teaching Grant Initiative Recipients' [3], an international awards where the best project receive financial support to equip a classroom with Tablet PC and do the proposed research project. The winning project was written in 2006 by a group of researches from UNICAMP interested in study

the use of Tablet PC in high education. This work is related with this project, that dispose a Tablet PC for integral use.

### III. TABLET PCs AND USED MODELS

The Tablet PC is a computing device designed to “imitate” a notebook, allowing the user interact with a pen. Resuming, the Tablet PC has the following hardware characteristics:

- (i) Pen sensitive screen;
- (ii) Screen that allow different positions (Fig. 1);
- (iii) Wireless network access by WLAN and bluetooth technology;
- (iv) Microphones and embedded loudspeakers;
- (v) Keyboard (some models the keyboard are detachable);
- (vi) Batteries.

In this exploratory study, we used two HP Tablet PC models, both models have processors similar with the laptops in them build year. The first model, used between 2006 and 2008, is a HP/Compaq TC1100 (Fig. 1) [4] with a 1.2GHz processor and 1 Gb of RAM and a 10.4” screen. Initially equipped with Windows XP Tablet Edition, after it was change for Windows Vista with Portuguese manuscript recognizer. After, we adopted Linux operation system Ubuntu distribution.

The second model, a HP TouchSmart TX2-1040br (Fig. 2) [5] bought in December 2008, has a 2.2 GHz dual-core processor with 3Gb RAM and a 12” screen. The installed operation system was Windows Vista with Portuguese manuscript recognizer. This model has the design more similar to HP laptops but equipped with the hardware described to Tablet PC, and have a touchscreen.

### IV. APPLICATIONS FOR TABLET PC

Passed by 8 year that the Tablet PCs are commercial explored, but there is few applications for them yet that can be used in the educational context. Comparing the software production for smartphones and the software production for Tablet PCs, we can see that the Tablet PC ones is timid yet.

During the study case time, tree software for Tablet PCs were used: Adobe Acrobat Professional [6], Windows Journal [7] and Jarnal [8]. All these software are for doing annotations or writing manuscript text.

The Adobe Acrobat Professional (Fig. 3) is a proprietary software that allows the creation of .pdf files and the use of some tools to typewriting text edition and doing annotations using the Pencil tool for manuscript text and the Highlighter tool for highlight parts of the text.

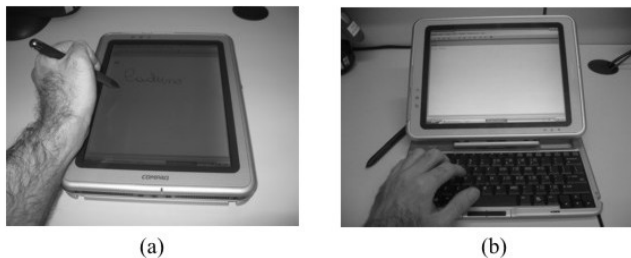


Figure 1. Different positions to use the HP/Compaq Tablet PC model TC1100.

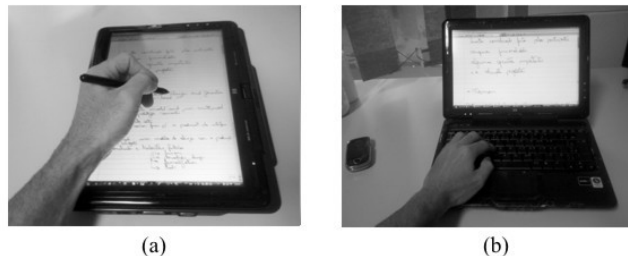


Figure 2. Different positions to use the HP Tablet PC. model TouchSmart TX2-1040br.

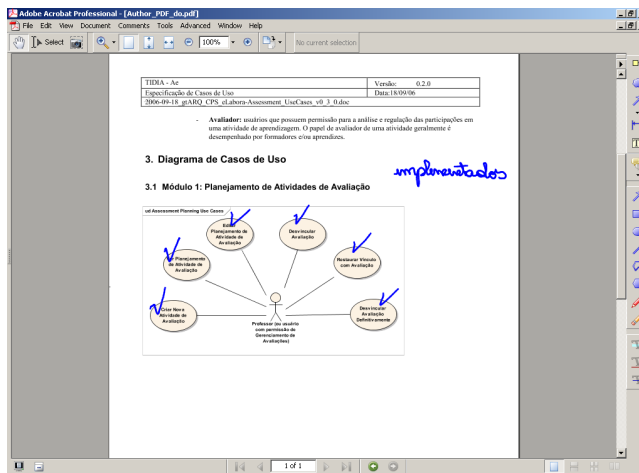


Figure 3. Example of Adobe Acrobat Professional to do annotations.

The Windows Journal (Fig. 4) is a software that comes with the Windows XP Tablet PC Edition and allow do manuscript annotations with tools to change the characteristics of the pen like fat width and color, and some functions like highlight, select and erase annotations, and commons applications functions like new file, open file, save file, copy, cut and paste text and annotations, and insert figures and text editor functions, like add or remove pages.

The Windows Journal save in a proprietary format (.jnt), and to be viewed in a desktop computer needs a special application, called Windows Journal Viewer, a software to visualize the electronic ink saved in the .jnt file. Windows Journal Viewer is distributed freely for Windows users.

The Jarnal is an application written in Java programming language with functionality similar to the Windows Journal, but it is multiplatform and free to use. Among the text editor functions and manipulate the electronic ink, Jarnal allows include files in the background so that is possible do annotations direct over the document. This function allows to use as background files like papers our presentations and highlight import parts of the text with the Highlighter tool (Fig. 5).

### V. TAKING NOTES WITH TABLET PCs

The first contact with the Tablet PC occurred in a Human-Computer Interaction classes, where the students were challenged to design applications to this device considering usability attributes. One of the applications developed was the Interactive Logic Notebook [9]. But the

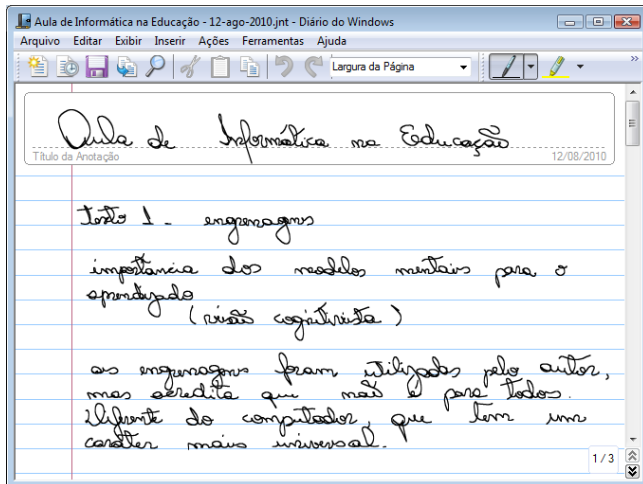


Figure 4. Example of Windows Journal to do annotations into classes.

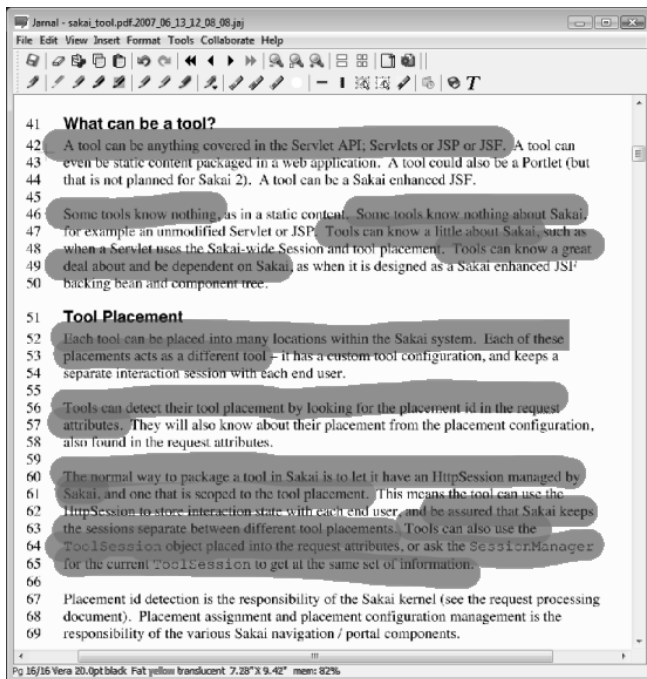


Figure 5. Example of using Jarnal to highlight text.

real use of the Tablet PC to support student activities occurred between 2006 and 2008, when we used the Tablet PC to do classes annotations and do exercises from Theory of Computing, Software Engineering, Distributed Systems and Informatics Applied in Education courses.

The first used model of Tablet PC was available for the students in December 2006, month without classes at UNICAMP. To stimulate the use and acquire experience in use Tablet PC and software, the student decided to use the device to support her in research day a day activities.

The first task the student used the Tablet PC was analyze an use case document available in .pdf format verifying which use cases about an application was implemented conform specified or identified points to update the document when the difference was result from a decision

process to change the design. The student’s goal was doing marks in the text to signalize points that need to be updated or points where the implementation needs to be reviewed.

The chose software was Adobe Acrobat Professional, because the goal was do annotations in an existing .pdf file. Some interactions problems where find in this use, resulting in the adoption of another tool to make this kind of activity in classroom.

The first problem dealt by the student when she used the Adobe Acrobat Professional was the reception of input data to render the electronic ink. In the manuscript writing, the letters were rendered in a sharpened form and sometimes only a trace was showed. Maybe this problem was result from the device do not match the hardware requirements that the software needs, so the Adobe Acrobat did not received all the points to draw correctly the electronic ink. This problem occurred mainly in a short time to start the writing. To resolve this problem, the student pressed the pen against the screen, waiting one or two seconds and start to write the word. But some letters become hard to recognize, because the forgotten points that compose the electronic ink. The solution adopted was written more slow.

Another interaction problem was related with the electronic ink selection function that the Pencil tool have. Pressing the pen near an existing electronic ink, the software interpret this action has a electronic ink selection. This way make hard write letters like “i”, “j”, “k”, “t”, “ç” in the manuscript way and accentuation, that require more than one trace to written the letter. When the users will write the second trace trace for one of these letters, the first trace usually is moved to other position. The user strategy was begin the second trace so far so that the second trace was recognized has a new electronic ink and not has a selection for the existing trace. But this strategy works fine with letter “t”, and does not work to write the dot for the letters “i” and “j” and write the cedilla for letter c.

Another problem deal with the student is related with the scroll bar position, disposed in the right corner. For a left-handed person, the case of this student, when interact with the scroll bar the arm embarrass the content visualization that are moving, become hard to put the content in the wished position. Another problem is the scroll bar width, that for the use with a pen must be more fat. Using the scroll bar in the default width, the student had the tendency to cross the scroll bar borders when the pen was in the second half of the screen. The pen cross the bar borders because the movement of the fist over the screen (the movement is not a straight line). When the pen cross the bar borders, the software back the visualization to the content part viewed before the scroll operation.

To scroll, the user adopted another tool that the Adobe Acrobat Professional has, the Hand tool. This tool allow press in any part of the content and scroll up or down, allowing change the document visualization. The users said the use of this tool is more efficient form to scroll the document.

To shared this use experience, the student written a manuscript text using the Jarnal application with the intent to publish the text in the Messaging Board tool of TelEduc environment, used as a communication platform among the project team. But the Internet browsers do not support



electronic ink or the Jornal format, so the student tried to publish the annotations as pictures, because her wanted to maintain the manuscript way for her readers. To convert the annotations made in the Jornal application in pictures, it was necessary save the annotations in a .pdf format (the Jornal does not have functions to convert annotations in pictures, but have functions to save the annotations in .pdf format), open the saved file and copy page by page using the Adobe Reader's Instant Photography tool. After the selection and copy operations, the student paste this content in a image editor and save the file as a picture format (.jpg). So the images are uploaded to the platform as attached files and referenced by the .html file as image to be viewed by the readers. This activity was considered too hard to do and abandoned lately.

The Tablet PC pen interaction differs from the interaction styles that laptops have (keyboard, track pad) and shows a great potential to facilitate the activity of do annotations in Theory of Computing classes, because in this discipline is necessary adopt symbols that not are in the QWERTY keyboards.

In Theory of Computing classes, exercises lists was shared with students using the .pdf format. As the exercises list is a sequence of problems enunciation without space among them, this become impossible to resolve the exercises using the document as background. So the student resolve cut the enunciation exercise and past in a Windows Journal archive (Fig. 6). The student needed to adjust the pasted object dimensions to become more readability in the zoom used to resolve the exercise (page zoom). After did this steps, the student resolve the exercises. The student justify this work answering her wants to have a map between exercise and resolution for future study., for example, for an exam.

Using the problem enunciation with the resolution can facilitate the resolution, because it is possible highlight parts of the text that are important to the solution or use pictures available in the enunciation (Fig. 6). The digital content allows duplicate items that need to be more than one time in the resolution, the case of the graph draw in the Fig. 7, when the enunciation ask to the students verify how many short-ways the graph has. The student duplicated the graph picture instead of draw it.

In problem resolutions, more than the answer, is important to have the record of each step until get the answer [1]. In some resolutions, some parts needs to be duplicate to show the rationale, as the case of the Fig. 8. The exercise asks a spanning tree for the given graph. The use of the Tablet PC was specially important to use copy and paste functions, turning the answering this exercise more fast because many parts did not need to be rewritten.

A common practice among students is share classes annotations and resolutions from exercises. This practice occurs in Theory of Computing course among the student that used the Tablet PC and the others one. So her sent this annotations by e-mail in the .jnt format. But the other students needed to install the Windows Journal Viewer application to view the file content, and asked to shared the annotation in a more popular format that not require a software installation, like .pdf format. The students adopted this format for all annotations sharing.

To explain different resolutions, doubt points or indicate errors in the shared resolution, the students that did not have a Tablet PC used to typewrite text artifices when use e-mail

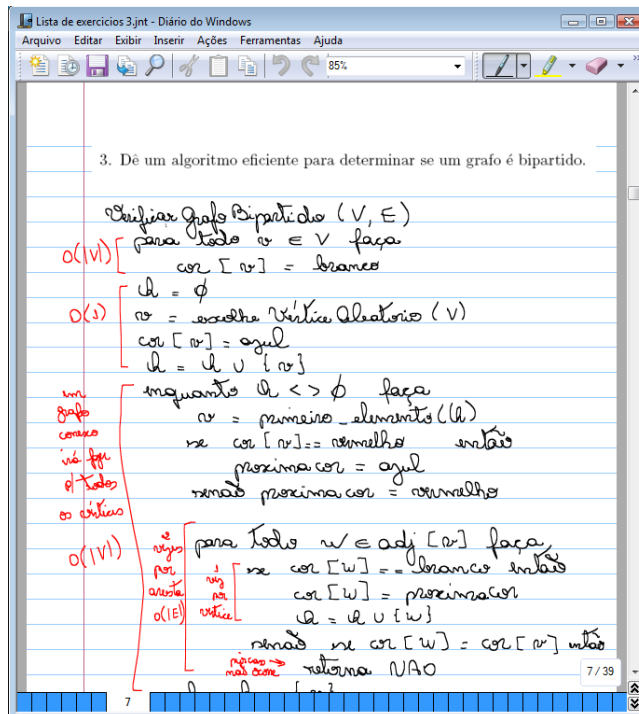


Figure 6. Example of manuscript using Windows Journal when resolving Theory of Computing exercises.

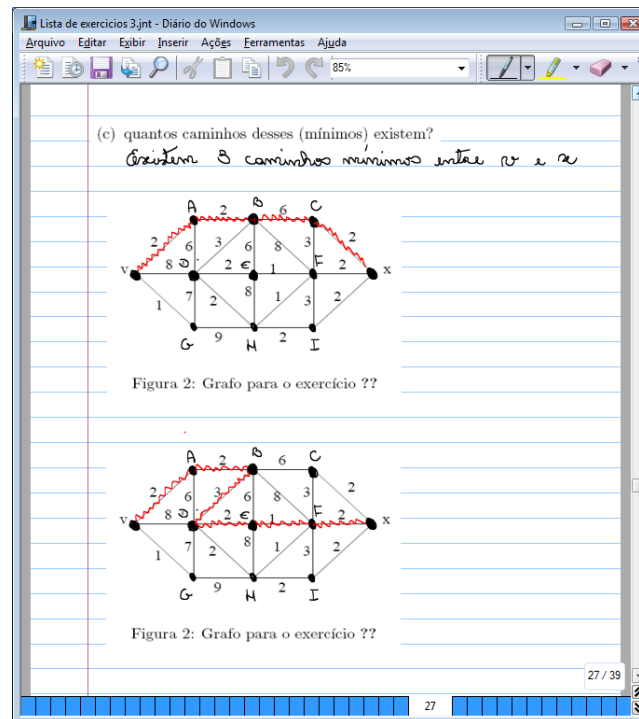


Figure 7. Example of annotations in duplicated enunciation part to resolve an exercise.

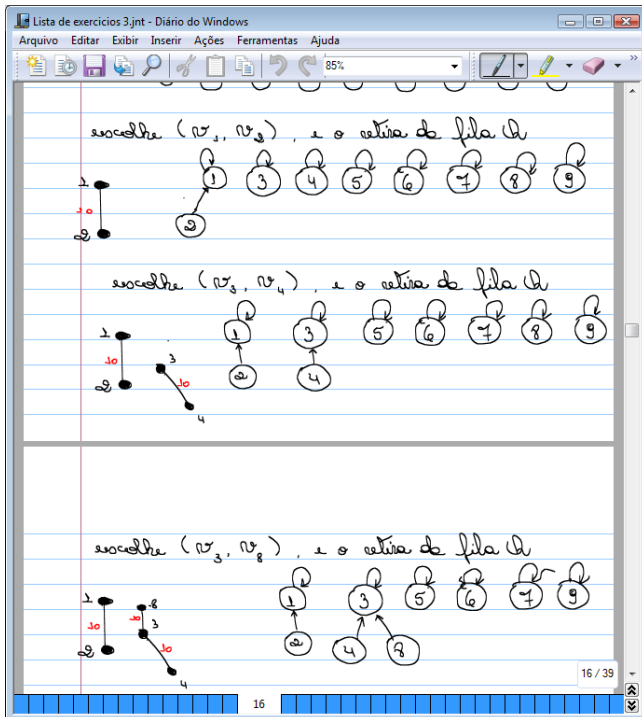


Figure 8. Example of use the copy and paste functions to duplicate annotations.

or to print the documents for do annotations with pen in meeting.

In the next course, Informatics Applied in Education (cursed in the first semester of 2008), the student used the Windows Journal (Fig. 9) to taking classes annotations, using the theme classes in the file name when save. The use of Windows Journal is justified by the better performance in receive the data input and convert into electronic ink, so the result letter is more closer than the other applications.

The Jarnal was used in the Informatics Applied in Education course to support the peer review activity. The peer review activity consist into read a text written by another student and points out how to improve the text. The available text was used as a background document, where the student did the annotations (Fig. 10).

## VI. USABILITY PROBLEMS OF THE ADOPTED APPLICATIONS

Analyzing the user interaction, it is possible identify some usability problems in the used applications. The first one described by the student is related with use the same tool to do manuscript text and select electronic ink. Considering manuscript letters, allowing select inks with the tool used to write it turns hard write letters composed by more than one trace, or have points or accentuation. So, one design issue for Tablet PC is avoid unify functions for write and for select in one tool.

To compose the traces of electronic ink, the application needs treat all input data emitted by the pen, composed by pen position on the screen and the pressure. For the letter do no be shaped and the manuscript in Tablet PC be more similar to the manuscript in paper with a pen, the application

needs treat all the events generated by the pen. Techniques for pour rendering of the electronic ink while writing and a high fidelity rendering after the the writing can be used to not loose data.

One of the differences between Windows Journal and the other applications (Jarnal and Adobe Acrobat Professional) is the buttons inside the Windows Journal tool bars are softly bigger than the buttons of the other applications (Fig. 11), this make more easy to select a tool with the pen.

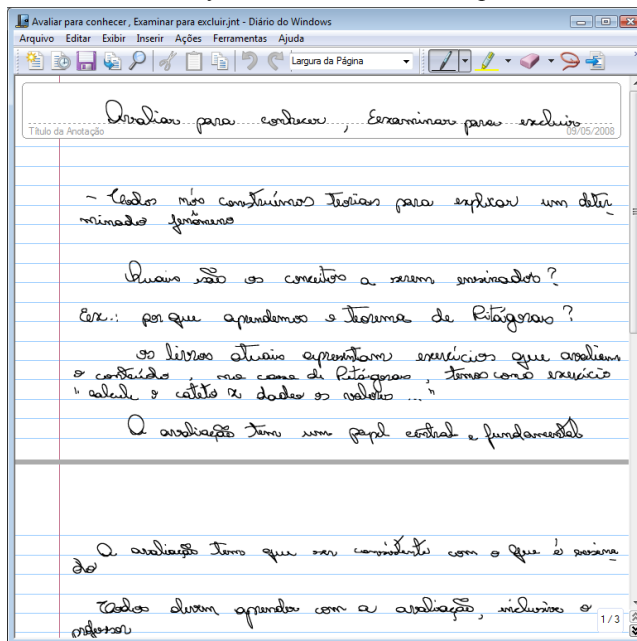


Figure 9. Example of use Windows Journal into Informatics Applied in Education classes.

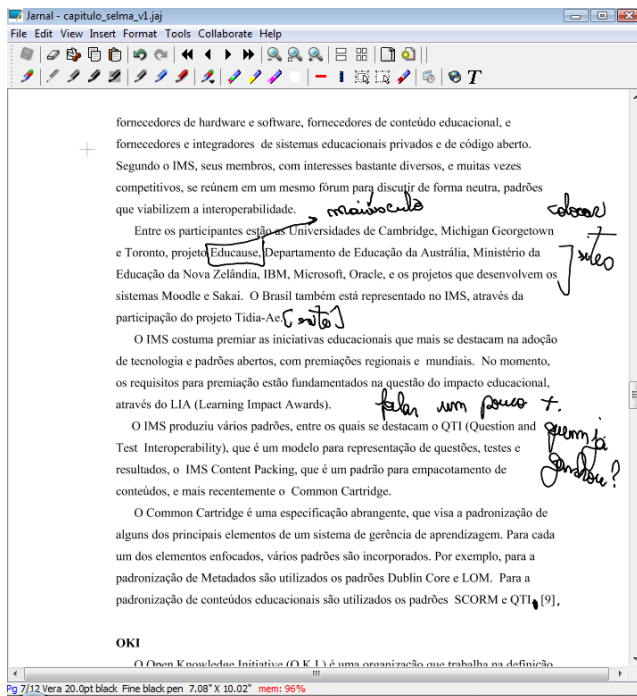


Figure 10. Example of Journal use to do annotations in a text.

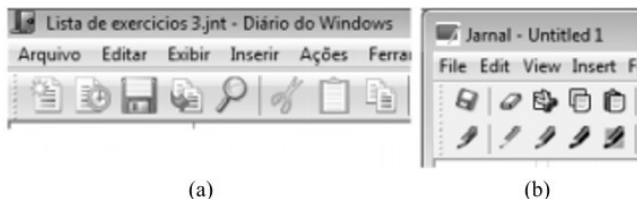


Figure 11. Dimensions between buttons into Windows Journal (a) and Jarnal (b) Tool bar.

Analyze the options to erase electronic ink into the Windows Journal and Jarnal applications, we perceive that the Windows Journal offers two kind of erase forms, while the Jarnal offers only one. The form offer by both applications is erase all the traces that the erase tool have contact. The Windows Journal offers too another way of erase electronic ink that erase only parts of the trace, allowing a better fine adjust of the writing.

Activities that needs collaborations among students are commons in educational context. So, the applications needs make easy the communication of many devices, by file transfer or by Internet. It is important do not restrict the communication only between Tablet PCs, but consider the possibility of many devices used like desktops, laptops and smart phones.

And for motivate the use of an application, the application needs have functions that explore the potential of digital artifacts. In this case, functions to copy, cut, paste and move the electronic ink. These functions turn motivational factors to adopt these applications.

We believe that these described issues must be considered in the design of Tablet PC applications, with the goal to explore the pen interaction and minimize usability problems.

## VII. CONCLUSIONS AND FUTURE WORKS

The Tablet PC is a computing device designed to be similar to a notebook, and the main hardware to be used in the interaction is a pen.

For five years, we did an exploratory study where two models of Tablet PCs are used to support a graduate student activities. The main use was do classes annotations in classroom, highlight part of texts and doing exercises.

The Adobe Reader Professional, Windows Journal and Jarnal applications were used in many periods as annotations editors. Many available functions was used like color, annotation selection, copy, paste, cut of annotations and pictures.

When the pen moves over the screen, it generates input data for the applications that need to be used to generate the electronic ink. Desktop applications does not manipulate the

electronic ink, resulting in loose of the Tablet PC potential because the pen is used only as a pointer device. In this case, the use of pen as a pointer device in desktop applications, there are usability problems.

We present and discuss some of them, like the dimensions of user interface components, the use of one tool to writing and selecting electronic ink and the difficult to see the content when user needs to cross the screen with her hand. The discussed issues plus the needs to explore the interaction style used by the users turns hard the design applications for multidevices, mainly when we need to consider many interaction styles.

## ACKNOWLEDGMENT

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## NORMALDB – A Logic-Based Interactive e-Learning Tool for Database Normalization and Denormalization

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**Abstract**—This paper introduces the design and development of an e-learning tool, NORMALDB, that teaches normalization and denormalization phases of database design. What characterizes and makes unique this tool is that it smoothly integrates two entirely diverse paradigms: at the internal level, an intelligent layer based on logic rules in Prolog implements the normalization and denormalization of a given database, whereas at the external level, the user may friendly interact with the tool through a common Web interface, and not concerned with the complexity of the tool internally. Using this tool, students may stepwise exercise and explore the whole process of normalization and denormalization, which otherwise constitute an important but troublesome phase of database design.

**Keywords**-E-learning tool; database normalization and denormalization; logic rules; client-server programming.

### I. INTRODUCTION

Learning technologies is one of the fields that highlighted the potential of the web for education. Easy access, location and time independent resources, unlimited design space, flexibility, and a wide range of functionalities of the web prompted the development of a new branch of learning named e-Learning [1]. The advantages of the web were by default inherited by e-Learning technologies built upon them, enabling thus more sophisticated teaching and learning environments. That way, the utilization of e-Learning technologies by universities has led them to transform from didactic teaching methods to flexible and independent learning. Subject-based e-Learning is an example of providing support for even more complex subjects to learn [2], as is database normalization and denormalization, which is a subject-to-learn through our e-Learning tool we will here introduce.

Database design is the art and science of improving the structure of database relations that are most suited to represent a small portion of the world called the “universe of discourse” [3]. The relational schema that results at the end of the design phase must consist of normalized relations accordant with the semantics of given entities and their integrity constraints, avoiding at the same time as more as

possible data manipulation anomalies. Hence, normalization is very important in practice, but also crucial to get familiar with for every student studying databases. Unfortunately, this subject is often dry and troublesome to learn, making it not well received by students.

To ease learning of database normalization and denormalization, we developed NORMALDB, a web-based e-learning tool that will be introduced here. The tool is designed to provide theoretical background on the subject (normalization and denormalization): it explains stepwise every single detail of the process as a whole. It also provides an interactive interface of learning the subject driven by own examples as given by the user (e.g., a student). The organization of the tool is a pure reflection of how the teacher organizes the subject.

There are already few tools that cover executing normalization, like JMathNorm [4], a Web-based tool of learning normalization [5], NORMIT [6], or a normalization tool that bases on UML [7]. NORMALDB is unique in that it smoothly integrates two entirely diverse paradigms, namely:

- at the internal level, an intelligent layer based on logic rules in Prolog implements the normalization of a given database as introduced by Ceri and Gottlob [3], whereas,
- at the external level, the user may friendly and stepwise interact with the tool through a common Web interface, kept thereby not concerned with the complexity of the tool at its internal level.

Moreover, using NORMALDB, students may step-by-step experience the whole life-cycle of database relations up to their normalized forms, or in a reverse process of denormalization which means rollbacking relations into their original form whenever deemed necessary for the sake of efficiency of join operations. Driven by examples, each step is in addition accompanied with comprehensive explanation of the theories applied in that given step. Navigation through theoretical blocks across individual steps / subtopics is another strong reason to leverage NORMALDB. The level of interactivity, the ease of use, and its logic-base of rules and the Web interface make NORMALDB unique among existing tools which support normalization.

This paper is organized as follows. A brief review on the main concepts of database normalization and denormalization in general is given in Section 2, while Section 3 introduces the NORMALDB, our normalization and denormalization tool. Further, Section 4 provides the software architecture of NORMALDB, with its features then summarized in Section 5. Finally, the conclusion and future work are discussed in Section 6.

## II. DATABASE NORMALIZATION AND DENORMALIZATION

It has been estimated that more than 80% of all computer programs are database-oriented. This is easy to believe since databases allow the applications to meet all their requirements for storing, manipulating and displaying data [8] at once.

For years now, the relational data model remains the most used data model in databases. The central data description construct in this model is a relation which can be thought of as a set of records. The description of a data in terms of data model is called a schema. In relational model, the schema for the relation specifies its name, the name of each field, and the type of each field. User requirements may in addition result into certain integrity constraints (ICs) within the schema. ICs may in turn cause redundancy-related problems like: redundant storage, update anomalies, insertion anomalies, and deletion anomalies. Special group of ICs that plays the major role in the schema refinement are called functional dependences (FDs) [9].

### A. Normalization

Following the FDs that hold over a relation, one may understand what redundancy problems, if any, might arise from the current schema. To provide such guidance, several normal forms have been [9] introduced in terms of FDs as follows:

- 1NF – First normal form: A relation R is in first normal form (1NF) if and only if all underlying domains contain atomic values only;
- 2NF-Second Normal Form: A relation R is in second normal form (2NF) if and only if it is in 1NF and every nonkey attribute is fully dependent on the primary key.
- 3NF – Third Normal Form: A relation R is in third normal form (3NF) if and only if it is in 2NF and every nonkey attribute is nontransitively dependent on the primary key.
- BCNF- Boyce-Codd Normal Form: A relation R is in Boyce/Codd normal form (BCNF) if and only if every determinant is a candidate key.
- 4NF and 5NF are rarely achieved, and hence not implemented in our tool at this stage.

The procedure itself of transforming a relation, given its FDs, into any of the abovementioned normal forms (NFs) is known as normalization, and it:

- leaves the relation unchanged if it already satisfies the NF sought after, or

- decomposes the relation in two or more smaller relations, i.e., relations with less number of columns, each satisfying the NF sought after.

### B. Denormalization

Normalization of a relational schema given a set of FDs results into a relational schema which is free of redundancy-derived anomalies, but might yet suffer from eventual performance-derived problems. To address that kind of problems, a reverse process to normalization, namely denormalization, has been introduced. Denormalization is the process of adding columns to the table to reduce joins in favor of performance, and is considered only if the integrity of data is not seriously compromised [10].

## III. NORMALDB

As stated in [11], students find it difficult to understand the concept of FDs and normalize data in order to obtain smaller well-structured relations. NORMALDB is a web-based e-learning tool that we developed to aid students understand and experience the most complex tasks of database design, i.e., normalization and denormalization. The organization of NORMALDB resembles the way how a teacher schedules his / her class while teaching normalization and denormalization. Further, the ability to explore every single step / subtopic of normalization by running own examples and breaking them down to elementary details makes NORMALDB far more advantageous vs. traditional in-class teaching of the subject.

In the following subsections, a description of NORMALDB to reflect its implementation in two layers, the logical and the interface layer, is given.

### A. Logical Layer

At the data tier and business logic layer of NORMALDB, we adopted the Ceri and Gottlob's script [3] implemented in Prolog. The Prolog programming language is known for its contributions to problem solving in artificial intelligence [12]. A common integrated framework for describing both data structures ("facts") and algorithms ("rules"), and the facilitated interaction with the code through the "trial and error" interface are few among several advantages readily provided by the Ceri and Gottlob code due to the representation in Prolog of the logic of normalization to the machine [3].

The adopted Prolog script [3] of normalization consists of the following:

- the facts which provide data about relations (the relation name, attributes, and FDs), and
- the rules which relate facts, and implement all algorithms throughout normalization.

For example, according to [3], a relation schema `rel` with the set `[a, b, c]` of attributes, and a set `[a→b, b→c]` of FDs is represented with the following facts at our logical layer:

```
schema(rel, [a, b, c]).
fd(rel, [a], [b]).
fd(rel, [b], [c]).
```

For each normalization step, there is a rule or a set of rules that may be invoked in any order. This way a user may observe results incrementally by executing certain rules step by step over the input base of facts. Some of the normalization rules provided in the script are as follows [3]:

- `findonekey(REL, K)` - Determines one key K of relation REL
- `assertallkeys(REL)` - Determines and asserts all keys of REL
- `findmincover(REL)` - Finds a minimal cover of the functional dependencies defined for REL
- `thirdnf(REL)` - Decomposes REL into third normal form
- `haslj(REL)` - Tests for losslessness of the decomposition of REL
- `makelj(REL)` - Makes the decomposition of REL lossless
- `projectfds(REL, REL1)` - Projects functional dependencies holding for the relation REL to the relation REL1
- `isinbcnf(REL)` - Tests whether REL is in Boyce-Codd normal form
- `bcnf(REL)` - Decomposes REL into Boyce-Codd normal form
- `formminimize(REL)` - Minimizes the decomposition of REL

Denormalization also supported in NORMALDB is a rather intuitive task driven primarily by queries which are frequently invoked in a database and involve expensive joins. The implementation in NORMALDB of denormalization extends the existing Prolog knowledge base of normalization with the following:

- rules for the direct re-composition of tables, and
- a parser written in Definite Clause Grammar (DCG) notation of Prolog, which is able to read queries against the database and reason upon them to infer which tables need re-composition in favor of performance.

In addition to denormalization, few more modifications of the Prolog script of Ceri and Gottlob [3] were applied to make that script work in our web-based tool, i.e., adding new rules and facts for rendering Prolog results into the web page. Most of new rules are HTML generators which convert the adopted Prolog script to the Prolog server, namely they generate HTML tags which hold the results of retrieved predicates. Section 4 will reveal more details about HTML generators.

### B. Interface Layer

Next we discuss the interface layer of NORMALDB which is mainly developed in PHP language. The HTML tag rendering is provided through PHP scripts, whereas JavaScript, especially its libraries jQuery [13] and jQuery UI [14] help make the interface of NORMALDB simple and easy to navigate.

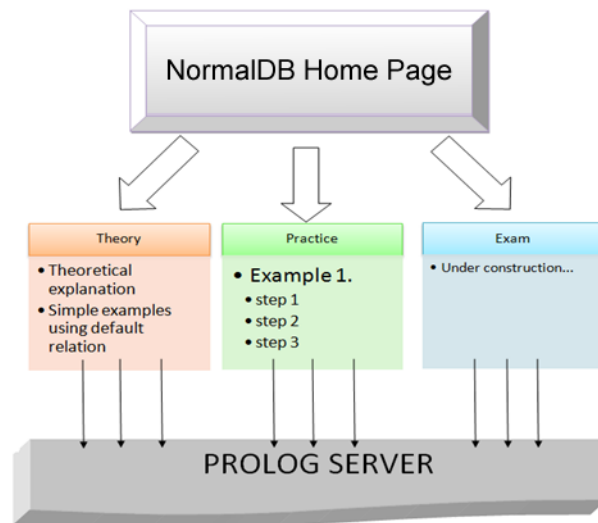


Figure 1. Organization of the interface layer in NormalDB.

Fig. 1 shows the organization of NORMALDB from a user perspective. The colored boxes represent web pages, whereas the grey box represents the knowledge base of the application supplied by the Prolog server which runs whenever examples are carried out. Connection to the knowledge base does not require any extra procedure from the user. Simply, the given connection hyperlink makes a request to the Prolog server which in turn displays the result.

The interconnection between topics and examples is done via hyperlinks, while results are represented in accordance to the actual web page template. Depending on the content, the result appears within a dedicated tag of the page, or in a message box that shows after clicking the link. The JavaScript language and its libraries jQuery and jQuery UI are employed for user-friendly purposes of the interface. jQuery tabs and message boxes helped us prevent the overload of the interface.

The whole interface of the tool (colored boxes in Fig. 1) is organized in three main parts:

**Theoretical part:** Consists of theoretical explanations of the topics covering the normalization phase of the database design. Each topic explanation appears as a hyperlink, and may further contain links which illustrate the application of the given theory to a given example. That example is referred to as a default example in our tool, and is designed to serve the demonstration of each of the theories over a given set of (default) relations and their FDs.

**Practical part:** This is the core part of NORMALDB, and is aimed to serve exercises. The user (e.g., a student) shall input the relation name, attributes, as well as functional dependencies of the relation that he / she wants to examine in terms of normalization and denormalization, and the tool will then start exploring the topics upon the given relation.

**Exam part (Self-assessment part):** This part is planned for future work. It is designed to provide a testing environment where users (e.g., students) may themselves examine their knowledge gained in the field concerning both exercises and the theory.

#### IV. THE SYSTEM ARCHITECTURE

The development environment in building NORMALDB consisted of the scripting language PHP, JavaScript, and the logic programming language Prolog.

The logic of the NORMALDB relays in the server side of the application. The client side shares just the functionalities given by JavaScript codes.

The server side of the application is comprised of two distinct servers. Apache server is needed for processing PHP scripts and generating HTML pages for the client while Prolog server provides the knowledge base of the system. The later one is accessed from the client side through links generated from the PHP scripts.

Fig. 2 describes the used architecture in NORMALDB with the pursued workflow of the functionalities. In the following subsections we will explain the challenges that appeared during the development of our tool.

##### A. Preserving the state

The process of normalization and denormalization flows over a step by step evaluation which requires keeping and following the active state of the script execution. This happens because of the modifications that are done to the knowledge base after evaluating a particular step. Traversing through the Prolog script to find the predicates that will implicate the required rule, results in asserting new facts that affect the next step. For example, if a user wants to test whether a particular decomposition has the lossless join property, a clause of the form `haslj(rel)` is searched in the base of facts. This kind of facts is provided after the execution of the 3NF algorithm. This way it was necessary to have the knowledge base updated with the information required by the future user requests. Hence, it was needed somehow the Prolog application to be active as long as a user session is active.

When addressing this concern, we ended up with three alternative solutions, each applying distinct techniques originating from different fields.

One solution was to run the Prolog script using the `system()`, `exec()`, and `shell_exec()` built-in PHP functions. These functions are easy to implement, but the troubles arise after running a required predicate since the script then closes up such that the newly asserted predicates cannot be saved.

Another solution was to use a relational database at the backend of the application which will track every inference deduced by the Prolog script, and accordingly modify respective tables in the database. Yet for the sake of the simplicity of the tool, and to avoid difficulties that might appear while tracking Prolog inferences, this solution was omitted.

Finally, we experienced the use of the Prolog server [15] as the most appropriate solution for surpassing this problem, which will be discussed in detail in the following subsections. Communication with Prolog server

The Prolog logic programming language supports a number of libraries for accessing data on HTTP (Hypertext

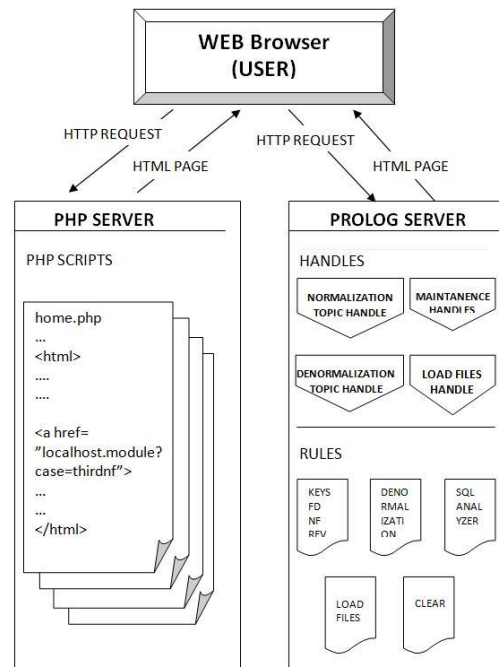


Figure 2. Workflow and request chains of NORMALDB tool.

Transfer Protocol) servers, as well as for providing HTTP server capabilities from SWI-Prolog. Both server and client are modular libraries. The server can be operated from the Unix `inetd` super-daemon, as well as a stand-alone server that runs on all platforms supported by SWI-Prolog [15].

In order to use these libraries, certain modifications to the actual normalization script in Prolog of Ceri and Gottlob were required. Thereby, the mere logic of the script is kept unmodified, extending it with built-in predicates to deal with HTTP requests to configure the HTML pages.

Request handlers are built-in predicates that handle the HTTP requests made from instantiated HTML pages using hyperlinks. When an HTTP request arrives at the server, then Prolog starts traversing through the predicate tree for finding the handle that matches the path came with the HTTP request. This required path is noted as first parameter of the predicate. The second parameter defines the main predicate that handles the handler. As the third parameter of this handler is the list of the options related with the handler. A code that creates a common handler is written below:

```
:- http_handler(root(module),home, []).
```

After calling a handler, one thread is employed to search for the predicate supported by the handler which is defined in the code. Within the HTTP request can be sent variables which can be extracted from the request and inherited to other predicates that build up the rule. The base predicate that is retrieved from the handler renders the HTML page with enclosed `html`, `title` and `body` tags, by the following rule:

```
home(Request):-http_parameters(Request,
[name(Name,[length >= 2]),
relation(Rel,[length >= 2])],
reply_html_page(title('Example'),
[\html_requires(css('style.css')),
\case(Name, Rel)]).
```

The body part of this new arranged HTML page is filled with other HTML tags that are derived from the next HTML generators used from other predicates.

Weaving of the HTML tags with the appropriate results is done through HTML tag generators included in the special defined rules which are called with DCG notation of Prolog. These rules get the results inferred from the base predicates and render them into HTML tags that can be read from every web browser.

The formulated HTML reply of the Prolog server is injected into the HTML page rend from the PHP server within a <iframes> tag.

A sample Prolog rule that makes the rendering of the result of 3NF normalization in a special div tag looks like follows:

```
case(thirdnf,Rel)-->
{cleandecom(Rel)},
html(div([\step1_html(Rel),
\step2_html(Rel),
\step3_html(Rel),
\step4_html(Rel),
\step5_html(Rel)])).
```

Some of the links are processed at runtime during the execution of the PHP page, while others are simple links and are invoked when a user clicks them over.

**B. Preserving Consistency**

The consistency of the Prolog server will be intimidated if the same predicate is queried two or more times without rolling back to the actual state of the server. Multiple queries are posed in case the user clicks the same link multiple times. To avoid unwanted results from the repeated clicks, there are specific rules asserted in Prolog server that take care to clear the server from the previous results.

Additionally, using the same relation name within the same knowledge base by different users will raise the problem of interference among results of different users. To avoid this, we used the unique session number functionality of PHP. The opened index page automatically creates a new session with unique number which will uniquely identify the relation schema used by that session, concretely by one user. The task of Prolog server in this case is to create a copy of the default relation schema and to rename it with a combination of its original name and the session number of the user.

In this way, normalization rules consider every user session as unique, enabling thus every user work with exercises separately at the same time on the same server.

**V. LEARNING NORMALIZATION IN NORMALDB**

Accessing NORMALDB through a URL will initially open its homepage as is common for web applications (Fig. 3a). As mentioned earlier in Section 3, the tool is organized in three individual modules: theoretical, practical, and the testing module.

The *theoretical module* (opens when clicking the green box in Fig. 3a) loads a sample example which illustrates all steps of normalization one after another running in the Prolog server. The relational schema used in the example is named *rel* and is given a set of predefined FDs.

The normalization steps or subtopics are each provided on a left menu in the page (Fig. 3b). Changing along the menu links which represent subtopics does not affect the Prolog server unless a button involving the example is clicked. Such buttons contain links to the Prolog server, invoking thus the corresponding predicate to run for the given subtopic.

The left menu contains also the denormalization module of the tool. This page, beside the theoretical explanation of the topic, includes a form where the user may textually input queries supposed to be executed over time against the derived database schema. These queries are then analyzed with a SQL (Structured Query Language) analyzer script written in Prolog, which yields the statistics about which tables need to be joined. This way, the user may decide which tables need to be recomposed.

Navigation to the *practical module* is possible from any page (by clicking the orange box placed at the top of the page), not just when residing at the homepage of the NORMALDB. Once opened, this module (see the Web page in Fig. 3c) will first retract all facts belonging to the

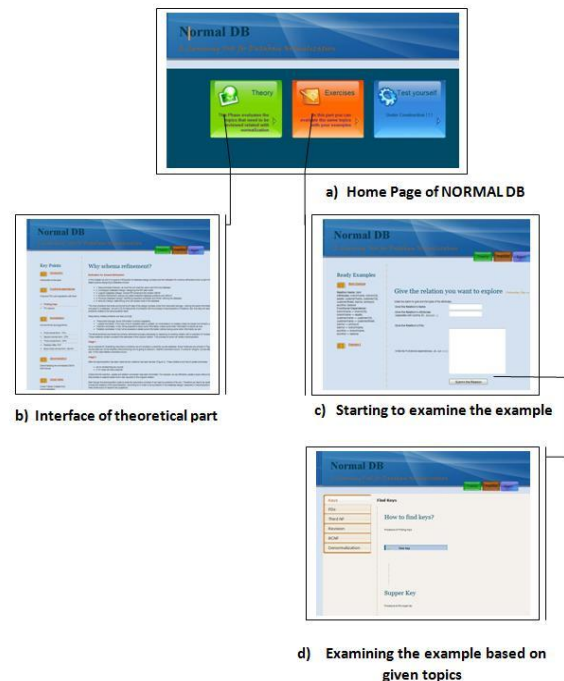


Figure 3. Web interfaces of NORMALDB.



sample example of the theoretical part, and afterwards eventually load a new relational schema entered interactively by the user through a Web form. At this input, if the user provides also the types of attributes of the relation, then the tool might generate a ready-to-deploy SQL script consisting of procedures for creating the database and its tables.

The relation schema, and its attributes and FDs entered through the Web form are then processed by PHP string manipulation built-in functions, and are written as new facts in a separate Prolog file. For instance, back to the example of Section 3, let us assume that the user enters the same input data, i.e., the `rel` relation schema with attributes `[a, b, c]` and a set `[a→b, b→c]` of FDs through the Web form of the Practice page as depicted in Fig. 4. It is the PHP script that would translate these Web form data into the Prolog facts listed earlier in Section 3.

Figure 4. Web form to enter own examples.

These facts are further consulted by the main Prolog server starting from the next opened page up to the last page that requires evaluation of normalization rules, this time over a given set of facts residing at an external Prolog file (Fig. 3d).

Continuing our example with the `rel` relation at the input, Fig. 5 illustrates how finding all keys of the relation works by clicking the `Assert Key` button which actually triggers the evaluation of the `assertallkeys(rel)` rule at the Prolog server. See at the “All keys are `[[a]]`” row rendered at the bottom of the Web page in Fig. 5 which reflects the result inferred by this rule.

Figure 5. Finding all keys of a relation with NORMALDB.

As one may experience while using NORMALDB, the requirement to keep its interface of teaching normalization process of database design as simple as possible is met. The organization of the page, its rich set of functionalities, and the simple layout contribute altogether towards bringing closer to students the normalization theory which has otherwise proved to be troublesome to capture in a traditional teaching classroom.

## VI. CONCLUSION AND FUTURE WORK

This paper introduces the NORMALDB, an e-Learning tool which provides to students a user-friendly environment for learning and experimenting the normalization phase of the database design. Simple interface with an internal complex system and a wide range of functionalities including experiments with self-chosen examples are some of the main advantageous features of NORMALDB. The main challenge was to enable an efficient communication between PHP and Prolog. Among several alternatives we considered, the interaction through a Prolog server [15] proved to be the most appropriate solution for our application since it already provides a number of Prolog libraries for accessing data on HTTP.

NORMALDB is further planned to expand its capabilities of a typical e-Learning tool by incorporating a test module where the student may test himself / herself by solving a given normalization problem, and then comparing his / her solution with the one generated by the tool. Moreover, the support for higher normal forms is also in view under future plans, and easy to implement, since the same rationale applies as when implementing the interface and its links to the Prolog facts and rules for, say, 3NF.

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## M-learning System for Learning how to Prepare a Negotiation

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**Abstract**—The advance of Internet and mobile technologies makes the use of these elements become increasingly comprehensive, and distance learning is an area that takes many advantages of these technologies. Some tools and systems help this process, but the most important tool is e-learning. A more contemporary version of e-learning is the one found in mobile devices, the m-learning system. The rapid advance of these technologies and their high dissemination determine this area as an important point in the decision makers' learning process. Following this point of view, this paper proposes a learning tool involving aspects of e-learning and m-learning for negotiators. This work will discuss how these tools can support professionals during the learning process of preparation step of negotiations. What is more, comparative and initial results will also be presented.

**Keywords** – *e-learning; m-learning; negotiation*

### I. INTRODUCTION

Nowadays, the demand for trained professionals, with a deeper and more extensive knowledge of specific subjects keeps everyone up to date and obliges them learning new things in different areas. However, due to limited free time that people have, some new forms of learning and/or some new learning tools should be used to achieve this goal.

Distance learning is not something new. It is a form of learning that does not require a classroom, where people (teachers and students) must be present at the same time, something often inconvenient for a particular group of people [25].

This form of learning can be supported by tools that use technologies, called e-learning. These tools can also be used as a complement to traditional methods, providing materials for online study.

According to 2010 census, Brazil has 194 millions inhabitants. It is amazing to know that this number is lower than the number of mobile devices – 202 millions [13]. What was once a luxury is now an item of easy access.

Due to this growth, which does not happen only in Brazil, appeared m-learning, i.e. e-learning applied to mobile devices. In spite of the technological limitations of these small devices, they are powerful tools in the distance learning process because they can be accessed anywhere and anytime.

This article proposes a mobile learning tool in the negotiation area. This paper is divided as follows: the next section shows a review of literature about e-learning, mobile devices, m-learning and negotiations; the third section discusses the integrated web system, used for negotiation students to learn how to prepare a negotiation, along with the

engaged m-learning system; the fourth section makes a comparison with other m-learning tools and the tool proposed; the last section presents the conclusion and further investigations.

### II. BACKGROUND LITERATURE

This section brings background literature of four important topics to this work: e-learning, mobile devices, mobile learning and negotiation.

#### A. E-learning

The use of technologies and tools to facilitate the teaching and learning process is what is commonly called e-learning [8]. Because of this, it is also usually related to distance learning, but is not restricted to it and can be used as support for traditional classes [9]. Its nature teaches that the learning process can be done anywhere, because then student is not restricted to a specific place or time, such as classroom, not restricting student to teacher's available time, taking the process and the material used in the learning process to the Internet [7].

The growth of the Internet and advance of technology have allowed an unprecedented breakthrough of e-learning [8]. Its use, however, was not confined with the context of traditional teaching in schools and universities. Its advantages have also been noticed in professional environment, making them use this type of tool [9].

E-learning has many benefits including its accessibility and the amount of time and money it saves. Flexibility is one of the e-learning highlights because it allows students to study at night, keeping their day jobs, fitting the learning time when it better suits their busy schedules. The student dictates the pace of learning as suits him best, as well as the learning style [17].

The downside of e-learning is that students need to have computers and Internet access, and knowledge of these technologies to use them, which should be considered in developing countries. Even though e-learning can fit any time the student wishes, it still requires available time just as traditional education method does. It can result in lack of motivation for the student. Instructors may not always be online to help the students, which can lead to isolation of a student. The communication provided only by electronic means can also cause misunderstandings by both sides [17].

#### B. Mobile Devices

There are many kinds of mobile devices in the market, and choosing one can turn to be success or failure decisive factor of an m-learning system. Below there is a list of

devices, their uses in m-learning, and their pros and cons [15]:

- iPod: the Apple's device is used to download and listen to podcasts with video and audio lessons, and to exchange material between students and teachers. Its advantage, besides its popularity, is to have many add-ons that can be useful. Its disadvantages are the high cost, small screen and the need to use the iTunes program.
- MP3 player: as iPod, students can download and listen to Podcasts. This kind of device is compacted and lightweighted, but other devices can replace it in addition, it is an instrument that has only one way, i.e., there is no interactivity.
- PDA (Personal Digital Assistant): devices that can use the Internet, play audio and video, access e-mails, document editing and use communication assistants. For a mobile device, they have a large screen and also dispose of text entry. Their disadvantages are their size, once they are bulky, and inconvenience of the entry of long texts.
- USB Drive: storage tool that can assist in sharing audio and videos between students and teachers and that can be compatible with most computers. But it is a device with a well defined and single proposal: storage. Other devices can easily replace it, such as iPod and MP3 players.
- E-book reader: used to download and read books, can store several books, with the appropriate light for easy reading and text markup tools being its strong points. It has a large screen, for a mobile device, suitable for reading. However, it has a limited capability of reading different proprietary e-books formats.
- Smartphone: has the combination of several features of other devices such as the Internet access, storage, camera, video, mp3 player. From the other side, it has a high cost, a small screen for a mobile device, in addition to not being efficient in text input.
- Laptops/tablets: the most complete of the devices, having the Internet access, Bluetooth, storage, Wi-Fi, easy text input, audio and video player, large screen and other features. Its disadvantage is the high cost, and its size that is too large when compared to other devices and cannot be used while walking, for example, as MP3 players and smartphones.

In addition to these limitations of each device, only PDAs, Smartphones, Laptops, Tablets and some types of iPod are programmable. Due to the growth and practicality of smartphones, these were the ones chosen for the development of the m-learning system.

Even though smartphones are being used for the development of the m-learning system, there is still a very large range of devices to choose from, and each one has its own limitation. These limitations are key factors in choosing a device for the development of the tool [5]. In addition to the various instrument options there is also a range of platforms for development. For this work, the platform

chosen was the Android platform, which is Linux-based, open source, created by Google along with other companies. The fact of it being present in several models of many companies was one of the key factors to the decision of using this platform, because it allows the user to choose which device best suits his/her needs, taking into account the usability, although the choice for a specific platform could be a negative point, due to its possibility to be outdated in a short period of time.

### C. M-learning

M-learning is a type of e-learning, supported by mobile devices, which can also be seen as a complement to distance education [3][9]. It can be defined as an acquisition of any knowledge and/or skills through the use of mobile technologies, resulting in a change of behavior [10].

The m-learning nature has two key characteristics: it can be accessed anytime and anywhere, it is quite similar to e-learning, but even more effective, since the mobility these small devices give is much higher than that given by conventional computers. In fact, this character develops a third feature, in motion, since the use of these devices can be done while walking.

The benefits of m-learning tools, in addition to providing mobility, are learning through interaction with different people, the ability to archive and organize a wide range of information in the devices' memory and the easiness in creating documents, texts and attach them into a system, and reducing communication and cultural barriers, using channels that make the student feel comfortable [15][16].

Challenges in the field of m-learning occur mostly because of their computational limitations. Among these constraints we have the bandwidth speed limitation, low processor speed, small screen size and low resolution, complicated methods of input, low battery life and low storage capacity. But the main limitation is the low bandwidth and processing power [4]. In addition to these technological impediments, there are other unfavorable factors in the use of m-learning, such as the fact that students who are not familiar with the technology will have more difficulty than others, the speed at which updates occur may make some content obsolete quickly [15], the conservatism of educators, the need to produce new content, plus the high cost of a device and, in some countries, the high cost the internet connection (WAP, 3G, GPRS) may have [16].

### D. Negotiations

The process in which two or more parties make decisions, seeking an agreement that brings benefits to all is called negotiation [11].

The negotiations are present in the daily life of all people, even though we are not aware of this fact. The joint decision of possible work themes by teachers and students is a simple example of a negotiation that can exist inside of educational environment, since the parties involved try to ensure that themes remain in their own liking.

Three concepts are important in the negotiation context: RP (reservation price), ZOPA (Zone Of Possible Agreement) and BATNA (Best Alternative To a Negotiated Agreement).

[18] defines RP as the last favorable point to a party which accepts the agreement. The RP can be understood as the limit value of the price a buyer will pay for certain goods. Similarly, for the seller, this value is the minimal accepted value for the purchase.

With the existence of both seller and buyer RP values, if there are intermediate values that satisfy both parties, there is a ZOPA. According to [18], ZOPA is an area that satisfies both parties involved, and then an agreement can be reached.

The concept of BATNA, introduced by [19], says that all negotiations should have an alternative, just in case the agreement is not reached. The better the BATNA is, the more power you have to negotiate, increasing the chances of an agreement to improve. Negotiation process can be divided into four phases: preparation, value creation, value division and execution [12].

The phase in which negotiators define BATNA, try to improve the relationship and make their positions is the preparation step [19]. In this phase, the negotiators should also define ZOPA [18].

The next step, after the preparation step, is the value creation. In this stage, the parties should explore the interests of the others, generating alternatives to increase mutual gains [20]. The value division is the stage where division forms are discussed, among the standards and criteria of division [20].

The final step is the execution. The arrangements for monitoring and verification of the decisions are established in this step. After that, the negotiators work continuously to improve their relationship and to resolve their differences fairly [6][12].

Among these, the preparation step is the most important, being the one where information is collected in order to facilitate the agreement by identifying the interests of all parties [2].

### III. M-LEARNING PROPOSAL

The m-learning tool proposed here is a part of Negotiation Support System. This NSS involves training, preparation, risk management and negotiation modeling tools, as illustrated in Figure 1. The m-learning contemplates the area of Mobile Statements, Knowledge Management and Visualization Methods, as seen in demarcated area at Figure 1.

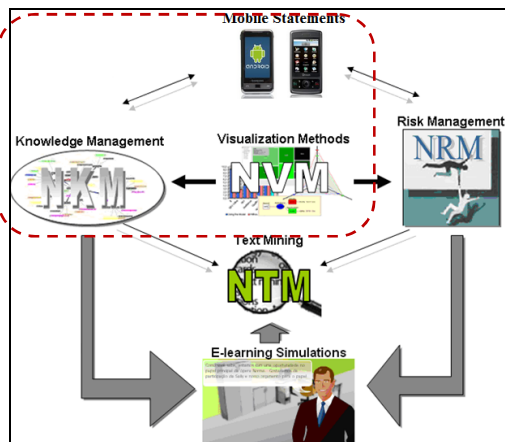


Figure 1. ENEG environment [14]

The proposal highlighted in this paper discusses how the learning elements – e-learning and m-learning – can help in the negotiation preparation.

#### A. Preparation Step in the Web Site

The preparation of a negotiation is the most important phase of negotiation [2], what is more this phase is the main point where the negotiation students should investigate deeper.

This step has interfaces to facilitate input of data about the negotiation, divided into 10 elements: Context, Interests, Options, Relationship, Power, Communication, Criterion, Legitimacy, Concession and Time [6].

For each of these elements there are facilitators to the externalization of the negotiator knowledge. The information about each of these elements can be informed by free text, which is more suitable for more experienced negotiators. For students of negotiation this way of data input is complicated. For those, other kind of input is available, in the checklist form, and public and private reports are also ready to be used.

Figure 2 shows the initial interface of the preparation step, in the NSS environment, contemplating the Context element.

Figure 3 shows the final stage of preparation, presented in a radar chart that, through mining all elements text inserted before, ponders which are the most relevant for the negotiation. This chart also takes into the account the risks associated with each element as it is inserted into the risk management module.

#### B. Using the Mobile System during Preparation Step

Mobile devices, even with all its technological and usability limitation, can become important tools in the learning process [5]. And it is not different when learning about negotiation.

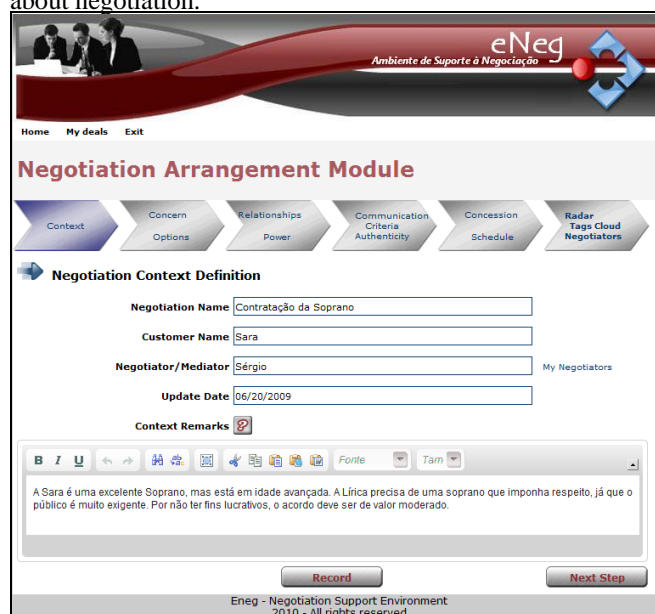


Figure 2. NSS Preparation Interface [14]

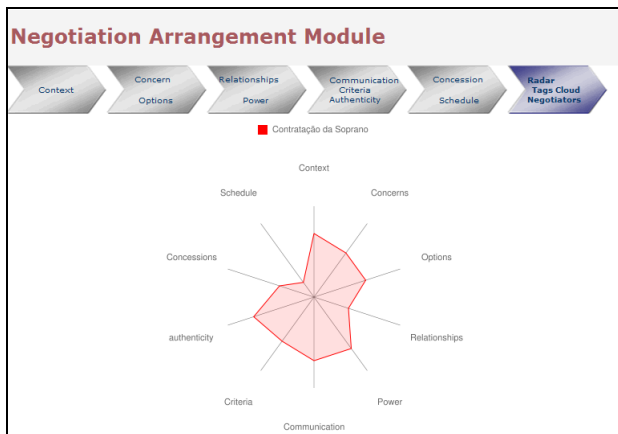


Figure 3. NSS Preparation Interface [14]

Figure 4 shows the integration structure between the mobile platform and the web platform, in the context of data preparation for negotiations.

The tool brings to the mobile device the entire negotiation preparation module and a few other features [1]. To keep the integration between these two platforms – mobile and web – web service is present. Web service is a tool for integrating applications, independent from the language and technology.

The tool, at startup, requests a login and password, which is the same used in the web system. After providing this information, the user will be directed to the negotiation preparation screen, containing the same five steps of the web tool. These steps are: Context; Interest and Option; Relationship and Power; Communication, Criterion and Legitimacy; Concession and Time. In addition to these five steps presented, the user can view the same charts/reports presented in the web tool.

Typing on a mobile device can become an obstacle to the widespread use of a learning tool. To circumvent this limitation, a feature of data input in the preparation module was included on the mobile system. Once the mobile devices have the basic functionality through voice communication, it becomes natural to use this as a form of data entry.

This mobile learning tool allows the input of voice data, accelerating and facilitating the insertion process. These voice recordings are associated with one of the ten elements of the negotiation where each element can contain more than one recording [6].

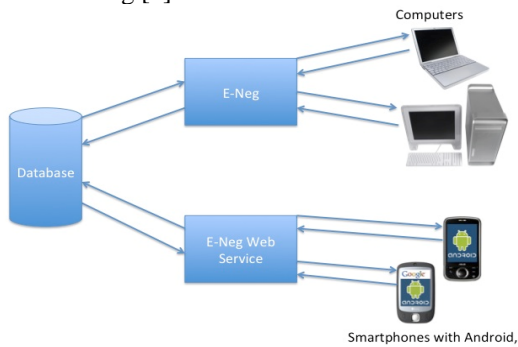


Figure 4. System Architecture

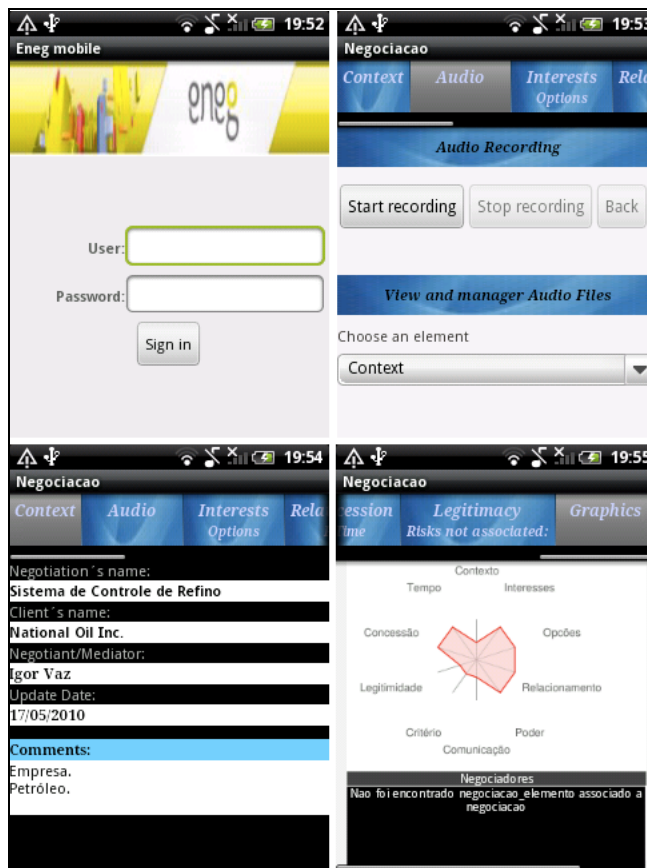


Figure 5. NSS Mobile Interfaces

Figure 5 shows the proposed mobile m-learning system interface. In this picture it is possible to see the login screen, display graphics, audio insertion and context step visualization.

#### IV. COMPARISON AMONG M-LEARNING SYSTEMS

To evaluate the proposed mobile tool, a comparison with other m-learning tools was made. The tools used for this purpose are:

- MOBILE (Mobile-Based Interactive Learning Environment) [21]: is an m-learning environment using PDAs as devices by the students, while teachers use computers for uploading materials like content and schedule. It has chat to implement direct communication between teachers and students, and notes function, quiz and FAQ.
- Bluetooth-based E-learning System [22]: as the name implies, it is a learning system that uses Bluetooth technology as a mean of communication, based on the client/server architecture. Students act as the client side using any device that supports J2ME technology and Bluetooth. The teachers act as the server side, using desktops or laptops. The need to be close to the Bluetooth server, due to the technology limitation, hurts the mobility nature of the m-learning tools.

- Athabasca University Mobile Library Project [23]: the project brings the idea of moving the library content to the student, regardless of where and when he/she is - a virtual library in the palm of the hand. It includes a virtual reading room, search engines and journal databases. By identifying the platform running on device, the content shown is the one that best fits the specification of the machine, differing by the format displayed in laptops and devices running PalmOS and Windows CE.
- MOLT (Mobile Learning Tool) [24]: A tool that sends SMSs (Short Message Service) developed for running on a Windows PC connected to a phone via Bluetooth. The cellphone sends messages to students

when the PC requests it. This system was developed for learning new words, increasing the students' vocabulary.

Table I was created taking into account the main characteristics of these four tools in comparison with the proposed mobile tool. The characteristics analysed take into consideration the need of Internet or other kinds of connection. If there is a bidirectional communication, the information comes not only to students, but also from them. The devices and platforms are supported by each tool. The content type is available in each one and integrations are possible with other e-learning systems.

TABLE I. M-LEARNING TOOLS COMPARISSON

Characteristic	Tools				
	<i>Proposed Tool</i>	<i>MOBILE</i>	<i>Bluetooth-based E-learning System</i>	<i>Athabasca University Mobile Library Project</i>	<i>MOLT</i>
<b>Communication way</b>	Internet	Internet	Bluetooth	Internet	SMS
<b>Bidirectional communication</b>	Yes	Yes	Yes	No, download only	No, receive only
<b>Devices</b>	Smartphone	PDA	PDA, Smartphone, Cellphone, Laptop	PDA, Smartphone, Palm, Laptop	Cellphones
<b>Access via Browser</b>	No	Yes	No	Yes	No
<b>Platform-specific</b>	Yes, Android	No	Yes, J2ME at client side	No	No
<b>Need installation</b>	Yes	No	Yes	No	No
<b>Works offline</b>	No	In parts, if the content is already in the device	Independs of Internet, but depends of a Bluetooth connection	In parts, if the content is already in the device	No, needs to be at cover area to receive messages
<b>Content</b>	Interactive	Provided by teacher	Providede by teacher	Provided by library	Small texts
<b>Easily adaptable to other knowledge areas</b>	No	Yes	Yes	Yes	-
<b>Integration with other e-learning tools</b>	Yes	-	-	Yes, with online library	-
<b>Anywhere, anytime</b>	Yes	Yes	No, needs to be close to server - Bluetooth technology limitation	Yes	Yes
<b>Teacher independent</b>	Yes	No	No	Yes	Yes

V. CONCLUSION AND FUTURE WORKS

Each person has his/her own way of learning, so there are different ways to teach. The traditional teaching, which is done in classroom, has proven to be effective, however, not everyone has access to this type of education.

Distance learning is an alternative to the traditional way of education, not limited to the classroom. Many institutions offer courses using distance learning.

With the Internet and technologies expansion, distance learning supporting systems has been developed, providing faster and greater interactivity. But these e-learning tools are not restricted to this function, as they also serve as complementary tools to the traditional methods, by providing educational materials and learning process.

Technology expansion, however, was not confined to the Internet, but devices have been shrinking and becoming more portable, like laptops, palmtops, PDAs, Handhelds, smartphones and tablets. With this technology, the learning process can have new tools, which can be accessed anytime,

anywhere. The m-learning tools, however, still have the problem of low battery life, small screen and etc.

This paper shows a proposal for m-learning tools integrated with an e-learning tool, where negotiation students can learn how to handle the preparation step of negotiation, the most important part of it [2].

There are many evolutions that this tool can undergo. Transcription of audio files recorded by users, where the existing text mining can be done is the most obvious one. Besides, the tool expansion for supporting other negotiation steps can be developed, such as the risk management step.

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## Integration of Exer-Learning Games in School

The Evaluation of HOPSCOTCH as teaching aid in specialised school

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**Abstract** – This paper examines the benefits of the exer-learning game HOPSCOTCH for students with special needs. We give a thematic overview about the theoretical foundations of digital game-based learning and about exercise in connection with learning; then we report on an empirical study in a public development centre comparing the new teaching method HOPSCOTCH and a traditional teaching method (run and write). In addition, the students' mood was examined because it was assumed that this factor should be enhanced by the integration of the exer-learning game in the classroom compared to the traditional teaching method. The results of the study have shown that students achieve the same learning success with the two learning methods; however, mood is increased by learning with HOPSCOTCH.

**Keywords** – learning; exercise; specialised school; exer-learning games; learning success; mood; motivation

### I. INTRODUCTION

Recently, the potential of digital games to support learning has been increasingly discussed [1] [2] [3]. The underlying assumption of game-based learning is that incentives inherent in games can be used to engage and encourage children and adults alike in learning activities, effectively fostering meaningful learning [4] [5]. HOPSCOTCH is one of a new genre of learning games that not only seeks to combine playing and learning but also introduces exercise as a principal component. This is the genre of exer-learning games. The design concept of HOPSCOTCH requires the learner to enter answers to simple questions or perform simple tasks, such as translating a German word into English, by jumping on a sensor pad. It therefore aims at the joyful and physically active acquisition of factual knowledge according to Bloom's taxonomy [6]. First studies with HOPSCOTCH showed that this exer-learning game could not only serve as an additional tool for private learning, but potentially could be applied in school lessons under special circumstances [7]. The results heralded the use of HOPSCOTCH for the education of students with learning difficulties.

This paper, therefore, focuses on the presentation of a study where HOPSCOTCH was integrated into everyday school life of a school dedicated to persons with disabilities – herein referred specialised school. The presented study was conducted in order to explore the potential of the

HOPSCOTCH exer-learning game for students with special needs.

### II. HOPSCOTCH: A CONCEPT FOR EXER-LEARNING

In the following chapter a theoretical basis is outlined. Firstly, digital game-based learning is examined more closely; then the connection between learning and exercise is introduced. Putting these components together, exer-learning games in general and HOPSCOTCH as first particular prototype are presented.

#### A. Digital game-based learning

The terms "serious games", "game-based learning" and "digital educational games" – widely used synonymously – mark the initiative to use the potential of digital games to actively engage and encourage players in learning [1] [2] [3] [8]. One important goal of game-based learning, however, is to foster an increase in intrinsic motivation and knowledge acquisition rather than just to provide an opportunity for enjoyable play [4] [5]. Intrinsic motivation arises from activity-specific incentives that are inherent in games but not necessarily in learning activities [9]. This will not necessarily lead to better achievements as such, but it could result in an increase in learning time. Traditional learning activities are often performed to meet certain external success criteria (to get good marks, to pass an exam, etc.), while game activities are rather focused on fun and flow experiences [10] [11]. Game-based learning tries to create intrinsically motivating learning experiences through integrated game activities that offer activity-specific rewards.

Several studies were conducted on digital educational games as instructional tools in schools – but most of them were not integrated into school lessons [12] [13] [14]. Recently there have also been attempts to integrate educational games within school lessons. Examples include the online multi-user virtual environment "anytown" [15] [16], or the computer game "Quest Atlantis" [17].

#### B. Learning and exercise

The body is in movement constantly, because even if we sit or lie, activity takes place inside. By the 1990s it had been found that the frontal lobes that are responsible for coordination of thinking are directly connected with the areas of the brain responsible for motor control [18]. As a result of the stimulation of the brain's activity and metabolism by movement, information processing is strengthened. Attention

increases because the brain is awake and receptive [19]. Therefore this strongly suggests that physical exercises should be increasingly integrated into learning processes. In addition, the brain is „[...] a pattern recognition organ, so engaging students in a movement exercise every 30 - 60 minutes can prevent them from going to sleep and help increase attention span” [20]. Investigations have shown that children are more attentive and concentrate better after ten minutes of exercise than before such physical activity [21]. Consequently learning could be intensified by physical activity because of improved concentration. The connection of mental processes and physical exercises to overcome motor deficits can increase confidence in personal skills [22].

The connection of learning and exercise could be preventive as well as therapeutic for children with special needs. In particular children and youngsters with dyslexia and dyscalculia can exploit their natural ability to move to overcome their inner restlessness that might be a factor that amplifies their learning difficulty. Cognitive performance of children with learning difficulties can be improved by active perception, specific action and personal experience [23]. Therefore, it seems that physical exercise should be increasingly integrated into schools. The initiative "Moving School" contains relevant aspects and developed different possibilities for lessons in specialised schools. The aim of this initiative is to integrate (1) physical learning, (2) physical breaks, (3) physical organisational structures and (4) physical thinking into schools [24]. The "Moving School" integrates exercise into everyday life of schools; however exercise and learning are still divided: Either the children do exercise or they learn. In this setting, exercise is an element that might promote faster learning, but it costs learning time. It would be better if children could exercise while they learn.

### C. HOPSCOTCH: A prototype of an Exer-Learning Game

Hopscotch is a children's game where the challenge is to hop on a series of numbered squares in the sequence of their numbers. The course is drawn with chalk on pavement (see Figure 1).

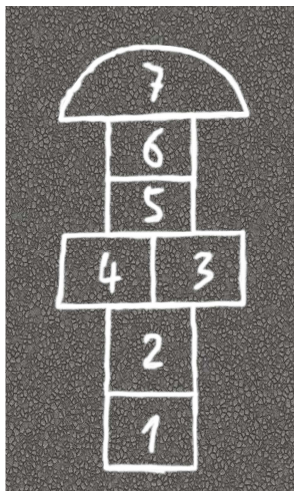


Figure 1. Hopscotch playing field

It is one of the world's most popular outdoor games for children, often played in the schoolyard. The idea of the children's game "hopscotch" has been adopted for the concept HOPSCOTCH, to create exer-learning games that can be applied for different learning tasks.

The concept of HOPSCOTCH was developed at the Fraunhofer Institute for Digital Media Technology IDMT, Germany. Instead of drawing numbered squares on the pavement, a dance pad with nine sensor fields is provided as an input device. The nine sensor fields resemble the keyboard of a mobile phone with numbers and letters for writing short messages (SMS). The sensor fields are multidimensional in the sense that tapping on a field once, twice or three times results in a different letter (e.g., A, B, or C when tapping the field "2"). The dance pad can therefore be used as an input device for letters and numbers by single or multiple taps on a certain field. These letters can then be arranged into words by jumping another pattern for the second letter and so on. Only the correct input is accepted by the system, so the player/learner always gets immediate feedback on his input. If he does not know the answer, he can find it out by jumping on the pad until all the correct letters are logged in.



Figure 2. HOPSCOTCH exer-learning game

The players can use their hands and feet to enter numbers or letters: they can either tap or jump on the sensor pad. Further, HOPSCOTCH can be played in single- and multiplayer mode. In the multiplayer mode, players can work in groups, either jumping words one after the other with the hints of their team members or jumping a word together by jumping one letter each in order to achieve a faster answering time (higher score).

When playing the game, the player receives questions that are presented on a monitor and is then asked to enter the solution by jumping on the sensor mat (see Figure 2). The game presents one question at a time. The player receives

game points as a function of the time taken to enter the correct letters or numbers. The playing component of HOPSCOTCH is, therefore, to move the body as quickly as possible on the sensor pad, touching the correct fields in a given order as fast as possible. In the case of a vocabulary game, the player may be asked, for example, to translate the German word for plum into English and therefore hop the word 'plum' on the sensor pad.

Up to now the HOPSCOTCH concept has been applied for different learning contents including mathematics (multiplication table), history (historical dates, events and names) and languages (English vocabulary words, learning letters and numbers). The levels of difficulty can be varied either by presenting hints (such as the dashes indicating the word length in the vocabulary game) or by asking for a free input (not providing any hints for the length of the word to be entered). Further, the high scores in the game can be based on the scores of either different players (norm-referenced feedback) or on the current player showing his or her improvements within the game (self-referenced feedback).

#### D. *Empiric results with HOPSCOTCH*

Since 2009 HOPSCOTCH has been tested and evaluated at fairs and in schools. The purpose was to get feedback on the application and to get input for further developments [7]. In the following paragraph we report major outcomes from these tests and studies.

1) *General feedback:* HOPSCOTCH was evaluated between 2009 and 2011 at an annual trade show focused on children entertainment to get first results about user acceptance and fun factor. The survey involved scholars (N = 276) aged between seven and twenty years (M = 11.41; SD = 1.31). The sample consisted of young visitors to the fair and school classes which were invited to hold English lessons with HOPSCOTCH. Children and adolescents who played at least ten minutes were requested to answer a questionnaire.

On a scale from 1 ("very good") to 5 ("poor") HOPSCOTCH was valued as "good" (31.3%) or "very good" (64.3%). The vast majority (87.2%) associated HOPSCOTCH as a learning game (11.2% sports game; 1.6% both). So, 62.5 % would use it for learning. More than a half of the respondents (56.1 %) would renounce on another present for getting HOPSCOTCH (e.g., their mobile phone, clothes, wii).

In addition to students the accompanying teachers (N = 33) were asked to fill out an additional questionnaire to get information about HOPSCOTCH as a possible teaching method. Rated on a scale from 1 ("very good") to 5 ("poor") the first impression of HOPSCOTCH was "very good" (75%) or "good" (25%). Almost all of the questioned teachers see the potential for learning as "high" (68.8%) or "very high" (18.8%). They (58.1%) could very well imagine using HOPSCOTCH for their classes as a teaching method.

2) *English lessons in Elementary School:* In two exploratory studies at a German elementary school, we investigated the potential of HOPSCOTCH to engage students as well as to facilitate the acquisition of factual knowledge (English vocabulary) and to improve the attitudes of students towards learning English as a second language.

In both studies a comparison of lessons was conducted, where new vocabulary words were learned and practiced via HOPSCOTCH in contrast to "traditional" teacher-centred lessons that also aimed at introducing and practicing new vocabulary words.

In the first study, 55 students of a 4<sup>th</sup> grade learned 13 vocabularies in "traditional" teacher-centred lesson and another 13 vocabularies in HOPSCOTCH-lessons. According to the results, playing HOPSCOTCH did at least not impair the performance of the students on cued recall tasks compared to a teacher-centred lesson. This was true although the vocabulary words were put into context within the teacher-centred lesson which was not the case when playing HOPSCOTCH. Further, even on the first encounter with the game, the additional exercise component - that may require cognitive resources to perform the "dance steps" – did not seem to impair learning.

In the second study we reduced the number of vocabularies to be learned. This was due to the fact that in the first study the children did not get the whole 45 minutes of a usual German school lesson, because the game and the rules were introduced by the teacher before starting. 58 students of the 3<sup>rd</sup> grade learned 10 vocabularies in a "traditional" lesson and another 10 in a HOPSCOTCH lesson. In contrast to the first study, the second study showed advantages of HOPSCOTCH on cued recall compared to a teacher-centred lesson. After playing the exer-learning game, the students were better able to remember and correctly spell the new vocabulary words. Lowering the number of words to be learned in the given time from the first to the second study allowed for higher repetition rates per word in the HOPSCOTCH lesson. This may then have led to the advantage of HOPSCOTCH in the second study suggesting that the students need enough time to repeat each word to be learned more than five times.

This result, however, needs further examination. In summary, the conducted studies yielded preliminary results that HOPSCOTCH, as teaching aid within school lessons, may be a fruitful approach to facilitate both active engagement and learning. Further, the application of digital learning games does not exclusively aim at fostering learning in terms of efficiency (learning as much as possible in a given time). Rather, it focuses on motivating people to engage in effective learning activities. The results of both studies showed that students who were below-average in the teacher-centred lesson have learned most with HOPSCOTCH. Therefore we assumed that weaker students benefit more from HOPSCOTCH. These results led to the idea that HOPSCOTCH could well be used for the education of children with special needs.

### III. EDUCATIONAL SUPPORT FOR CHILDREN WITH SPECIAL NEEDS

There are special schools for gifted and talented learners as well as for those with learning difficulties. In this paper we only refer to children with learning difficulties when we address special schools. For a clear demarcation in this context we refer to specialised school.

Since 2009 the *UN Convention on the Rights of Persons with Disabilities* requires a reduction of specialised schools and integration of impaired students into regular schools [25]. Therefore, new innovative teaching methods are needed. The following section gives an insight into structural conditions and didactic concepts of specialised school.

#### A. Structural conditions

For many years school reform has been a controversial subject in Germany. The existing system excludes children with learning difficulties and puts them in specialised schools. Nearly half a million children and youngsters need special education. Only 15.7% of them are taught together with all other students in regular schools – in contrast to 90% in the Scandinavian countries [26]. Once again Germany lags behind in the European comparison. For example, Italy has abolished the specialised schools in the 1970s; the Scandinavian countries generally teach all children, whether handicapped or not, together; Austria and the Netherlands have been gradually ending the separation of regular and specialised schools since 2007 [27].

In the discussion about integration of students with special needs, politicians have to find a solution by weighing the advantages against the disadvantages. On the one hand, intellectually disadvantaged children should have same chances as others [28]; on the other hand a drop in performance is expected by integrating slower learners [25].

A proper education system needs to offer integrated education to all students. So, special requirements have to be met by innovative teaching and learning methods whenever the need arises. For children for whom the traditional teacher-centred approach is not adequate HOPSCOTCH theoretically complies with these conditions by integrating new media as well as connecting learning with exercise and enjoyment. Therefore the concept of *exer-learning* could offer a certain adaptivity which allows an individual support within the class. Due to physical exercise an increase in success is expected for children with special needs as mentioned in chapter II.

#### B. Didactic concepts

From developing-psychological point of view *support* encloses (1) promoting intra-individual changes of people for a certain period (for example: learning to swim); (2) reducing inter-individual differences between people of different ages (for example: learn to read and write) and (3) lower inter-individual differences in intra-individual changes (for example: individual support to relieve development gaps) [28]. Support for all three areas is always adjusted to educational aims which should be reached by promotion, suggestion and care [29]. The aims of the special-educational

support are the dismantling of developing problems and therefore enabling integration in society [28]. According to this discipline, children and youngsters with special needs should be encouraged by reducing the differences in achievement – not by repressing the achievement more able children but by raising the achievement of the less able. They should be able to integrate themselves in the existing education system and later into the labour market.

In this area of research there are different fields which should be strengthened by certain measures. Besides the support of learning there is the strengthening of linguistic, intellectual, social-emotional, and motor aspects to be supported. The present paper deals with academic success. This is defined by two components: (1) ability and (2) motivation [30]. With reference to the theoretical outlines of chapter II we assume that HOPSCOTCH could support the two major components ability and motivation relating to academic success.

Furthermore studies empirically confirmed the effects of psychomotor support, showing that the best results are observed with slower learners. In particular the long-term support shows positive effects concerning the increase in output as well as the strengthening of motivational and emotional aspects with four to 12 year old children [22]. Therefore a specialised school was selected for the present study, particularly children of grades three and four.

### IV. EMPIRIC EXAMINATION

As in the aforementioned studies in chapter II, a comparison of learning methods – HOPSCOTCH and a traditional teaching method – was conducted, to see which teaching aid leads to better outcomes in terms of ability.

Therefore a superior teaching aim had to be determined, to which both learning strategies could be adjusted. This aim defines a certain qualification which should be provided by the teaching-learning process [31]. For the present study the chosen aim was to improve the abilities in the field of orthography. Spelling is a skill needed in most tasks and for problem solutions. In essence, an improvement in a child's ability to spell could strengthen their performance level in school.

The objective of the investigation was that students should learn the correct spelling of a defined number of words. Half of the words were to be taught with a traditional method, the other half by using HOPSCOTCH.

Also mood was appraised to make some initial statements about the multidimensional construct of motivation. On the one hand, mood can determine action choice; on the other hand the intensity of action could be influenced [32]. Both could implicitly lead to a strengthening of academic success. Within the scope of this investigation it was assumed that cognitive learning and mood is positively influenced by HOPSCOTCH.

#### A. Two learning methods

Because HOPSCOTCH has already been introduced in detail in the theoretical section of the paper, merely the description of the traditional teaching method – *run and write* – will now be discussed. This learning method is

traditionally used in the selected school to teach students the spelling of new words.

Different words are hung on the wall of the classroom. Then the children walk through the classroom, look at a word, memorise it, go back to their seat and write it down. After writing, they start with the next word. This process is repeated until all of the words are recorded and written. At the end the students have to look over their words again, to find and to try to correct their mistakes.

This traditional learning method can be compared with HOPSCOTCH very well. First, the systematic repetition of words provides the base for both strategies. Second, both methods include exercise (walking in the classroom vs. tapping on a sensor pad). Nevertheless, there are also differences between these learning strategies. One aspect is the (immediate) correction. With HOPSCOTCH only correct input is accepted by the software. Thus the students do not memorise wrong words, because these are indicated always correctly. In contrast, in *run and write*, students sometimes memorise a word wrongly and reinforce their mistakes before correcting themselves. A second difference between these methods is the input that is either hopped or handwritten. HOPSCOTCH fosters a connection of each word with a special body movement or dance. In contrast, the writing process of the words from *run and write* is made without body movement. On the one hand the permanent exercise could affect the learning process positively. On the other hand the transfer between the HOPSCOTCH way (reading and hopping) and the later process of writing on paper could be difficult because the kinaesthetic memory of hand movements has not been developed. However, as outlined in chapter II we suppose that exercise is supporting the process of memorization, the dance steps could even serve as memory aid to support the recall process. By contrast in organisation HOPSCOTCH needs less effort for preparation and observation.

#### B. Execution and stimulus material

All together the investigation in school took five weeks. In the first week HOPSCOTCH was introduced to teach participants the handling of HOPSCOTCH itself, and to reduce the novelty value of the exer-learning game. During the following four weeks the students practiced twice a week using both learning methods for a period of 20 minutes each. The observation units were carried out one day on a weekly basis. In addition, each learning method was observed to get information about the technical handling as well as to get an impression about the learning process.

The content arrangement of the learning methods was carried out in close co-operation with the teachers. So, 68 words (20 adjectives, 20 verbs and 28 nouns) were selected.

Within those four weeks 34 words should be learned by *run and write* and another 34 by using HOPSCOTCH. Adjectives and verbs were given in written notation and could be copied by the students (see Figure 3: Type the following word! 'grumble'), while nouns were shown as pictures and had to be written by the participants (see Figure 4: What do you see in this picture?). Two learning units were set up. The first learning unit run the first two weeks,

whereas the second unit run the third and fourth week. During the first learning unit 34 words were taught (17 words per method), in the second unit the remaining words were practiced.

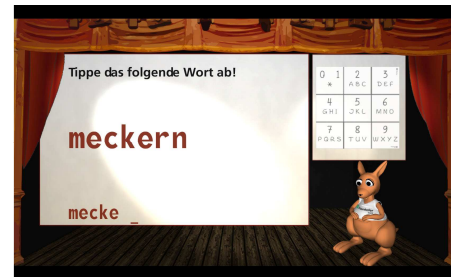


Figure 3. Words which were given in written notation

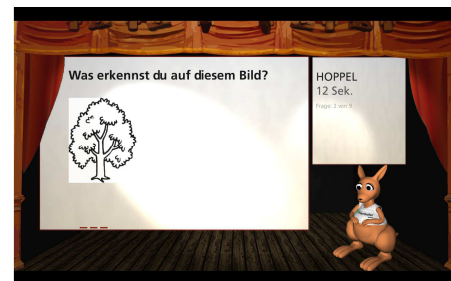


Figure 4. Words which were shown as pictures

Vocabulary tests were set up at the end of each practice week. These tests consisted of 20 words – ten words of the practice with HOPSCOTCH and the other ten taken from the *run and write* lessons. Participants' previous knowledge of spelling was not raised.

#### C. Analysis

For the evaluation of the learning success the vocabulary tests were analysed by counting the number of correct letter sequences. According to this method, the participant gets an achievement point when two correct letters follow each other. In addition, an achievement point was given for the correct initial letter and last letter in each case [33]. Consequently a student would get four points for a correctly spelt word "cat" (+c+a+t+) whereas he would get just two points for the wrong spelling of "dog" - "dok" (+d+ok).

To visualise an increasing in learning success an evaluation standard is needed. A comparison of learning success over time used the *individual relation norm*. Thus this relation norm was used to be able to measure the changes in spelling ability of the students over the period of four weeks. The comparison of the two methods (*run and write* vs. HOPSCOTCH) in terms of learning success was assessed by using the *objective relation norm*. Using this objective relation norm learning success could be set against a predefined educational objective [34].

Mood was evaluated by a short questionnaire after every learning unit with HOPSCOTCH and *run and write* (see Figure 5: How do you feel? Mark one smiley!). Therefore

the participants had to specify which learning method they had used (questionnaire: I learned with ( ) HOPSCOTCH ( ) *run and write*.) With the help of nine different smileys current feelings were be given by the pupils.

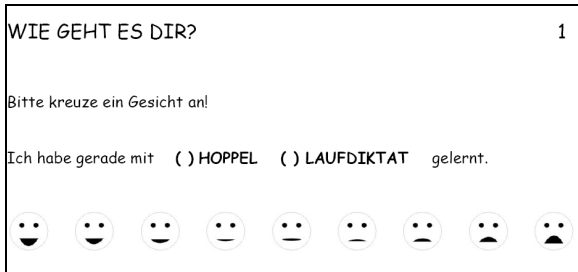


Figure 5. Questionnaire about mood

Due to the small sample (N = 30), the significance level was fixed to  $p = .10$ .

V. RESULTS

30 students at the age of nine to eleven years (M = 10.40, SD = .62) participated in the study – 77% boys, 23% girls. The participants attended grade three (n = 16) and grade four (n = 14) in the specialised school. This average age corresponds with the average age of students in fourth and fifth grade in a German regular school.

In each class HOPSCOTCH was played on average for 16 minutes (M = 16.34, SD = 2.62). As shown in Figure 6, the students of the fourth grade (M = 16.05, SD = 2.78) spent as much time practicing as the third graders (M = 16.19, SD = 2.54).

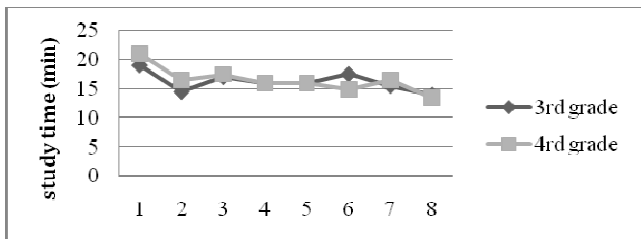


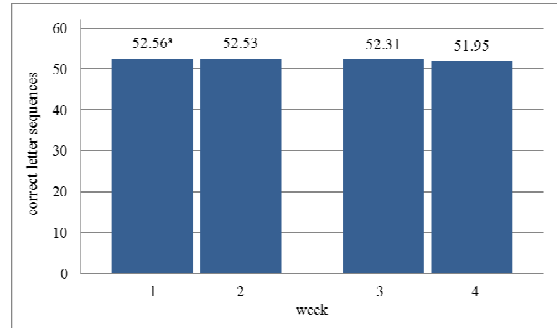
Figure 6. Study time of the eight HOPSCOTCH units

A. Improvement of spelling ability

In a first stage learning success was analysed, to check whether students of a specialised school could achieve individual improvements with HOPSCOTCH. The variable consists of the numbers of words which were learned during four weeks. Paired sample t-tests were calculated for the comparison of the results of vocabulary tests within each unit.

Contrary to expectations no significant differences were found for the learning success within units. The comparison of vocabulary tests one (N = 26, M = 52.56, SD = 8.21) and two (N = 26, M = 52.31, SD = 9.93) showed no changes ( $t(26) = .14, p = .44, d = .03$ ) as with the tests of week three

(N = 19, M = 52.53, SD = 10.39) and four (N = 19, M = 51.95, SD = 13.82) ( $t(19) .30, p = .38, d = .05$ ). The achieved mean values in the vocabulary tests for the words learned with HOPSCOTCH are shown in Figure 7.



a. 62 points could be reached maximum.

Figure 7. Mean values of correct letter sequences learned with HOPSCOTCH

B. Comparison of learning methods

For the examination of learning methods (*run and write* vs. HOPSCOTCH) the students’ results were compared. Table I presents the comparison of the percentage averages in performance level which were reached by the two different learning methods.

TABLE I. MEAN VALUES OF PERFORMANCE LEVEL FOR BOTH UNITS

	learning method	N	M	SD
Performance level <sup>b</sup>	HOPSCOTCH	30	84.31	14.77
	<i>run and write</i>	30	85.34	13.98

b. The data are percent values.

In order to compare the learning success in terms of orthographic results towards different methods, paired-sample t-tests were calculated. As expected no difference appears in the learning success with HOPSCOTCH and the method *run and write* ( $t(30) = -1.12, p = .28, d = .07$ ). For teaching German spelling, the use of HOPSCOTCH in specialised schools is as good as the use of *run and write*, but needs less effort for preparation as mentioned in chapter IV.

C. Exploratory data analysis

During the first two days of introducing HOPSCOTCH in school lessons it became obvious that the students were particularly open-minded towards the new learning method. The children quickly understood the principle of the game and had no problems with providing the required input. This fact shows that there was no excessive demand on the students in contrast to the supposed doubts which were expressed by the class teachers before the tests. The students got used to the new learning strategy very well and, besides, had a lot of fun while testing it out. However, there were also few students who were critical and showed little desire in interacting with the exer-learning game HOPSCOTCH.

Regarding the material's degree of difficulty, the observations during the four weeks showed that students were insufficiently challenged. In particular the fourth graders assessed the degree of difficulty as too simple. This is supported by the achieved percentages for both types of words in the vocabulary tests which were reached with HOPSCOTCH. Paired-sample t-tests were calculated to compare words to be copied (copy words; see Figure 3) and words to be recognized (word pictures; see Figure 4) towards the learning success. Words that were learned on the basis of pictures (N = 30, M = 88.74, SD = 11.80) were significantly more correct ( $t(30) = -3.86, p = .00, d = .48$ ) than words that were written (N = 30, M = 81.66, SD = 11.79). Figure 8 shows the achieved learning success.

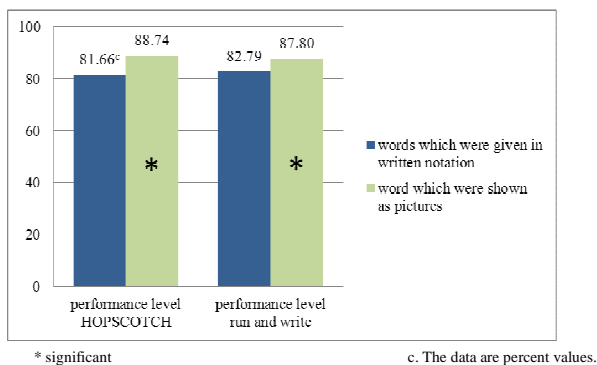


Figure 8. Mean Values of correct letter sequences

Also the comparison of the percentages which were reached with the *run and write* shows a significant difference with small effects ( $t(30) = -2.565, p = .00, d = .35$ ) between the learning of the transcribed words (N = 30, M = 82.79, SD = 16.90) and the word pictures (N = 30, M = 87.80, SD = 11.92). We assume that the results of the comparison of methods could differ if the tasks were more difficult. However, the observations and log file data indicate that students get much faster in typing the words and make fewer mistakes. Especially highly underachieving students showed an enormous increase in handling the words. Because of the high number of correctly given answers by the many fast-learning children at the beginning of the evaluation, an additional increase over the time was hardly possible.

D. Mood after learning

For the examination of *mood* the feelings after learning with HOPSCOTCH and *run and write* were compared. Table II shows the mean values of the variable mood in comparison. A lower score signals a better mood.

TABLE II. MEAN VALUES OF MOOD

	learning method	N	M	SD
Mood <sup>d</sup>	HOPSCOTCH	30	2.00	1.70
	<i>run and write</i>	30	2.44	2.19

d. A lower value shows a better mood.

To compare the mood of the students after learning towards the two different methods, non-parametric tests were performed. As expected, a significant difference was found ( $Z(30) = -1.65, p = .05, d = .23$ ). The mood after learning with HOPSCOTCH was better than by practicing *run and write*. Another interesting point was that pupils love to learn generally. Worst moods were mentioned rarely.

VI. SUMMARY AND CONCLUSION

In this paper we introduced exer-learning games that not only combine playing and learning but also integrate exercise as principal component of a digital learning game. Physical activities may constitute incentives within playing that facilitate engagement. Research from different disciplines suggests that physical activities may be positively related to cognitive performance.

We reported on a study with HOPSCOTCH over a period of four weeks where we compared two learning methods based on exercise in school everyday life. The comparison results of both learning methods indicate that students can learn with HOPSCOTCH as well as with the traditional teaching method *run and write* – but the former with more pleasure in learning.

The explorative data analysis has shown that words with a higher degree of difficulty were significantly better remembered irrespective of the learning method. So the students seemed to be under-challenged with the degree of difficulty of the requirements imposed on them.

Furthermore the difficulty level of the method *run and write* was obviously higher than HOPSCOTCH, because students had to memorise the exact spelling of the word before writing it down. In contrast, they could copy each letter individually when playing HOPSCOTCH and were not forced to memorise the word. Therefore, the assumption is made that students would have reached better results with HOPSCOTCH if the content had been more demanding. It seems that the degree of difficulty had to be defined individually for each student before the training starts. Additional investigations should be done with more difficult problems or more comprehensive content of educational workload to verify this hypothesis.

As HOPSCOTCH is based on a digital platform, it offers numerous new advantages. The option to integrate adaptive elements and individual levels as well as to run it without the immediate help of a teacher could support the integration of special students in regular schools. Therefore, HOPSCOTCH could become part of the new integration reform of students with special needs into regular school.

Slow learners could be supported individually in regard to their special needs within a large class. Nonetheless, further research is needed to provide more evidence in order to confirm this assumption and to optimise the relevant applications.

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# Knowledge-Building Support through Social Navigation in Learning Community

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**Abstract**—In information search on Web as learning activities, by utilizing social bookmarks as a mechanism to classification and organization of the collected information, tags are added when individual learners bookmark a Web page, to be shared. In this paper, we describe the method for building knowledge models by analyzing the structure and the temporal nature of tags to estimate the knowledge structure of learners and learning community. We propose supporting information search on Web based on the knowledge model, and a mutually supportive learning environment to achieve knowledge building in the learning community.

**Keywords**—Learning Community; Information Search; Social Bookmark; Knowledge Structure; Ant Algorithm.

## I. INTRODUCTION

With the development of social web technologies, Internet-based learning activities have become increasingly diverse. In particular, the learning support focused on knowledge sharing in communities formed by Wiki, Blog, Wiki, Blog, and SNS (Social Network Service) have been actively researched. On the other hand, in the technology to support information search on Web, social navigation and social search have been remarkably widespread [1] [2]. Reflecting that, the learning support utilizing social navigation [3] [4] has been attracting attention.

In this research, our purposes are to support information search on Web as a learning activity, and to promote of mutual support for building knowledge in the learning community. We perform our purpose by utilizing the technology of social bookmarking to realize social navigation based on the concept of sharing bookmarks. Also, in this paper, we define the group of learners sharing the common learning objectives taken from the viewpoint of knowledge, skills and applications, problem solving, as "Learning Community".

By utilizing social bookmarks, they consider the classification of a bookmark pre-arranged, they add to the bookmark information (e.g., title, URL, and evaluation) the equivalent of a bookmark metadata called "tag", and they register them on the Web site. Social bookmark is a social web technology to share and manage tags by multiple users. Tags associated with the Web pages based on user's knowledge, represents the user's own expertise [5]. In

addition, differences in the classification system for Web pages by tagging interact in communication between users, and influence the formation of community.

When analyzed in terms of the Bloom's Taxonomy of Learning, learners who use tags show evidence of moving up the hierarchy from the lower "consumption"-based levels of learning (knowledge and comprehension) to higher levels of applied and metacognitive knowledge (application and analysis). Further, reviewing of tags (i.e., comparing tags used by a community of taggers) would potentially facilitate the move to the highest levels of Bloom's Taxonomy of Learning (synthesis and evaluation) [4].

Therefore, in this paper, in inquiry learning including information search process on Web depending interests and purposes of individual learners to achieve the learning objectives, we propose a knowledge-building support by utilizing social bookmarking as a mechanism to classification and organization of the collected information. First, in information search on Web as learning activities, we provide support by the navigation of Web pages based on the knowledge model of learners and learning community. Next, we will provide mutual support for building knowledge in the learning community, by encouraging participation to the community, and by recommending members to the community.

The paper is as follows. In Section 2, we discuss related work, and examine the use of social bookmark to support knowledge-building in the learning community. In Section 3, as our research approach, we explain how to create the knowledge model of learners and learning communities. Then, we propose social navigation based on the knowledge model of the learning community. In Section 4, we describe overviews of our system and the details of important processing module. In Section 5 shows a running example and discuss the preliminary experiment. In Section 6, we describe future plans.

## II. RELATED WORK

Social navigation [6] is a technique to support the activities of learners by using information about other learning activities. For example, learning support using bookmarks, links, and annotation [3] in learning activities, has been researched. In this section, we describe related research studies focusing on social bookmarks created by

collaborations in the community. Then, we discuss creating learner's model utilizing social bookmarking, and examine techniques to support knowledge-building.

#### A. Social Navigation and Learning Support

Social navigation is intended to support information search using bookmarks, links, and annotations created by a collaboration of the community [1] [2]. Farzan [3] realized learning support using the AnnotatEd (Annotations for Education) by incorporating the annotation to provide social navigation in e-Learning. In addition, Bateman [4] focused on the potential educational benefits of collaborative tagging proposed by John [5], and developed collaborative learning system OATS (Open Annotation and Tagging System) as an open source tool. Bateman showed the possibility of adaptation of collaborative tagging on e-Learning by analyzing learner's tagging, automatic tagging provided by system, and expert's (instructor) tagging for e-Learning contents, from data obtained by experiments. However, any support is limited in the areas that the learning content domains in e-Learning. For information search on Web, learning support has not been done according to interests and purposes of individual learner. Also, the environment as the interaction between learners is not provided.

In this research, in inquiry learning activities on Web, we provide an environment for social navigation and community as a learning support by utilizing social bookmark applying the capabilities of collaborative tagging and Folksonomy (i.e., classification by people).

#### B. Social Bookmark and Learner's Knowledge Model

John [5] proposed two methods for ranking ExpertRank to quantify the expertise of the user in the context of a specific tag. One is a simple way that is not expected in the relationship between the tags on unstructured tag space, the other is a realistic way that assumes the classed tag space. In the latter method, each cluster of tags can be represented graphically. Nodes represent tags, and edges between nodes represent the strong contextual relationship between tags.

ExpertRank, instead of determining all areas of expertise for a specific user, that is important to find a user who is familiar with a specific area. However, the temporal aspects of the tag have not been considered. So, Michlmayr [7] proposed the Add-A-Tag algorithm for profile construction, which takes account of the structural and temporal nature of tagging data, as a complementary approach to John's proposals. Michlmayr extended the co-occurrence approach [5] with the evaporation technique known from Ant algorithms, in order to consider the time course of the bookmark. However, the relationships between the tags are not the result of a community-driven process, but entirely created by one user instead. Hence, the relationships between the tags might not make sense to anyone except to the user who created them.

In this research, our system accumulates, as learning history, tags granted to a Web page when individual learners bookmark, and semantic tag consisting features of Web pages, rating, registration date. We extract tags that represent concepts from the stored data. By analyzing timing of the

appearance of concept tags and subsequent relationship between concept tags considering the temporal aspects, we estimate the knowledge structure of learners and learning community. Thus, we represent model of their knowledge to the graph.

#### C. Social Bookmark and Navigation

Social bookmark has achieved social navigation by the recommendation of Web pages based on information obtained through the sharing of useful bookmarks. The methods of navigation are classified as recommendation by analyzing the contents bookmarking, recommendation by analyzing the co-occurrence, and recommendation of the graph-based user model by analyzing the structure of tags.

As a graph-based recommendation, Sharma [8] applied the strategy of evaporation of the pheromone of ants to deal with the temporal nature of the tags that Michlmayr [7] proposed. Their method is different from the way to add weight to the edges of Michlmayr. In the proposals of Michlmayr, the evaporation is done at all edges and the weights are added to the specific edge. In the proposals of Sharma, if not already present as nodes in a graph of all the tags associated with a specific user at a specific time, nodes are added with equal weight. Then, evaporation is performed on the existing edges, which consists of tags provided by users than the specific user. Thus, the recommendation considering the temporary user interest has been discussed and that it is beneficial to specific users. However, if a specific user provides tags, we consider evaporation is reasonable to be done on the edges, which consists of tags provided by the specific user.

In this research, we also apply the update strategies of the Ant Algorithm to the time course of the tag. However, our approach is different from related research in terms of the method to update the edge weights and to reflect the recommendations of dynamic interest and purpose in the community using the knowledge structure of the learning community.

#### D. Social Bookmark and Community

The concept of community is the basis for social Web. Lacher [9] discussed that members of the community can facilitate communication because members share perspectives common to observe the real world, and vocabulary, common concepts and common system of concepts are prescribed in terms of this common. Based on this basic concept, Ogure [10] proposed the method for automated information retrieval system utilizing the concept of experts as the community ontology. However, in the method of Ogure, there are problems that the cost of building the community ontology is high, and non-experts have to search for information using unfamiliar ontology of experts. In these problems, Bateman's [4] results of a comparative analysis of tagging by learners and experts showed that to be effective Collaborative tagging. On the other hand, Freyne [2] proposed a method to collect the wisdom of the community by integrating social search and social navigation.

Therefore, our approach is utilizing the knowledge structure of the learning community built by social

bookmarking as community-particular conceptual system, to support the individual learner's information search. In addition, by implementing the search function of learning communities and community members, we provide mutual support for building knowledge in the community.

### III. OUR PROPOSED APPROACH

In the learning cycle assumed by our research, first, we describe how to create the knowledge model of learners and learning communities. Then, we propose the method for social navigation based on the knowledge model of the learning community. After, we describe how to encourage participation for mutual support for building knowledge in the learning community.

#### A. Learning Cycle

In this research, as shown in Figure 1, we assume learning cycle to repeat "Search", "Browse", and "Classification and Organization by Bookmarks" on Web [11].

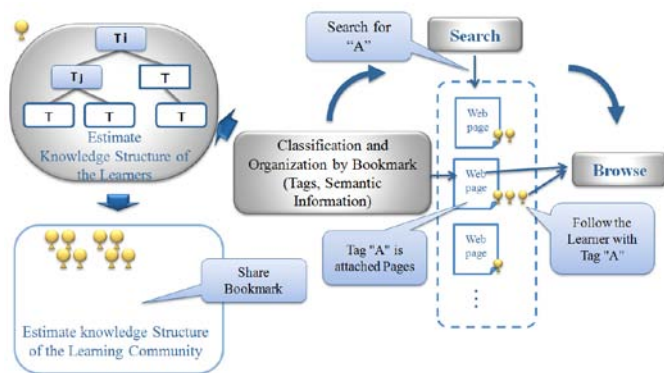


Figure 1. Learning Cycle

First, learners search by keywords or tag cloud (list of tags) for individual interest and purpose. Then, they select a page from the list including the title of Web page, URL, etc. that is presented as a search result to browse for their interests and purposes. When they bookmark the pages they visit, they store tags and semantic information in the system and work together to classification and organization of Web pages.

In this system, log data of tagging behavior in information search on Web (i.e., the title and URL of Web page bookmarked, important keywords), tags and semantic information (purpose of the tag, reading amount, difficulty and importance, usefulness, registration date) is stored in a database as a learning history.

#### B. Knowledge Model of Learners and Learning Community

In this system, target learner's model of learning support is created based on the accumulated history of individual learning. We determine from semantic information of individual learning history and extract the tags that represent

the concept. Then, we represent learner's knowledge model to the graph containing the concept tags extracted as nodes, and co-occurrence as edges. Moreover, as with the proposal of Sharma, we apply the update strategy of Ant algorithm to the weight of the edge of the graph by considering the passage of time. However, our method is different from the way to add weight to the edges of Sharma. We proposed to make the evaporation on the graph that consists of tags of target learner. Because, if the target learner will make a new tag, target's interest will fade from existing tags. Thus, the graph of other learners is not affected, but the graph of the learning community will be affected.

The graph of a learner  $G = (V, E)$  has node set  $V$  and edge set  $E$  where:  $V = \{v_1, v_2, \dots, v_n\}$  is (corresponding to tags  $t_1, t_2, \dots, t_n$ ) and  $E = \{e_1, e_2, \dots, e_n\}$ . If tags  $t_i$  and  $t_j$  appear at the same time, the edge corresponds to tags  $t_i$  and  $t_j$ , the weight assigned to the edge is represented as  $w_{ij}$ . We describe the weight  $w_{ij}$  update procedure, as follow: (1) to (3).

- If there is not  $v_i$ , all tag  $t_i$  will be added to the graph as a vertex  $v$ . (1)

- Evaporation is performed using the following formula on the existing edges, which consists of specific learner's tags.

$$w_{ij} = (1-p) * w_{ij} \quad (2)$$

- If there is an edge between vertices  $v_i$  and  $v_j$ , the weight ( $w_{ij}$ ) is as follow:

$$w_{ij} = w_{ij} + \beta \quad (3)$$

Here,  $\beta$  is a real constant,  $\beta > 0$ .

Otherwise, it will be added as a weight  $w_{ij} = \alpha$  to the edge between vertices  $v_i$  and  $v_j$ .

Here,  $\alpha$  is a real constant,  $\alpha > 0$ .

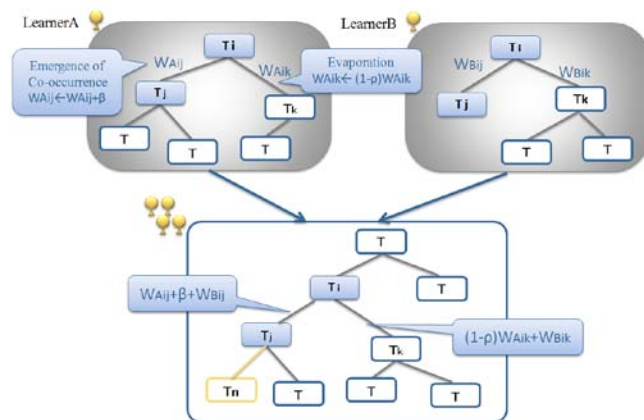


Figure 2. Knowledge Model of Learners and Learning Community

On the other hand, the knowledge model of the learning community is created based on the learning history of learners that participates in the community. Similar to the learner's knowledge model, we represent the knowledge model of the learning community to the graph. Here, the weight  $w_{ij}$  of the edge corresponding to the tags  $t_i$  and  $t_j$ , is the sum of edge weights  $w_{ij}$  corresponding to the tags  $t_i$  and  $t_j$  of the individual learner. Once the update is made under the weight of the individual learner, the update will be done in the community. Thus, the dynamic interest and purpose of individual learners will be reflected in the community.

### C. Social Navigation using the Knowledge Model of Learning Community

As stated previously, our system will also create the knowledge model of the entire system (i.e., social), while creating the knowledge model of learners and learning community.

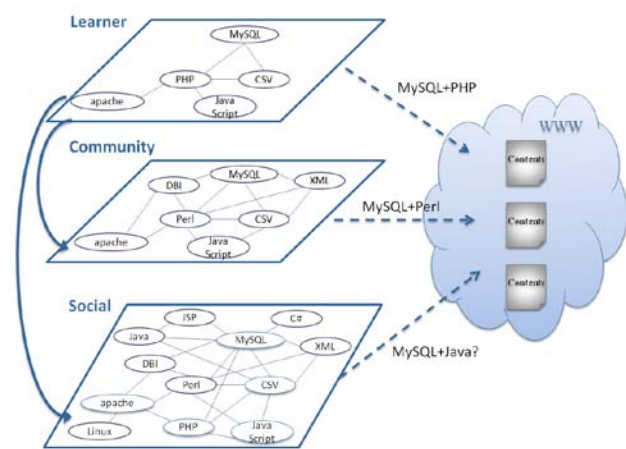


Figure 3. Social Navigation utilizing the Knowledge Model of Learning Community

Therefore, as shown in Figure 3, if a learner will participate in the learning community with a aim, for example, if the learner has learned "PHP" will participate in the learning community has learned "Perl" already with the aim of learning "Perl", to support to explore the appropriate Web pages for search keywords of the learner, based on the knowledge model of the learning community, our system extracts concept tags needed by the target learner, and recommends the Web pages associated highly with those tags. For example, if the learner's search keyword is "MySQL", the traditional social bookmarking sites recommend highly relevant pages with "MySQL". However, they are not always highly relevant pages with "Perl". If the system recommends based on the learner's past history, it recommends highly relevant pages with "PHP". On the other hand, if our system recommends using the dynamic knowledge structure of the learning community, it reliably recommends highly relevant pages with "Perl", which has been formed in the community at that time.

### D. Mutual Support for Building Knowledge in Learning Community

In this system, by implementing the search function of the learning community, it would recommend the learning community to adapt for learner's new interest and purpose, based on the knowledge model of learners and the community. In addition, it presents the community recommended in the page of "Learning Community Bookmark".

On the other hand, by implementing the search function of members for additional members of the learning community, it would recommend additional learners needed to achieve the objective of the learning community, based on the knowledge model of learners and learning community seeking additional members. In addition, it presents the member recommended in the page of "Learner's Bookmark". By the recommendation of members and learning communities, it promotes the participation of the community for mutual support for building knowledge in the learning community.

## IV. SYSTEM CONFIGURATION

As shown in Figure 4, our system is comprised of "Social Bookmark Database" and the seven processing module. Among them, the following describes the details of important processing module in the learning community; "Community Bookmark Management", "Community Bookmark Recommendation", "Learning Community Recommendation", and "Community Member Recommendation".

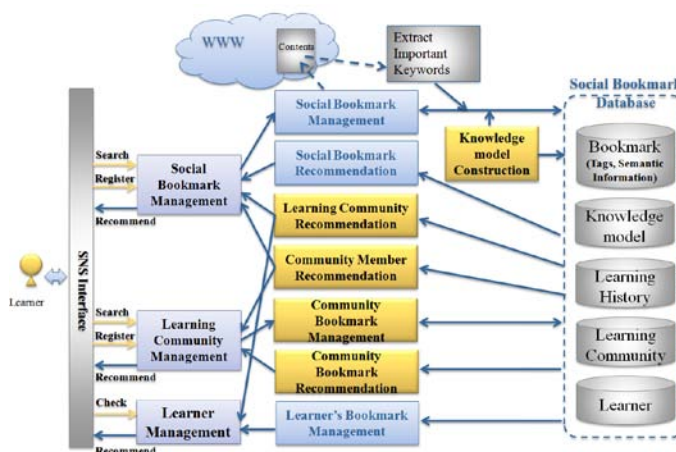


Figure 4. System Configuration

### A. Community Bookmark Management Module

In learning communities, this module performs main processing; to search information, to represent search results, and to register tags and semantic information at the time of bookmarking. Learners enter b), d), h), i), and j) of Figure 5 by themselves during the registration. Otherwise, our system automatically extracts, and store in the database. In

addition, it extracts the concept of tags based on "Content Theme", "important keywords in the content" in i), and items without "after" in h). Mainly, Learners search by keywords or tag cloud, and store tags and semantic information in our system when they bookmark the pages they browse. Our system automatically extracts the title of a Web page and keywords at URL that learners entered during registration, and stores them in the database.

a) Tag-ID	b) Tag-Name	c) Category
d) URL	e) important keywords (contained in 4.)	
f) Learner-ID	g) Registration Date	
h) Reading Amount: •all •half •some •diagonally •after		
i) Purpose of the tag		
Objective: •Content Theme		Concept Tags
•Important Keywords in the content		
•Type of the content (news, blogs, and articles)		
•Content Author		
Subjective: •Content Comments		
•The procedure to use the content (preparation, review, and reference)		
•Relevance of their content (own blog, post comments)		
j) Characterized of the content		
Difficulty:	•Difficult •Normal •Easy	
Importance:	•High •Normal •Low	
Usefulness:	•Useful •Normal •Useless	

Figure 5. Tags and Semantic Information

Also, in Community Bookmark Management Module, our system has performed navigation by presenting high ranked pages calculated based on the knowledge model of the learning community from the top of the search results.

#### B. Community Bookmark Recommendation Module

The consensus among learners in the learning community that are built in the community is done on special Web page classification using particular tags. Also, as shown in Figure 2, the weight of edges in the graph of the knowledge structure of learning communities is the sum of the weight of the corresponding edges of each learner. Thus, dynamic interest and purpose of individual learners will be reflected, and the knowledge structure of the community is continually updated and is codified by evaporation. So, based on the dynamic knowledge structure of the learning community, our system recommends Web pages tagged with particular tags related search keywords in the community. Thus, we navigate common keywords in the community and relevant knowledge has become a subject of interest and purpose.

First, in order to narrow the search results with related tags for search keywords, our system extracts tags to recommend in the learning community. If there is a node in a graph of the knowledge structure of the community, our system extracts the edges with Top-k weights connecting the node to the other nodes, and recommend tags combined of the search keywords and the extracted node tags. Then, by the relevance between Web page and tags to recommend,

we obtained in accordance with the following calculation method to rank the page. Our system presents high ranked pages from the top of search results.

The page's rank is calculated as follow:

Calculate the relevance between the page P and tag T.

$$P = \sum W_i \quad (4)$$

( $W_i$  is the important keywords contained in the page P)

Let the relevance between the page P and the tag T be  $rel(P, T)$ ,

$$rel(P, T) = \sum rel(W_i, T) \quad (5)$$

Here,  $rel(W_i, T)$  and T is the relevance between  $W_i$  and T.

Thus, the page rank is calculated as follow:

$$\text{page's rank} = \sum rel(P, T_j) = \sum \sum rel(W_i, T_j) \quad (6)$$

#### C. Learning Community Management Module

##### 1) Recommendation of the Learning Community:

Our system calculates CommunityRank for search keywords, and presents high CommunityRank communities from the top of search results. In the page of "Learner's Bookmark", the search keywords is the tags in the learner's most recent bookmarks.

CommunityRank is calculated as follow:

The graph of the learner's knowledge structure  $G = (V, E)$  has node set V and edge set E where:  $V = \{v_1, v_2, \dots, v_n\}$  is (corresponding to tags  $t_1, t_2, \dots, t_n$ ) and  $E = \{e_1, e_2, \dots, e_n\}$ . Where a set of keyword search is  $K = \{k_1, k_2, \dots, k_m\}$ , and  $k_i$  is an element of K,  $k_i \in V$ , if there is  $e_{ij} \in E$ ,  $e_{ij}$  is the edges corresponding to a tag  $t_i (= k)$  and  $t_j$ , and the weight represented as  $w_{ij}$ . This time, let a set of  $t_i$  and  $t_j$  with Top-k ( $w_{ij}$ ) be  $V_{Top}$ . On the other hand, let the graph of the knowledge structure of the learning community be  $G_c = (V_c, E_c)$ . Where  $V_{Top} = \{v_1, v_2, \dots, v_n\}$ , an element of  $V_{Top}$  is  $v_i \in V_c$ , if there is  $e_c \in E_c$ , the weight of the edge  $e_c$  represented as  $w_{cij}$ .

Thus, CommunityRank is calculated as follow:

$$\text{CommunityRank} = \sum w_{cij} \quad (7)$$

##### 2) Recommendation of the Community Member:

Our system calculates MemberRank for search keywords, and presents high MemberRank learners from the top of search results. In the page of "Learning Community Bookmark", the search keywords is the tags in the learner's most recent bookmarks.

MemberRank is calculated as follow:

The graph of the knowledge structure of the learning community  $G_c = (V_c, E_c)$  has node set  $V_c$  and edge set  $E_c$  where:  $V_c = \{v_1, v_2, \dots, v_n\}$  is (corresponding to tags  $t_1, t_2, \dots, t_n$ ) and  $E_c = \{e_1, e_2, \dots, e_n\}$ . Where a set of keyword search

is  $K = \{k_1, k_2, \dots, k_m\}$ , and  $k_i$  is an element of  $K$ ,  $k_i \in V_c$ , if there is  $e_{ij} \in E_c$ ,  $e_{ij}$  is the edges corresponding to a tag  $t_i (= k)$  and  $t_j$ , and the weight represented as  $w_{cij}$ . This time, let a set of  $t_i$  and  $t_j$  with Top-k ( $w_{cij}$ ) be  $V_{cTop}$ . On the other hand, let the graph of the learner's knowledge structure be  $G = (V, E)$ . Where  $V_{cTop} = \{v_1, v_2, \dots, v_n\}$ , an element of  $V_{cTop}$  is  $v_i \in V$ , if there is  $e \in E$ , the weight of the edge  $e$  represented as  $w_{ij}$ .

Thus, MemberRank is calculated as follow:

$$\text{MemberRank} = \sum w_{ij} \tag{8}$$

### V. THE PRELIMINARY EXPERIMENT

As shown in Figure 8, we have developed the knowledge-building support system that provides supporting information search on Web as a learning activity, and mutual support for building knowledge in the learning community. In a) of the figure, learners search information and bookmark as learning activities in the learning community. Our system represents high ranked pages from the top of search results. When learners bookmark, they register tags and semantic information in b). As shown in c), learners are able to see the knowledge structure of the learning community. As shown in d), our system recommends members, and it is possible to see the bookmarks and the knowledge structure of members. If necessary, they are able to invite members to their community.

sbm_knowledge	c_member_id	from_tag	to_tag	weight
107	34	72	67	0.99
117	35	3	76	0.98093601
114	35	17	74	1.95059601
115	35	17	75	0.950990499
123	35	24	80	0.9801
113	35	49	73	1.9212890499
126	35	74	75	0.99
128	35	75	81	0.99
119	35	78	24	0.9801
118	35	78	79	0.9801
120	35	78	80	0.9801
121	35	79	24	0.9801
122	35	79	80	0.9801
129	35	82	81	1
133	36	24	3	0.904382075009
132	36	49	3	2.845489338885
131	36	49	24	0.904382075009
136	36	49	68	0.99
130	36	49	83	0.895338254259
134	36	49	84	5.821794
135	36	49	85	0.9801
200	37	3	101	0.99
197	37	49	66	0.9801
196	37	49	85	0.970299
198	37	49	100	0.9801
201	37	49	102	1
199	37	66	100	0.9801

Figure 6. The data used to create the knowledge model of Learners

c_commu_id	from_tag	to_tag	weight
1	42	43	0.904382075009
1	42	25	0.904382075009
1	42	24	0.904382075009
1	42	42	0.895338254259
1	42	25	0.895338254259
1	44	46	0.913517247404
1	44	45	0.913517247404
1	45	46	0.913517247404
1	47	48	0.922746894428
1	49	172	0.970299
1	49	110	0.96059601
1	49	172	0.96059601
1	49	82	0.932065347907
1	49	51	0.932065347907
1	49	50	0.932065347907
1	50	49	0.99
1	50	57	0.941480149401
1	50	82	0.932065347907
1	50	51	0.932065347907
1	51	52	0.932065347907
1	56	57	1
1	56	60	0.950990499
1	56	58	0.950990499
1	56	57	0.941480149401
1	56	50	0.941480149401

c_commu_id	from_tag	to_tag	weight
4	47	48	0.922746894428
4	49	73	5.90099601
4	49	84	5.821794
4	49	3	2.845489338885
4	49	85	1.9801
4	49	105	1.940598
4	49	73	1.9212890499
4	49	169	1
4	48	24	1
4	49	102	1
4	49	145	1
4	49	65	1
4	49	146	1
4	48	148	1
4	49	144	0.99
4	49	144	0.99
4	49	65	0.99
4	49	68	0.99
4	49	147	0.99
4	49	148	0.99
4	49	138	0.99
4	49	65	0.9801
4	49	106	0.9801
4	49	100	0.9801
4	49	85	0.9801

Figure 7. The data used to create the knowledge model of the learning community

(tag\_id, tag\_name)=(3, php), (17, Web), (49, MySQL), (73, database), (74, html), (75, css), (84, primer), (85, Reference), (110, command), (172, dump), (173, dumpdata), ...

In July 2011, we conducted the preliminary experiment intended for students of the information system course. As a result, as shown in Figure 6, we obtained the data used to create the learner's knowledge model. If we focus on the learner (c\_member\_id: 35), information about MySQL (tag\_id: 49) has not hardly been collected. On the other hand, as shown in Figure 7, we obtained the data used to create the knowledge model of the learning community model. The community (c\_commu\_id: 1) shown on the left, has been collected information about the dump of MySQL. The community (c\_commu\_id: 4) shown on the right, has been collected a lot of information about entry-level MySQL. If the learner (c\_member\_id: 35) joins the community of right, and search "MySQL", the entry-level information about the MySQL will be recommended using the knowledge structure of the community. In addition, the community of right will be recommended to the learner as highly CommunityRank.

### VI. CONCLUSION AND FUTURE WORK

In this paper, we proposed the learning environment to support information search on the Web as a learning activity, and to promote of mutually support for building knowledge in the learning community. As the technique to achieve knowledge-building support, we have developed the system to take advantage of social bookmark in the process of information search on the Web. The results of preliminary experiments, we confirmed that it is possible to extract the respective interests and objective by using the knowledge model of learners and learning community.

In the future, we continue to inquiry learning including information search process on the Web, we will evaluate the effectiveness of knowledge-building support system that focuses on the dynamic knowledge structure of the learning community.

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Figure 8. A Running Example of our System

- a) Our system presents high ranked pages from the top of search results.
- b) Learner registers tags and semantic information.
- c) Our system presents the knowledge structure of the learning community.
- d) Our system recommends members, and presents bookmarks and the knowledge structure of members.

## Understanding and Improving Personal Negotiation Skills With E-learning Tools

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**Abstract** — In the modern world of developing industries, people see a growing importance of negotiation skills. Businessmen come to the negotiation table as frequently as problems occur between two or more parties. Therefore, it is essential to evaluate negotiation skills of an individual and practice them as much as possible. Contemporary technologies like computers and cell phones have made it possible to create special interactive programs which serve as a platform for practicing deals. Specific software is aimed at developing decision-making approaches by various means and tools and enables negotiators to come to mutually beneficial agreements with higher frequency and efficiency. Each program is useful in its own way and can be applied differently by negotiators all over the world. Therefore, this article shows an e-learning tool in which people can discover and improve their negotiation skills through several types of computational mechanisms. Comparisons and initial results are also mentioned in this work.

**Keywords** – e-learning; m-learning; negotiation; decision making process

### I. INTRODUCTION

“The biggest obstacle to innovation is thinking it can be done in an old way” said James Wetherbe from Texas Tech University. Ways of getting knowledge are undergoing great development, evolving into a new generation of e-education. With respect to it, global trend in modern business has shown an escalating demand in e-learning not only in educational establishments but also in companies that are interested in increasing the efficiency of the work of their employees. According to recently presented data in 2001, £224 million was spent by European enterprises on e-learning projects [1]. Eight years later, the 2010 State of Industry Report has calculated that the United States' businesses opted for investing \$125.9 billion on the education of their workforce [2]. The same report revealed that the direct costs of learning for American companies went up to 0.71 percent from 0.59 of revenue in year 2009. The most interesting feature of this tendency is that e-learning compounded 27.7 percent of the educational sessions [2]. The authors of the report (2010 State of Industry Report) argue that the growth can be explained by high efficiency of the e-learning methods and the ease of accessing to e-learning programs. Therefore, it would be reasonable to estimate the benefits that modern companies see in the e-learning.

These work aim at presenting an e-learning negotiation environment in which people, mainly inexperienced negotiators, can learn about negotiation concepts and also discover their own psychological tendencies during the deals. The computational environment has been developed since 2008 and combines technologies such as e-learning, m-learning, mining and visualization methods to show useful interfaces for all users.

### II. BACKGROUND LITERATURE

#### A. E-learning

Howard Hills [3] shows the benefits e-learning could bring into the decision-making process of managers. He sets an example of the election process of employees by a manager. Hills argues that for a manager an employee and his skills implies the same thing, but in practice this assumption is not accurate. According to his viewpoint, e-learning motivates employees on fulfilling tasks that most fit them and their skills, it gives them a range of choice and eases the work of the manager, making his decisions more efficient [3].

Though e-learning can seem an easy thing to comprehend, the understanding of some of its facets may be ambiguous and lead to certain problems that will impede successful results of using e-learning tools. Rosenberg [4] has outlined nine myths about e-learning that can produce the mentioned above effect:

- E-learning is easy;
- Anyone can define the term “e-learning”;
- E-learning technology and strategy is the same;
- Functioning of e-learning can bring its user to success;
- E-learning will do without classroom
- Online teaching cannot be applied in many contents;
- The decrease of the cost of training delivery lays the basis of e-learning's value proposition;
- “If you build it, they will come”;
- The learners really matter.

Rosenberg [4] argues that the development of e-learning was spurred on by the “e-enablement of business operations”, i.e., the fact that every aspect of the modern business, be it marketing, commerce, human resources or else, was under significant influence of e-technologies created the basis for accelerating growth of e-learning that fitted the environment with easy availability and application of its tools. In the work of Rosenberg [4], it is also stated that



the usage of e-learning in the management of a company supports innovation in the enterprise; furthermore, it is a part of training for the company that can make the decision-making process more effective. Advocates of e-learning, such as Rosenberg [4], claim that companies are more prone to using e-tools since it helps them withstand the main enemy – time. Here, time zones and organizational walls are implied [4].

**B. M-learning**

According to the statistics [5], countries such as Italy, United Kingdom and Sweden have 100 percent penetration by cell phones. As one of the reasons for this, Prensky [6] sees cheap service that telephone companies provide people with. Indeed, telephone coverage in regions all over the world is growing rapidly enabling people to connect through cellphones or use downloaded educating programs wherever they are. In Brazil, for example, there are more cell phones than inhabitants [26] - 224 million cell phones against 190 million of people [27].

Prensky [6] claims that there is no limit to the educational capabilities of a cell phone if it is designed properly. Billy Biggs and Rob Justice [7] assert that m-learning can be regarded as a supplement to a developing strategy of an enterprise. They say that that to improve an m-learning strategy, managers of a company should follow certain steps [7]:

1. Outline “business challenges” and strategy
2. Work out a solution
3. Start-up an “m-learning solution”
4. Build data and evaluate results.
5. “Adjust” the problem.

**C. Negotiation**

For sure, there are some drawbacks of e-learning communities for the purpose of acquiring negotiation skills. McConnell [8] outlines two main problems:

- Production versus community process
- Structure versus negotiation and openness

From the other point of view, McConnell [8] sees that e-learning is a better tool for studying negotiation process as face-to-face discussions fail to involve a large amount of individuals negotiating at the same time with the same extent. For instance, if there is a big group of negotiators that are holding discussions and all are actively participating in it, it is extremely hard to keep the discussion going and come to a mutual agreement quickly. It takes a lot of time and effort [8]. From this perspective, it can be concluded that online negotiating tools enable people to train their skills and be individually assessed.

Koskinen [9] classifies negotiation methods as four modeling groups:

1. Utility function and concession based methods,
2. Utility function based joint gains searching methods,
3. Interactive methods based on concession making,
4. Interactive methods searching joint gains”

It should be noted that some of these methods involve a third party in the negotiation process, which is the mediator. He possesses specific information about two negotiating parties. In computer software, mediator can be the software itself or a human being that is supporting negotiations [9].

**III. E-LEARNING TOOLS**

Three e-learning tools will be discussed in the further part of the article. Each of them will be given a short insight that will allow a comprehension of the programs and their aims. All of them have specific mechanisms for decision makers and negotiators learning.

A peculiar approach to decision making-process has been discussed by Tanja Arh and Borka Jerman Blažič [12] and is denominated as “multi-attribute decision making” [10][11]. The main principle of this approach is to divide the existing problem into smaller “subproblems” [12]. Hence, it will become less complicated and require less effort. Applied in practice as an e-learning tool this approach is utilized in an interactive expert system DEX [13]. The program is used for evaluation of the existing options and supports decision-making process [14][15]. Therefore, the division of the problem comprises a hierarchy. One of the most typical features of the method is that its assessing approach is qualitative, but not quantitative [14][15].

The application of DEX includes such areas as:

- Selection and evaluation of computer hardware and software,
- Performance evaluation of enterprises and business partners,
- Project evaluation,
- Personnel management.

The system of DEX includes “tree of attributes” and “utility functions”. And the tree itself depicts the decision-making process. The attributes depend on “characteristics of options” [12]. One of the advantages of the program is that the attributes can be modified by a special editor. It also allows copying and deleting the subtrees. An example of a tree editor is presented on Figure 1 [14].

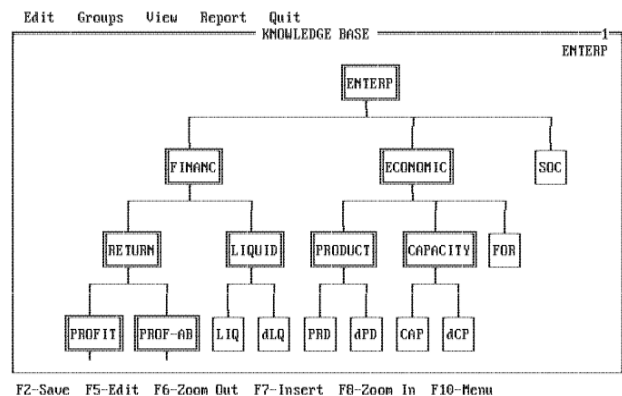


Figure 1. DEX tree editor [14].

What is more, the decision-making process is decomposed into five stages:

1. Identification of the problem,

2. Criteria identification and criteria structuring,
3. Utility function definition,
4. Description of variants,
5. LMS (LMS – Learning Management System ) evaluation and analysis [12].

A study held by Ehtamo *et al.* [16] regards negotiation analysis as primarily linked with decision analysis. According to [16], the main difference between a mere decision making process by an employee, is that negotiations create a set of people who are in charge of making decisions and that jointly determine the solution of the problem. To deal with such situations Joint Gains software, which uses a “jointly improving direction method”, has been created [17][18][19]. There are several features of the software:

- Every user is able to set up his own case,
- The number of participant must be not less than two, but is not limited,
- There are “linear inequality constraints”,
- The number of “continuous decision variables” must be not less than two, but is not limited,
- The participants of the negotiations are dispersed in the web [20].

The software becomes a mediator between the parties and makes them follow certain steps [18]:

1. Outline preferred directions of the negotiators at the intermediate point,
2. Decide on a compromise direction according to the preferred directions,
3. Work out a new favored intermediate point “along the compromise direction”.

Ehtamo *et al.* assume that when negotiators are led through these three steps, they reach a “Pareto optimal agreement” [16]. They also stress on the fact that if the initial point of the process is altered Pareto point will be altered as well and move on the graphic presentation of the case. Hence, negotiators will approach Pareto frontier [16].

Within the Joint Gains software students build their own case for negotiation specifying the parties and the matter for negotiation. An example could be seen in Figure 2 [16].

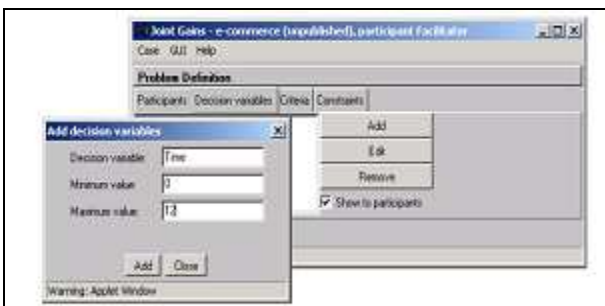


Figure 2. Case Creation in negotiation games [16].

During the process of negotiations, the software acts as a mediator between the parties, elaborating proposals for the purposes of negotiations. This interaction can be seen in Figure 3 [16].

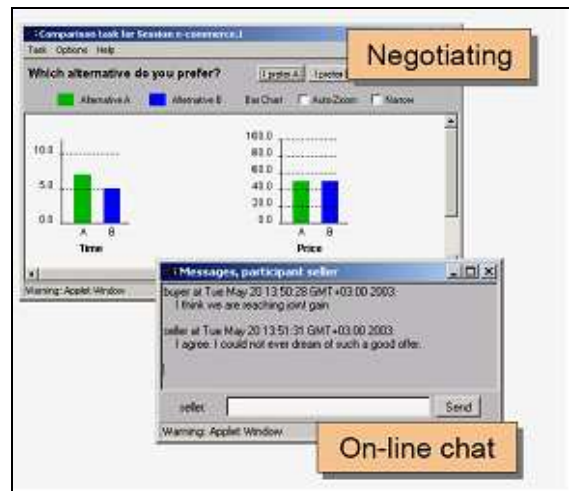


Figure 3. Negotiation process [16].

The program itself is available to wide audience as an online course that takes only 90 minutes. With the help of the presented information users of the course become well-prepared for the negotiations. What is more, the course is divided into three sections each of them compounding a scenario challenge:

- Collaborative Negotiation
- The ICON Value Diamond
- Conducting the Negotiation.

The aim of this approach is to enable prospective negotiators to have a better perception of the problem and to prepare them for an adequate solution for any type of negotiations [22].

#### IV. THE PROPOSAL

By analyzing some types of learning tools, it is possible to see how important the use of such tools is to improve concepts of decision making processes, mainly, in the learning of negotiation elements. Thus, this paper presents a learning tool to be regarded in this context.

The e-learning negotiation tool proposed here provides mechanisms to understand and also improve users' negotiation skills. For this purpose, several technologies have been used, such as trading games, quizzes, psychological tests, wizard forms and visualization reports.

The e-learning mechanisms proposed here, are parts of a Negotiation Support System developed for academic purposes and to share negotiation games among universities. The framework, called ENEG, is based on such technologies as: Knowledge Management [4], Risk Management [30], Visualization Methods [25], Text Mining [28][29] and Mobile Statements [6].

These modules were developed based on researches about software project negotiations. Although not being unique, the focus of this environment is IT projects. Thus, the negotiation knowledge flux was a concept to prioritize negotiations that involve IT context.

The Knowledge Management Module aims at controlling basic negotiation information, such as: customers, contacts,

deadlines, negotiators and initial negotiation prospects, what is more, there are several forms and wizards to help the users.

Risk Management is the Module where users can identify risks (threats and opportunities) and point out negotiation elements that can be impacted by stored risks. Examples of negotiation elements are context, concerns, options, relationships, power, communication, criteria, legitimacy, concessions and schedule. Moreover, this module contains a preliminary list of about 500 risks from software projects domain that assists inexperienced negotiators to manage them.

Text Mining tools and Visualization Methods are used for mining the data stored in the Knowledge and Risk Management modules and transform data to information through a group of intuitive graphs and dashboards.

The environment also provides mechanisms to increase IT professionals' negotiation skills. For this purpose, e-learning tools focused on the IT context have been developed, e.g., trading games, quizzes and psychological tests. This approach is the focus of this article, as shown in Figure 4.

More sophisticated platforms have been developed to support experienced negotiators, which require agility and the most current available information. Based on these requirements, a mobile platform has been developed that lets the users to manage data registered in the negotiation. This platform is integrated into Knowledge Management and Risk Management Modules.

Currently, this environment is available at and its use is free (see [23]). The translation to Spanish, Russian and Mandarin is underway. Figure 4 shows the overall architecture of this Negotiation Support System, which can highlight the e-learning tool, contextualized in this article.

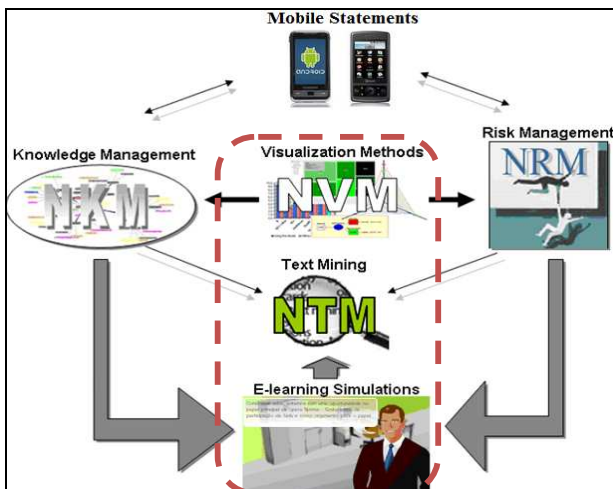


Figure 4. NSS Architecture [23].

The e-learning infrastructure aimed at indicating to users which negotiating skills can be discovered and improved. Figure 5 shows an example of negotiation games.

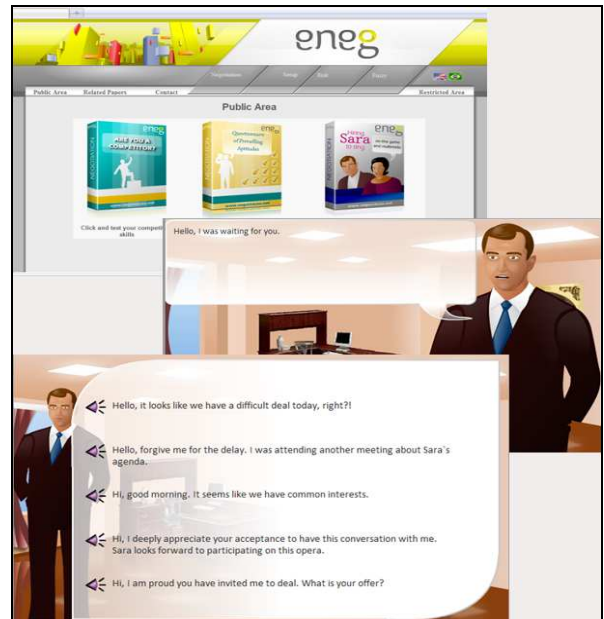


Figure 5. Negotiation Simulation Games.

Other platforms have been developed to support inexperienced and experienced negotiators, which require agility and the most up-to-date information. Based on these requirements, psychological questionnaires have been developed which let users manage the data registered in the negotiation games. This platform is all integrated into e-learning and knowledge management modules. An example of using psychological questionnaires is depicted in Figure 6.

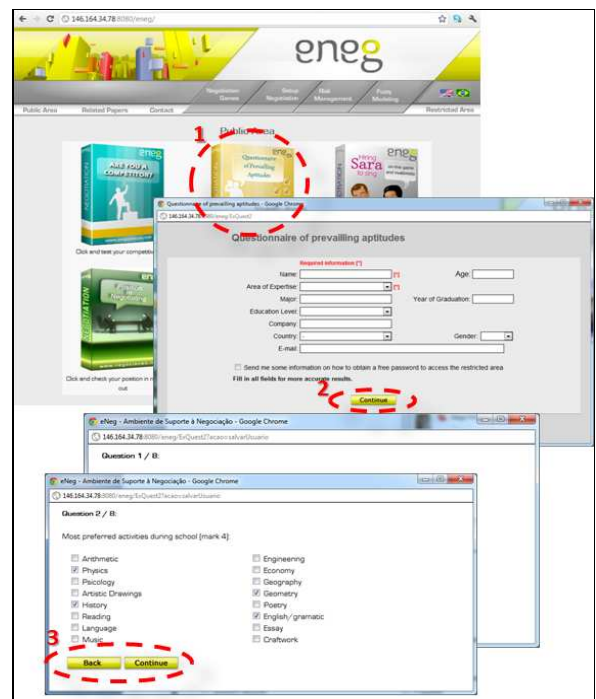


Figure 6. Example of psychological questionnaire (questions).

After answering each questionnaire, the tool's user can see his personal result. The graphs compare the user's result between IT and non-IT people. This comparison is part of the focus of this academic working group.

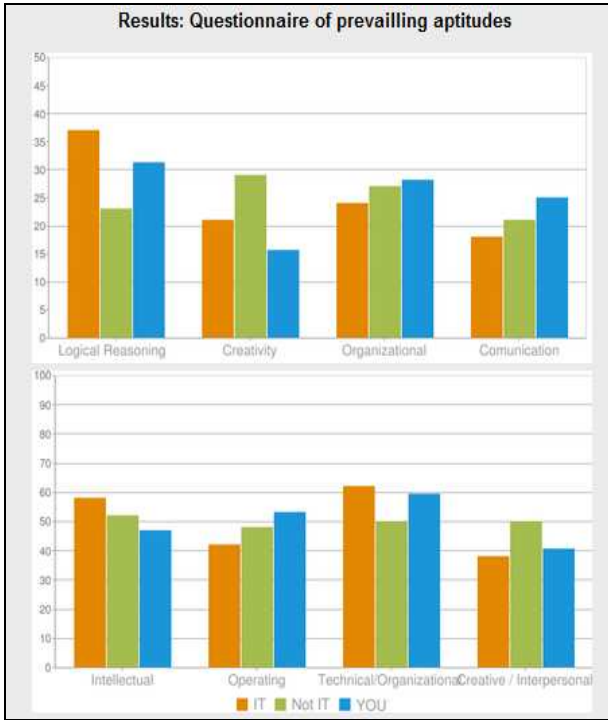


Figure 7. Example of psychological questionnaire (results).

Figure 7 shows the results of the questionnaire applied in the Figure 6. There are other quizzes, tutorials and games that are used to generate personality graphs and highlight the professional's style during conflict management, as showed in Figure 8.

In this example (Figure 8), the results depict styles (Collaboration, Competition, Commitment, Accommodation and Deviation) and compare user's profile between IT and Not IT people. Here again, all results can be achieved in the website referenced in [23], purpose of this work.

The graphs depicted in these figures are made through the lenses of visualization methods and previous work [25] has improved quality and usability of each result.

Besides, the results of each mechanism of learning (negotiation games, questionnaires, quizzes, preparation form) are inputs of a text mining tool in which it is possible to combine the individual results and, then, generate other types of graphs.

Nearly 80% of data is stored in text [28], so it is imperative to be able to recover and share this information. Text Mining provides mechanisms to explore large amounts of textual data in a reasonable cost, making possible the retrieving and analysis of this information [29].



Figure 8. Another example of personality graphs (results).

In the approach proposed here, once there are enough data on the process, the tool can use mining tools to cross the negotiation data (Figure 9) and then, the visualization methods provide reports to highlight possible ways of increasing the chances of agreements.

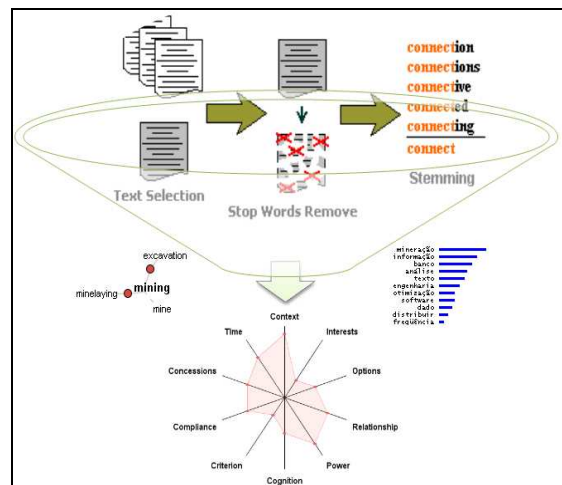


Figure 9. Textmining techniques.

As shown in Figure 9, for each text (negotiation data – questionnaire, negotiation game, quiz, form, etc), the algorithm removes stop words and applies the stemming method, which considers the stems to evaluate the number of common words (e.g., negotiation, negotiations, negotiator).

Afterwards, the process manages the output with a thesaurus to balance the weights (proposed by experienced negotiators) and relevant word frequency. The quantification criterion depends on the type of element (questionnaire, negotiation game, etc). As a default, a merger between words' frequency and weight to find each element value was used. At the end, these quantified values will be used to create the radar graph, which considers a dynamic number of negotiation elements. In the example depicted in Figure 9, ten elements are showed: context, interests, options, relationship, power, cognition, criterion, compliance, concessions and time.

## V. CONCLUSION

The article has given an insight to several aspects. It has been showed that negotiating skills can be acquired not only by face-to-face situations but also by online approaches with a usage of certain programs that can become available through two tools: personal computers and cell phones. Both of them are useful although PCs have a wider range of products that can be applied to learn negotiation skills. It can be concluded that with the help of software negotiators can expose themselves to real situations and analyze their results and progress. Several types of software have demonstrated various approaches to training negotiation skills. One of the main differences among them is the distinction of decision-making process and the way they regard problem solving situations. The proposal given in this article is distinguished by specification of conflict management styles. The suggested learning tool has a wide range of questionnaires and is able to give detailed feedback on the results of carried out quizzes. One of the other advantages of this tool is that it presents a graphic outcome of the case created by a negotiator and allows easy perception of results.

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## E-learning and M-learning in African Languages

### A Survey of Oshikwanyama Students at a Northern Namibian School

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**Abstract**-The paper reports on a small-scale survey carried out in a northern Namibian urban school about mobile and computer experiences as well as attitudes towards the use of Oshikwanyama in an ICT domain among grade 11 students. This paper provides some discussion of Learner Centered Education (LCE) as a useful framework for research into emancipation through technology use. It highlights the importance of African language teaching in a globalised world. The experiences and attitudes of students in relation to ICT and Oshikwanyama are presented and discussed. The findings indicate a pervasive access and use of technology, particularly mobile. Attitudes towards the use of an African language such as Oshikwanyama in the ICT domain highlighted some articulation on the part of the students. These encourage the further exploration of the potential for the use of developing ICT resources in an African language as a pedagogical tool, which is the topic of a broader study by the authors.

**Keywords**-Information Communication Technologies (ICTs); Mobile learning; Electronic learning; Constructivism; Learner-centered approach; African indigenous languages.

#### I. INTRODUCTION

Governments around the world are adopting policies that permit private sector to expand communication network and services [11][16][19]. Individual ownership of computers and Internet connection is often difficult or impossible for most third-world indigenous groups. Community access centres are the most common means to provide access in developing contexts [11]. This situation is common in Namibia where most teachers and indigenous people are connected through the internet café and a vast number of individuals are connected through the mobile phones.

Leiberman [11] asserts that “We have to manage the process of global integration in such a way that everyone can benefit and no one gets crushed.” Since ICT is an emerging tool of globalization, there is a need for education stakeholders to be involved in its integration into learning. Dalvit [4] asserts that “in order for ICT to be effective in education, the conditions must be created for students to effectively appropriate the use of the new technologies, understand how they work and how to use them”. This means that teachers need to create opportunities where students can interact with ICT; need to research in depth the

curriculum implementation and the classroom real-life situation because that is where the educational products are being harvested.

The focal point of this paper is a small-scale survey of the use and availability of ICT tools to students of Oshikwanyama as a first language. This serves as an explanatory tool for both the benefits of ICT in Oshikwanyama learning and the implications of ICT use in the classroom. Students' attitudes and previous experiences with the use of Oshikwanyama in the ICT domain are part of the study. This paper attempts to answer some of the following questions:

- a. What are the current mobile phones and computer access and use among students at a High School in northern Namibia?
- b. What are the perceived benefits and challenges of using and learning Oshikwanyama in an ICT domain?

To address these questions, two strands have been addressed in the sections that follow. Firstly, is the provision of teaching and learning using ICT and secondly, the presence of the African languages in the ICT domain. Those are discussed in sections two and three. Section four gives a description of the methods used in carrying out this survey and the last two sections provides the analysis of the findings as related to access and use of ICT and the students' perception about learning Oshikwanyama in an ICT domain.

#### II. THEORETICAL FRAMEWORK

When considering the dynamics of mobile and electronic learning, several pedagogical principles and theories are relevant. The learner must be the agent of change and transition at the centre of learning and be given the technological tool at his/her disposal to conquer the world in which s/he lives. The Learner-centred approach (LCE) is rooted in the constructivists, progressivist and Freirean models of education and drawing upon Vygotskian theory

of social constructivism [15]. Learning is seen as a social act and knowledge is viewed as a matter of human construction.

LCE, underpinned by the emancipationist and liberation ideals was adopted as part of a much broader political imperative to transform, democratize, and humanize teaching and learning [12][13]. Empowering students by promoting the use of ICT is aligned with this vision. Concerning ICT use in Oshikwanyama first language learning, educators need to adopt a constructivist approach to learning. Teaching and learning African languages needs to be situated and understood within the one of the phenomena shaping the student's daily life, i.e., an ever more pervasive penetration of ICT (particularly mobiles, see [2]).

Students' experiences and attitudes need to be at the centre of research in education. Learner-centered education is informed by a view of the student as an active, visible, and central position in the pedagogic process, [15]. The interest and life-world of the student form the basis of the curriculum and students are actively involved in determining the content of education [15][14]. Furthermore, this principle evokes an emancipatory vision where students take control of their own learning, and are seen as active, creative and self-regulatory [12][22].

### III. AFRICAN LANGUAGES IN THE ICT DOMAIN

African language teachers are struggling to overcome the limitations in their own education and the shortage of indigenous language instructional materials, [11][16]. African Indigenous cultures are valuing more and more the unique knowledge they possess and are seeking to conserve and disseminate this information before it is lost to globalization. Osborn [16] stressed that Africa, which is recognized today both as a continent struggling with aspects of its own development and one where the use of ICT lags behind most of the rest of the world, is beginning to see some attention to localization, (p. 1). It is also important to note that Africa is a large continent and the one with most of the multilingual societies in the world, and thus, the European languages cannot meet all of Africa's needs, and African languages have much to contribute, (ibid. p. 5).

The Millennium Development Goal 8, aim to develop a global partnership for development and this includes the promotion of Africa's Indigenous people's participation in the Information Society while protecting the traditional knowledge against appropriation, exploitation and misuse and preserving their rights to access to ICT and connectivity [8]. In addition, the languages of indigenous people need to be uplifted through ICT, by the people themselves through indigenous literacy [18], and skills to compete in mainstream society and the need to uphold Indigenous culture and identity, [6]. This means that there is a need to develop accessible ICT resources in African languages that can be used as platforms for ICT content creation and localisation of pedagogical tools from everyone who can positively contribute.

According to [1], "the choice of a language of instruction in Africa is a political choice, a choice that may redistribute power in a global context, as well as within an African country". It is very important to note that many Namibian people believe that the previous government apartheid policy contributed to the creation of unequal language development process, whereby some language groups, e.g., Afrikaans and English were given a head start while others languished under neglect [7][20]. Oshindonga being the first written Oshiwambo indigenous language, followed by Oshikwanyama, have been dominated by the spread of European languages. However, their promotion is found lacking, since many people only advocate the use of English because it is the Language of Learning and Teaching (LoLT) [20], and many African parents prefer their children taught through the medium of English in order to gain a head start in life [20].

It is also important to note that English, Afrikaans and other European languages are the dominant languages in the ICT domain. African parents and students seem to value them more than their own language because they can give access to the world and to better jobs. This in turn encourages cultural dependency on the western world [4]. The mindset of African students has changed with globalization. They believe that English gives them a chance to face global forces, while their own indigenous languages do not.

Lieberman [11] points out that creative access and local dissemination of information within a community though ICT will provide residents with timely, useful, and relevant information. Thorne [23] indicates that "the internet does not exist in a neutral medium; it is rather a cultural artifact", (p. 437). If used wisely, the use of ICT in development of responsive pedagogical didactics and programs or activities in the classroom can result in the growth of the language at the global level and a participation of a wider community [11][16]. Paulsen [17] and Shazia [19] propose that the Internet presence of language, the appearance of new and improved web research tools, strategies, on-line reference works and electronic resources; and the development of ICTs that facilitate cross-curricular communications and collaboration is necessary. Thus, the question is not which subject is more conducive to the use of ICT, but how to use it across the curriculum, including in African language teaching and learning.

### IV. METHODOLOGY

#### A. Research Context

This study was conducted in a northern Namibian school located in Oshana region. Though representative of other Namibian schools, the selected one presents specific features such as: 1) the school is one of the top-performing schools in Namibia, in an urban area but in one of the previously disadvantaged regions in the country. 2) Most of the students came from both rural and urban areas in the northern region).

3) There are ICT infrastructures at the school, which comprise a full-equipped computer laboratory with 22 workstations as well as personal desktops, connected via wireless, (satellite) TV, Video and DVD players and video projector. 4) Most of the students have mobile phones although, according to the school as well as national policy, cell phones are banned from being used at school and especially during lessons.

This research site was purposively chosen because it is the school where one of the researchers is currently teaching Oshikwanyama as a first language and English as a second language. Though a minority language within Namibia, Oshikwanyama is the mother tongue of the researcher herself and of most students. For the sake of convenience, her students were used as a focus group.

The researched group consists of 32 respondents of which 11 are boys and 21 are girls from two grade 11 Oshikwanyama classrooms, with age ranges from 15 to 18 years old, the mean age being 16.3. The respondents were chosen because of their varying educational backgrounds with 63% of students having attended their primary school in urban areas and 37% attending primary school in rural areas. These students are in their first senior year and did not go far with their syllabus, and some of them have done Word Processing as a subject in the last 3 years.

#### *B. Methodological Orientation, Process and Limitations*

A case study approach was chosen as the methodological orientation for this study as it may be mostly suitable for learning more about a poorly understood or little known situation, [10]. This approach is consistent with an interpretative-qualitative methodology [3][5][21]. Such an approach appears particularly appropriate to explain the process of ICT in an African language as a potential new and emerging phenomenon and the idea of integrating ICT and African languages as part of a constructivist learning pedagogy.

Paper-based questionnaires were administered to 32 respondents. The questionnaire included 26 open-ended questions and 5 closed questions, mostly rating scale questions and multiple choices. The questions were set on a nine-page questionnaire in English. They covered previous and current use of computers and cell phones as well as attitudes towards language use in the ICT domain. Questions were analyzed qualitatively, although descriptive statistics were considered whenever possible.

The respondents were briefed on the importance of answering the questionnaire and assured that their responses would be handled confidentially and anonymously. However, the fact that one of the researchers was their teacher might have influenced their responses. Findings based on such a small sample are neither reliable nor generalisable and the school is not truly representative of most Namibian educational contexts. However, reflections on students' answers provide a platform to reflect on ICT penetration in Africa and the potential role of African languages in this domain.

## V. ICT ACCESS AND USE

It is difficult to assess ownership of cell phones among low-income youth since there are varying concepts of what 'to own a cell phone' means [9]. This same situation applies to computer ownership when most of the students are from disadvantaged families and whereby most of them are still depending on their parents and guardians, and some came from rural houses with no water and electricity, and whereby mobile communication infrastructure and network reception is very poor. Thus, in measuring, the focus was diverted from individual ownership of computers/cell phones to individual access at home and school.

#### *A. Computers*

The findings indicated that only 31% of the respondents have access to a computer at home the rest 69% do not have access they only see and sometimes use computers at school. Over 70% of the respondents have less than 5 years experience with the computers leaving 24% with between 7-9 years experience and only 2% with over 11 years computer experience.

Only 44% of the respondents have basic knowledge about computers whereby 20% gained it from the Keyboard and Word Processing subject at school and 22% indicated to have attended a computer course at their primary schools, and the last 2% did not specify, whereas 66% of the respondents indicated they had not attended any computer course. These figures are consistent with self-assessed proficiency, whereby 45% of the respondents rated themselves as having basic computer skills, whereas 15% indicated to be very good with computers and the remaining 40% of the respondents' competency rated from being poor to very poor. None of the respondents had indicated to be excellent with the computers.

The respondents indicated to have used the computers for multiple tasks, whereby 50% have indicated to use it for school related activities such as research, typing etc, and the same percentages use it for connecting to social networks like Facebook, Twitter, etc. About 31% of the respondents have indicated to use the computer for playing games, download music and for journal keeping, alarms, and calculator.

Most of the respondents (about 19.8% at average) have never used the fully equipped computer laboratory at the school whereas those that have used it, (12.2% at average) have done it occasionally, more especially on monthly and weekly basis. Over 60% of the respondent have indicated to have used the computer lab for research and typing documents purposes, with the remaining percentages using it for playing computer games (10%), Social networks (16%) and other (9%) such as watching movies and videos on YouTube.

#### *B. Cell Phones*

A 97% majority of the respondents indicated they have access to a cell phone leaving only 3% without access. Most of the cell phone that the respondent have access to are the latest models and fancy phones which ranges from the smart HTC Hero and Samsung Corby TXT to NOKIA 3310. A



78% majority of the respondents indicated they have used the cell phone for less than two years, 19% for three to four years and only 3% with more than five years usage.

Over 69% of the respondents have cell phones with internet access or connection abilities. Students and other users, particularly in developing countries, are not always aware of or capable to use all the features of their cell phones. However, respondents in the present study seemed to be able to do more activities than those supported by their phones. The discrepancy between ownership and access might provide an explanation (i.e. students knew how to do some things the phones they *normally* had access to did not support). A greater percentage of students was able to access rather than post content using these applications. The distinction between access and production is important in terms of language use. Table 1 shows which features a student's phone had and what he or she could access/post.

TABLE 1: CELL PHONE FEATURES AVAILABILITY, PASSIVE AND ACTIVE USE

Cell phone Feature	Has	Can access	Can post to
YouTube	31	47	34
Twitter	41	41	44
Facebook	72	75	69
E-mail	52	59	41
Skype	19	22	22
IM	50	44	44

The respondents connected to the internet occasionally using a cell phone, with 25% connecting on daily basis, 28% on weekly basis, and 22% monthly basis. 19% of the respondents indicated not to have connected to internet in their lives with cell phones. The high percentages in the social network category as Facebook (63%) indicates that the respondents are hooked on to the internet whereas since the respondents are still school students Google and mailing services have also aroused their interest more especially for research purposes. Of all the 32 respondents, 13% indicated they posted something on social networks on daily basis, 56% occasionally, and 31% indicated to have never posted anything. Instant Messaging platforms such as MXit and others seems to have been unfamiliar with a large number of respondents (N=28). Only 3% of the respondents have used Google talk, 9% Yahoo Messenger, 22% MXit. Most of the respondents (about 69%) indicated they used Facebook as a chatting and messaging platform with their friends.

## VI. OSHIKWANYAMA AND ICT

The respondents were asked to give their views on the use of Oshikwanyama in the ICT domain i.e. computer and cell phones. Not surprisingly, Oshikwanyama was used extensively in voice communication via cell phone. 91% of the respondents indicated that they usually communicate in Oshikwanyama on their cell phones when talking to their parents, with a reduction to 63% when talking to their

friends. Only 19% of the respondents indicated they used Oshikwanyama on their cell phones when chatting to their school friends/colleagues and parents and in cases they happen to pick up the phone from an unknown or unregistered caller.

### A. Content and Interfaces

When asked if they post information in Oshikwanyama on an English website or web pages, 23% of the respondents indicated they do it in rare occasions, but only mostly on Facebook whereas 77% indicated they have never done it. Furthermore, more than 93% of the respondents indicated they had not searched for information in Oshikwanyama pointing out that they have never thought it could be available on the internet and some have indicated they have never thought of it.

When asked to mention the website that seem favorable to use Oshikwanyama and where Oshikwanyama is often used, Facebook and e-mail received preferences of 41% and 22% respectively. Meanwhile, 22% of the respondents feel that website would be an appropriate platform to use Oshikwanyama as long as it is specifically devoted to Oshikwanyama. Other social sites such as Netlog and Twitter have received minimal amount of votes since the respondents feel that they are not really used by them and most of their users are more interested on what is going on in the world of entertainment and new and not on developing educational matters.

E-mail was the most important, followed by social networks and instant messaging. 39% agreed that Wikipedia should be accessible in Oshikwanyama, Skype received the lowest percentages of the preference rate, it is indicative that some of the respondents do not normally use it and thus not sure of how it works.

### B. Use

Only 6% indicated that Oshikwanyama should be used more in the ICT domain as they feel that there are people out there who cannot understand English and have to communicate in Oshikwanyama at all times. 12% of the respondents felt that Oshikwanyama is never used at all because not all people have access to the language. However, 72% felt that Oshikwanyama need to be used more in the ICT domain. Cultural preservation was cited as the main reason. Respondents also felt that there is a need for providing an alternative to English in Namibia and this will help improve school grades and understanding of the subjects.

It was apparent that the research participants experienced mixed feelings concerning learning Oshikwanyama in an ICT domain. Numerous respondents were delighted because they think it will make life easier for the people who are not fluent in English to be involved in the ICT world. People whose language is Oshikwanyama will be able to access information faster and have a wider variety of information at their disposal. People would experience pride in their mother tongue or/and first language, as its use will uplift their own indigenous language. Respondents also believe that using Oshikwanyama ICT tools will give the language recognitions

and the respect it deserve and this will diversify the use of the language, allowing pupils to explore an advanced level of the language.

An 82% majority of the respondents identified potential benefits if Oshikwanyama was to be used in an ICT domain, and only 18% felt it would not be beneficial. Various respondents highlighted that the introduction of Oshikwanyama in an ICT domain will enable them to easily and efficiently do their Oshikwanyama related work with a greater understanding and motivation. They indicated that the level at which Oshikwanyama is used/learnt will be improved and that this could lead to increased language skills. Some respondents indicated that newly devices for language learning and studying techniques should be developed through ICT.

### C. Challenges

The findings indicated that although there is a will and interest among the respondents towards learning Oshikwanyama in an ICT domain, there are mixed feeling concerning the possibility of it happening. This led to an upwelling of several challenges. The respondents believed that Oshikwanyama is not used enough so increase knowledge in this area will not be relevant. This then diminishes the interest of students in using the language in an ICT domain. The respondents maintained that communicating in Oshikwanyama using ICT domain greatly limit the number of people they are able to have conversations with, as most of their acquaintances are non-Oshikwanyama speakers. The respondents indicated that it is not easy to find written information in Oshikwanyama (i.e., novels, poetry, articles etc.).

Oshikwanyama was perceived to have a limited vocabulary. As a result, ICT tools and manuals would be longer and make extensive use of English borrowings. The respondents remarked that most Oshikwanyama words are longer and they require a larger space, and it is not easily abbreviated. One commented that: "English is easier to write in short, e.g., hw r u, if you perhaps shorten something in Oshikwanyama, one will not know how to translate it and know what you mean exactly". In addition, the respondents also felt that the use of Oshikwanyama would cause complications and lead to confusion.

## VII. CONCLUSION AND FUTURE WORK

In this paper, we explored the access and use of ICT by Oshikwanyama-speaking students in Namibia, and their attitudes towards the use of their mother tongue in the ICT domain. In a developmental context, the two are deeply interrelated and need to be considered together. Our study showed that students in the sample were relatively proficient users of ICT. They appeared to be favorable to the use of Oshikwanyama in the ICT domain. Most importantly, students were able to articulate reasons in favor and against the use of their language in such an English-dominated domain. Promoting debate around language issues constitutes groundwork to the broader project of which this study is part. The project is concerned with the development of ICT tools in Oshikwanyama as a pedagogical tool. The

findings presented here show that students possess the necessary skills and sophistication around language issues to be involved in this challenge.

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## Development of a Mobile Scheduling System for Interactive iLabs

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**Abstract-** Makerere University has for the past seven years used internet-based laboratories or iLabs to support practical courses in the curricula of the undergraduate electrical, telecommunications and computer engineering programmes. The iLabs have provided a meaningful laboratory experience to students in the face of increasing numbers, insufficient lab equipment, space and lab personnel. One version of the iLabs, the interactive type, requires pre-scheduling so that a user is granted exclusive access to the experiment hardware, a procedure previously conducted online. The online scheduling is inconvenient since it requires a lot of time investment for the users before conducting the lab. The paper presents the work undertaken in development of a Short Message Service application to facilitate the scheduling process. Starting with an overview of iLabs and the requisite scheduling procedures, the rationale for development of the Short Message Service application for the interactive version of the iLabs is explained. A technical overview of the application is given, including the requirements specification, the system design and the implementation. Finally, a demonstration of the application, error handling mechanisms and benefits of utilizing the service are presented. The application has provided a convenient scheduling system for interactive iLabs, thereby improving the efficiency of access to the lab.

**Keywords-** SMS, interactive iLabs, iLab Scheduling

### I. INTRODUCTION

In Africa, Universities and other Institutions of Higher learning are challenged when it comes to provision of relevant practical and technical training because of inadequacies in equipment, space and personnel. The equipment, if available, is in most cases obsolete. To get around the impasse, Makerere University has adopted online teaching and learning methods. Thus, although hands-on laboratories have traditionally been argued to provide the best avenue for experimentation, Makerere University has greatly utilized internet laboratories, also known as iLabs. With iLabs, users are able to access, interact with and control equipment remotely over the internet (or intranet), with the support of the relevant hardware, suitable graphical user interfaces, protocols and software. All a user requires is a computer that can connect to host, which is connected to the laboratory hardware.

The idea of iLabs was developed at Massachusetts Institute of Technology (MIT) by Prof. Jesus del Alamo in 1998, and introduced to Makerere University in 2004. Since then, the

iLabs Project at Makerere University has developed several laboratories to support different fields in the curricula of the Department of Electrical and Computer Engineering [1],[2].

MIT initially developed a generic web service infrastructure, known as the iLabs Shared Architecture (ISA) to support access to a wide variety of online laboratories. The package offers generic services like user registration and authentication and laboratory administration that are independent of any particular experiment domain. The lab provider customizes the ISA to host particular laboratories through establishing connections to suitable hardware, development of user interfaces and other intermediate services requisite to deliver the laboratory experience remotely through web services.

The iLabs developed at Makerere University fall into two categories, the Batched and the Interactive iLabs. Batched experiments are those where the entire course of the experiment is specified way before the experiment begins whereas Interactive experiments are those where the user monitors and controls one or more aspects of the experiment during execution [3]. Although they provide a more enriching experience for users, interactive labs are more complex to administer.

Unlike Batched iLabs where user requests are queued and de-queued on a First In First Out (FIFO) basis, interactive labs require pre-scheduling. This therefore calls for a scheduling policy whereby a student schedules for a lab prior to conducting it. The available scheduling system hitherto utilized was an online one, under the control of the User Scheduling Service (USS). With the USS application, students are required to a specific time for executing the due experiment. Figure 1 shows the USS interface.

### II. RESEARCH CONTEXT

Although e-learning has become popular today, its effectiveness highly depends on the ease of access to resources deployed, especially in instances where time-sharing is inevitable. Mobile phones applications have become a popular tool worldwide in facilitating e-learning. Access to curricula material in form of video lectures, e-notes and lab resources can all be controlled with mobile phones [4]. In fact, some online laboratory technologies have a Short Message Service (SMS) service for user registration, scheduling of time slots and notification [5].

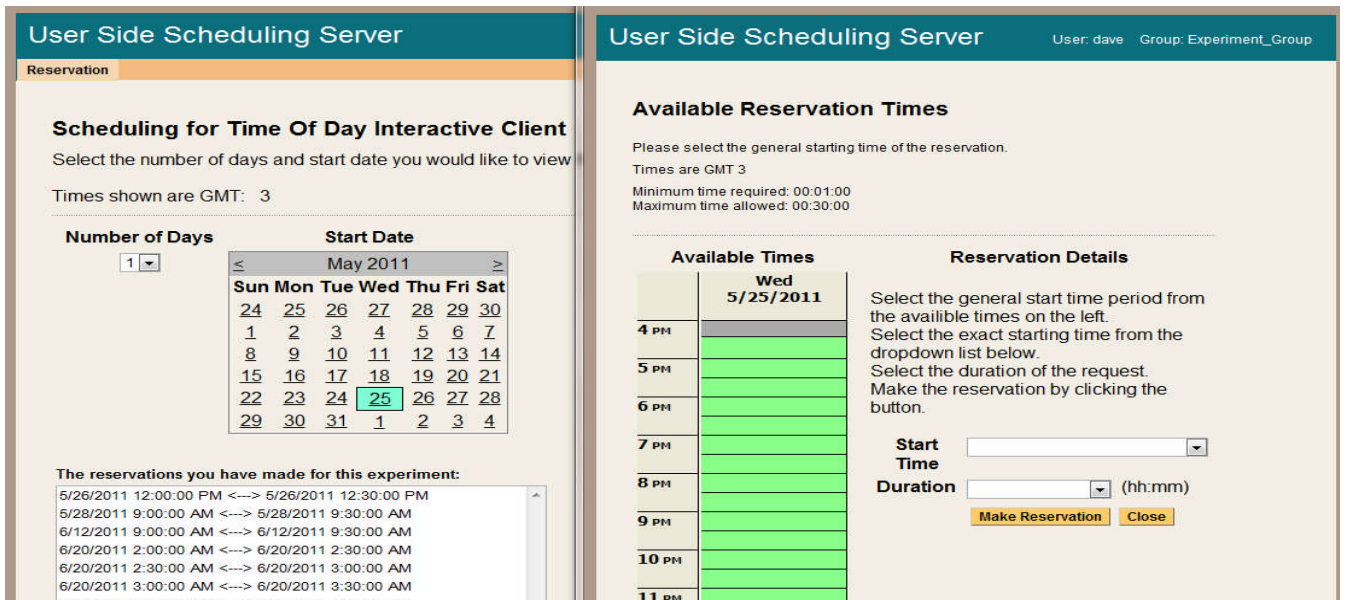


Figure 1. USS interface

The implementation strategies for the online laboratories differ and no single unified architecture exists, although various models have been suggested [6], [7]. Thus, integration of services like SMS support for scheduling or notification is also specific to the platform and technology used. Makerere University adopted the MIT ISA, which had no inherent support for SMS [8],[9].

The recent surge in student numbers at Makerere University has necessitated great efficiency in scheduling interactive laboratories. For this to be effected, students need to make timely reservations during the time when a particular laboratory is deployed. As mentioned before, this was only possible by way of online computers. It is known that the access mode to the lab has a huge bearing on the learning outcomes for students [10]. We conducted a survey, which revealed that 60% of students in the College of Engineering, Design, Art and Technology (CEDAT), who were targeted by iLabs do not own personal computers. Of the 40% who did, less than half had more than two hour access to the internet on a day to day basis. On the other hand, 99% of the students own mobile phones. Leveraging some of the popular applications on mobile phones for the purpose of scheduling laboratories would thus be a silver bullet, with SMS at the forefront. The idea for the application was henceforth born out of the need to provide a flexible platform for scheduling interactive laboratories, using Global System for Mobile Communications (GSM) enabled phones. This would in turn alleviate the inconveniences and inefficiencies that used to arise while utilizing the online scheduling system.

### III. SYTEM OVERVIEW

Generally, the development of mobile scheduling system involves an integration of services whose major objective is to ensure automated timed reservations and administration for the service provider to the clients. Services provided by the mobile scheduling system include; a mobile scheduling service for the clients, an administration panel for the service provider to set time blocks and view reservations made and ability for the

client to cancel an already made reservation. The design of the system followed the traditional cycle of requirements specification, system design and implementation.

The Requirements Specification handled three major concerns; the functional requirements, non-functional requirements and integration requirements with the ISA. Figure 2 shows the use case diagram for the application, detailing how a typical user interacts with the system.

Various architectures were designed to depict how the application was to be developed, deployed and function. The functional architecture design portrays system behaviour in the event of a user request. The information architecture developed shows the information distribution among the various entities of the application, right from the user to the core of the application.

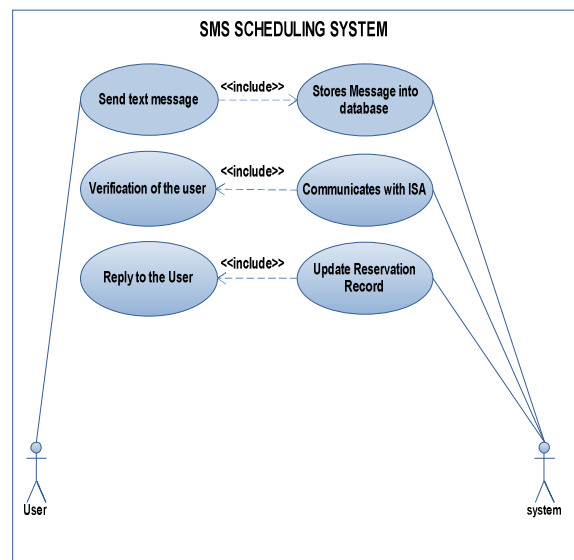


Figure 2. System use case analysis

The entities include; user (who is the actor), the SMS Gateway, the core application and the ISA, which contains the interactive iLab. Figure 3 shows a high level context diagram designed for the application, describing how it is meant to work with the ISA. The standard protocol for the application and the error handling procedures were also set up. These described the standard message to be sent by a typical user and the errors

involved if the standard message was not followed. The standard message expected by the system is in the format:

“iLab Username Lab\_Acronym Date\_of\_Schedule Start\_Time\_Range End\_Time\_Range”. Table 1 shows the functions of each of the elements required in the scheduling process.

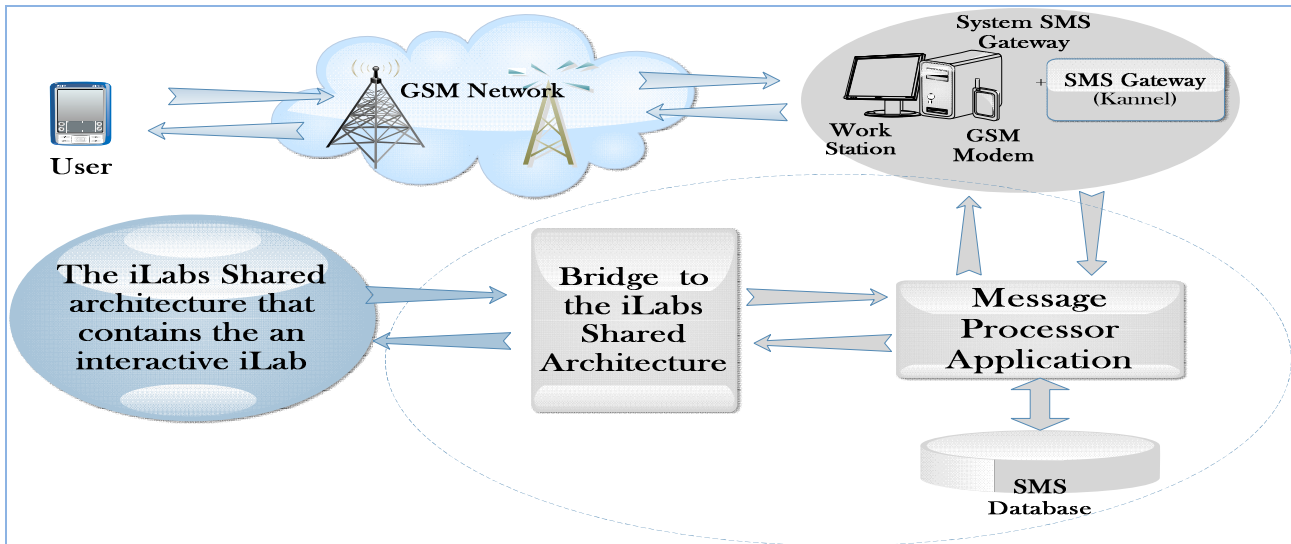


Figure 3. System context diagram

TABLE 1. MESSAGE PARAMETERS

Element value	Description and Function	Format
<b>iLab</b>	The default keyword that users make to identify the message for iLabs server application	Must be 'ilab' or 'ilabs'
<b>Username</b>	The username of the student as used by the student while registering with the iLabs Service Broker. Used to attach the scheduling session made with the username	Should be similar to the username used for registering the user, should have no spaces in between
<b>Labname</b>	The name of the lab the user is requesting to schedule and experiment for.	Should have no spaces in between, should be similar to the name specified by the administrator
<b>Date</b>	The date that the user wishes to do the lab Specifies the date when the user wants to do the lab	The date should not have passed, should be of the format "DD/MM/YYYY where DD is date MM is Month and YYYY is year, the day, month and year should be separated by either '/', or '-', or '.', and should not contain any spaces
<b>StartTimeRange</b>	(Start Time Range) the time for the range within which the student would like the lab to be scheduled.	The Start Time given should not have passed, it should not be after the End time Range provided, it should be of the format "HH:MM" where the HH is the hour and MM is the minute, the hour and the minutes should be separated by either ':' or ';', and it should not have any spaces in between.
<b>EndTimeRange</b>	(End Time Range) this is an optional element that defines the user sets to give the end of the time range within which the lab can be scheduled.	The End Time given should not have passed, it should not be before the End time Range provided, it should be of the format "HH:MM" where the HH is the hour and MM is the minute, the hour and the minutes should be separated by either ':' or ';'; it should not have any spaces in between.

The development Architecture describes the environment used for developing the SMS Scheduling application. Since the ISA was developed with the .NET framework and with SQL Enterprise Manager 2005, the SMS application had to be built with the same technologies to ensure compatibility. Kannel, an open source Linux based gateway was used for the system [11].

The deployment architecture describes how the application should be setup for use on a given system. The deployment of this system is implemented with two work Stations, which communicate via http Get and Post methods: a Linux based server that holds the SMS gateway, and the Windows Server, which hosts the ISA and the SMS Scheduling System. The deployment also involved the installation of the database files of the application and the configuration of the application before running the application. The iLab administrator is required to setup a virtual directory through the Internet Information Service (IIS) default web site. This deploys various web sites for setting up the Lab and the Web Service, which holds the SMS reservation application. The administrator then registers the SMS Reservation Application with the iLabs Service Broker and address the Lab to be scheduled, and the other credentials that users apply while scheduling into the application.

With the different architectures in place, the requisite code modules for the system were developed, and debugged individually and wholesomely to eliminate syntax and runtime errors. System tests were carried out to ensure proper functionality and stability.

#### IV. DEMONSTRATION OF THE SYSTEM

Consider a student, Dave, who would like to carry out an experiment on the 26th of May 2011 sometime between 12:00 to 14:00. He initiates the session by sending an SMS message to the iLabs System. The iLabs System has been setup with a modem, which contains a SIM card and SMS gateway (Kannel) to receive and send SMS messages although a Short Code could be used. The user has to follow the protocol or a particular format that has been described in the previous section. The test results for the message that Dave sends are illustrated in Figure 4. According to the message, the student Dave has requested to do a lab called “tod” between 12:00pm and 2:00pm on the 26th of May 2010.

Almost instantaneously, the system sends feedback to Dave, indicating the reservation status. If the reservation is made, the reply contains the user name, the detailed date and time scheduled for the user. The system reply is shown in Figure 5. In this case, his desire was fulfilled and a request was made between 12:00 and 12:30 on the 26th of May 2011.

To prove that the scheduling was made successfully, the online scheduling system should depict that the time slot for the schedule made via SMS, is taken up. The online Scheduling system lists the available time slots for the user and also identifies available time slots via a pop up window as illustrated

in Figure 6. The green sections show the free time slots while the red sections show the time slot which has already been booked by the user, through the SMS system.

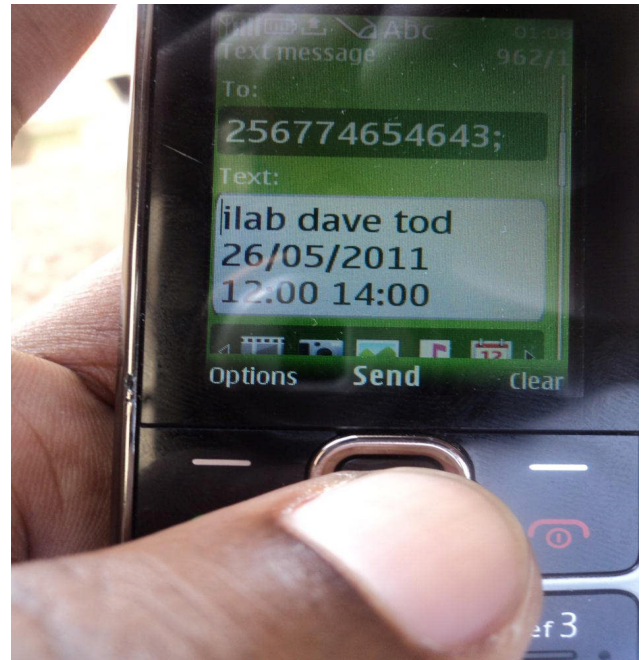


Figure 4. User sends a scheduling request

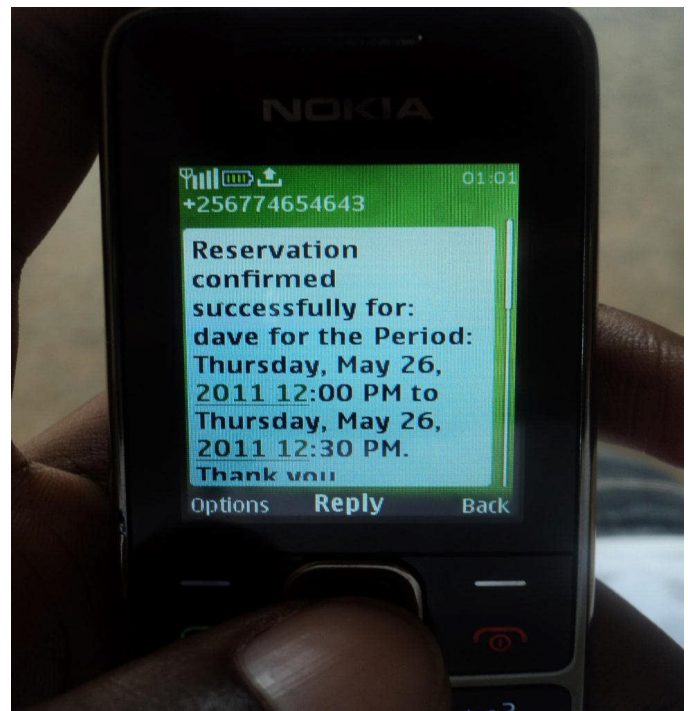


Figure 5. Reservation confirmation

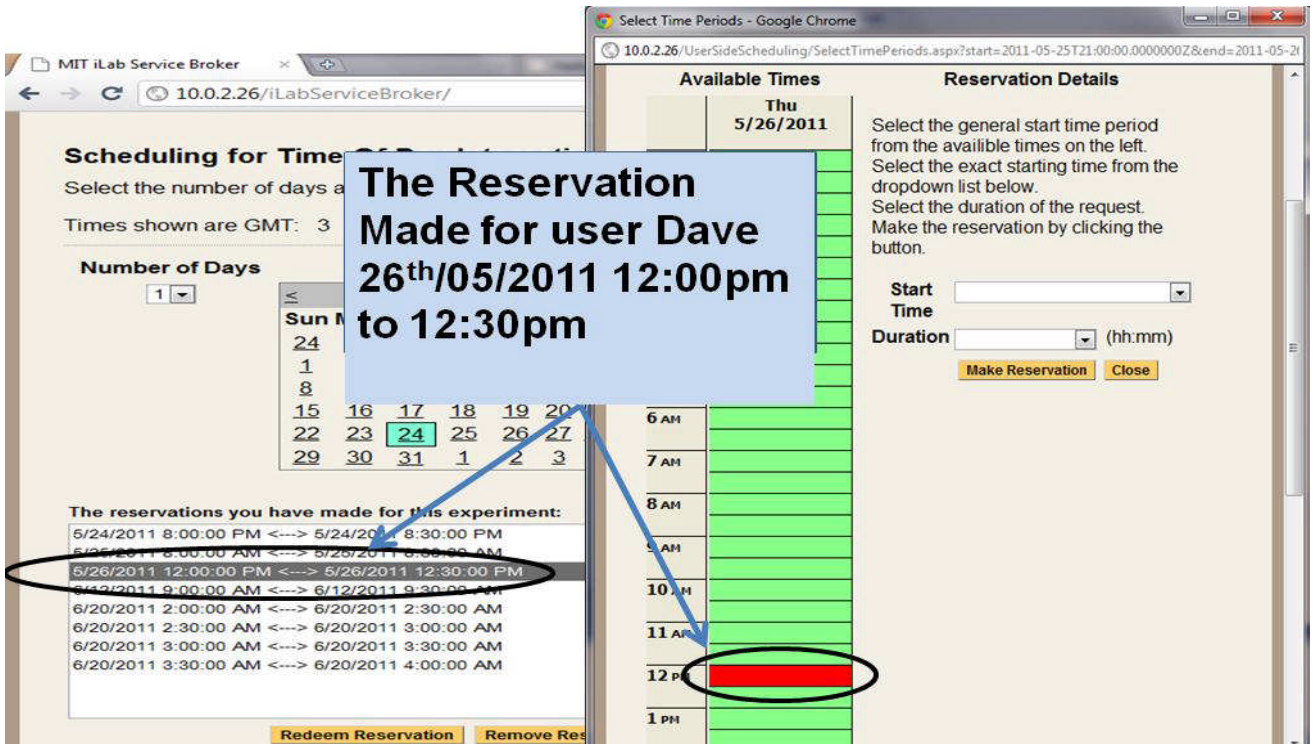


Figure 6. Online system reserves the time booked

### V. ERROR HANDLING

Systems are made close to perfection. But this is not the case with the people using them. At times, users tend not to follow instructions while using the system and definitely our case is not any different. In order to deal with errors and wrongly formatted messages, the system was tailored to identify these errors and reply accordingly. Consider a scenario where Dave, at one point attempts to schedule for an interactive iLab by use of SMS, but unfortunately, he types his username twice. This brings a reply that points out why the schedule could not be made and gives advice on how to overcome the error as illustrated in Figures 7 and 8.

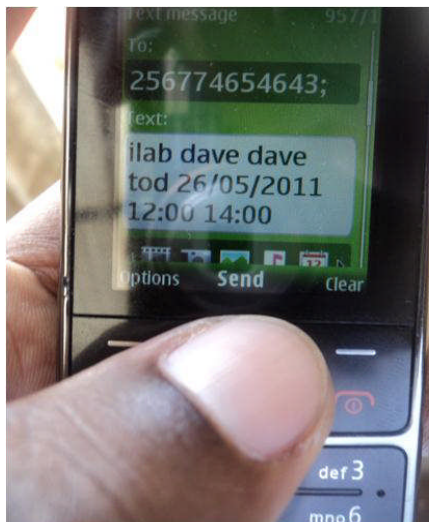


Figure 7. Wrongly formatted message



Figure 8. System response to a wrongly formatted message

### VI. RESEARCH CONTRIBUTION AND CONCLUSION

The development of the SMS Scheduling project is coupled with various benefits, not only to the students who use the ISA for carrying out interactive labs, but also lecturers and administrators overseeing iLabs, the iLabs Society and the entire academia fraternity.



The students are the main beneficiaries of this research as they have convenience in carrying out interactive labs. Students who find it difficult to access computers will have their problem half-solved as they won't have to move up and down while trying to make reservations for the lab. Also, the time taken in making reservation by SMS is way too short compared to that of the online system. The time wasted in log-in and authentication is saved. This application brings in more flexibility in not only scheduling for the iLabs, but also in using the iLabs Shared Architecture to carry out interactive online laboratories as a whole. The student will find it much easier to make a request to do an iLab by sending a message, which is more familiar to them, and much more accessible than internet hotspot services.

Over the years, administrators at iLabs@MAK have encountered endless problems of students failing to meet deadlines for laboratory work. The application will help students to meet their deadlines more effectively since it cuts short the time spent in scheduling for a laboratory. iLabs@MAK and the iLabs society at large will for the first time be enriched with the availability of mobile applications. Therefore, this application has open doors for the optimization of internet laboratories using mobile applications. Needless to say, the SMS Scheduling System for interactive laboratories has added functionality to the iLabs Shared Architecture, and has the potential to support access to interactive iLabs worldwide to tens of thousands of users.

The concepts presented in this paper, along with the system requirements and expectations are also currently being used to develop similar and more comprehensive applications for other service providers, such as hospitals, clinics, restaurants and travel agencies in Uganda.

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## PLAIME: Multimedia Platform for the Integration of Handicapped Children in Music Education

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**Abstract**—This paper focuses on the use of multimedia technology to augment instruction for a special population. In Spain, the main musical instrument used in music classes is the recorder. However, the integration of children with disabilities in music classes that strictly follow a traditional learning system can be very difficult or even intractable, resulting in a negative effect on students. Information technologies represent a valuable means to overcome this potentially negative situation. In this work, we present the PLatform for the Integration of handicapped children in Music Education (PLAIME), a multimedia tool to assist children in learning music, disregarding having some disability that inhibits handling the recorder. This tool is not intended to replace the teacher but to serve as a complementary learning mechanism, integrating e-learning with traditional learning. PLAIME includes theoretical lessons, customized activities, and collaborative games using peer-to-peer technology. Initial results show a positive acceptance by children.

**Keywords**—media in education; computer-assisted instruction; handicapped children; interactive learning environments; music learning tool.

### I. INTRODUCTION

The Information Age is imposing new challenges in current education systems. In Spain, one of the compulsory areas for primary education is Artistic Education that includes Music and Plastic. The curricula for primary education include two significant goals. The first goal is to use Information and Communication Technologies (ICT). ICT functions as a facilitator of active learning and higher-order thinking and also serves as a tool for curriculum differentiation, adapting the learning content and tasks to the needs and capabilities of each individual pupil [1]. Moreover, the significance of cooperation and interaction in the classroom environment in order to promote the acquisition of learning skills and social relations has been demonstrated in previous works [2], and [3] has shown the positive impact of software games on pupils' logical and strategic reasoning skills. The second goal is to be able to communicate through oral, corporal, visual, and musical means, developing the capacity of enjoying artistic expressions. The combination of these two goals results in an interesting music learning approach, e.g., Chan *et al.* [4] identified that ICT enabled pupils to approach music-based

activities with greater confidence, a deeper level of understanding, and appreciation. Moreover, music has gained recognition through the years, and is playing a key role in the field of learning disabilities, providing a better quality of life to this group [5].

Although the current offer of software tools for music learning is varied, there is still a gap on the use of ICT in music teaching. With our proposal, we propose to address a current problem in Spanish primary schools: how to approach to a handicapped student during music classes? Through the collaboration between music teachers and university researchers in the telecommunications field, we present PLAIME (PLatform for the Integration of handicapped children in Music Education), a useful multimedia tool for both teachers and pupils in primary music education. With PLAIME, a handicapped student can learn at the same pace as other pupils using the software tool instead of playing the recorder. Thus, PLAIME assists children to learn the primary education music curriculum whatever their physical condition is, creates a common ground for music learning promoting social inclusion, and fills the gap between ICT and music teaching.

The rest of the paper is organized as follows. Section II reviews other similar tools for music education with children. In Section 3, we identify the goals of our platform and describe its functionalities. A first insight on children's attitude towards the platform is included in Section IV. The paper ends summarizing the most important facts.

### II. RELATED WORK

Networked DrumSteps is a free tool for meaningful, collaborative, interaction in a constructionist music composition environment. It allows multiple users in different locations to collaborate in the process of music composition, but without the use of standard notation. Students that were tested confirmed that music composition in groups was much more fun and different than working alone, hence proving the advantages of collaborative software for music learning. Gall *et al.* [7] evaluated the impact of eJay in the development of composition skills in children aged 10–11 using Dance eJay. This music software provides the user with a variety of short musical samples that students can organize to create their own piece of music. After their study, authors argued that the use of eJay in the classroom led to a collaborative work among students that

increased their music creativity. In a similar way, the commercial software Teach me Piano Deluxe (TPD) teaches basic practical keyboard skills in music, focusing on rhythm, staff notation, and fingering. After being studied, authors concluded that TPD had clear effects on high school students, enhancing their rhythm, note-reading, and pitch.

The i-Maestro project [8] is intended to develop interactive multimedia environments for technology enhanced music education. The main technical objectives of the project include: basic research and development on new solutions and enabling technologies to support traditional pedagogical paradigms for music training, novel pedagogical paradigms, and a framework for technology-enhanced music educational models and tools to support the creation of flexible and customized e-learning courses to improve accessibility to the musical knowledge. Compared with our proposal, i-Maestro is a more ambitious project tackling much deeper music knowledge, excellent for arts schools, but maybe less indicated as a supportive application for a primary school curriculum. As a minor observation, it has been thought for string instruments, whereas in this proposal we work with a wind instrument due to its popularity in Spanish primary education. Finally, Lenmus [9] is a free open source program to practice music reading skills, to improve aural recognition abilities, and to acquire theoretical music knowledge. It also includes a score editor. Above all, it focuses on recognition of intervals, chords, scales, and tonality. It is based on the use of music books written in XML that teachers have to create using the DocBook XML format. In our opinion, Lenmus is not children-oriented, and would be recommended for music knowledge much deeper than the requirements of a primary education music curriculum. Moreover, the use of XML syntax is not straightforward, requiring an extra effort from the teacher's point of view. Table I summarizes PLAIME's features compared to these tools from the related literature. The comparison has been completed based on the corresponding works mentioned above. Observe that, up to the knowledge of the authors, none of these works makes any reference to disabled pupils.

### III. PLAIME

PLAIME is a complementary method for music learning in primary education, promoting social inclusion of

handicapped children in a music learning environment. With the proposed multimedia platform, children with disabilities will be able to emulate music practice at the same pace of other pupils. Although they will not play the instrument physically, they will become more knowledgeable in music basics and will be part of the same educational environment. Designed for children, PLAIME includes basic concepts about the recorder and assists in acquiring competences such as basic scores and notes identification. Following guidelines from the teachers and from the primary education Spanish curriculum, PLAIME provides a gradual acquisition of music knowledge.

Bearing this in mind, the specific challenges of the platform can be described as follows. This tool has to be useful in order to help in the understanding of music in primary education, thus being necessary to attend the music teacher demands to achieve a real useful tool, and to avoid teachers' negative beliefs about the benefits of ICT on primary education [10]. The platform has to be interactive and versatile through the combination of theory, exercises, and games. Outstanding over other platforms, activities and games in PLAIME address student differentiation issues. Particularly, games and exercises of our platform can be used not only in the classroom but also in extracurricular activities or at home. The graphical interface has to be simple, attractive, and intuitive for teachers, parents, and children, carefully taking into account design requirements for handicapped children. Previous works [11] have verified the relationship among button size and number of buttons in a touch screen and the effectiveness of the assistive communication device interface. We follow these recommendations. Observe that a normal screen could be also employed. Last, Java is the selected high-level object-oriented programming language. With platform independence, PLAIME can be run in any software or hardware platform. We have followed the Factory and Singleton programming patterns, which allow an easier error recovery and memory saving, particularly interesting when using a graphical interface. In addition, the system has been designed to take advantage of polymorphism to reduce processing load.

The platform starts with a launch screen, a user selection screen, a character screen, and a main menu screen (see Fig. 1). Regarding the pedagogical agents (character), we decided

TABLE I. COMPARING PLAIME WITH OTHER AVAILABLE MUSIC LEARNING TOOLS (L=LOW;M=MEDIUM;H=HIGH)

	<b>i-Maestro</b>	<b>Networked DrumSteps</b>	<b>eJay</b>	<b>TPD</b>	<b>Lenmus</b>	<b>PLAIME</b>
Audience	All ages	All ages	All ages	All ages	All ages	All ages
Instruments	String	Drums	Several	Piano	Several	Recorder
Music knowledge	H	L	M	H	M	L
Lessons	Yes	No	No	Yes	Yes	Yes
Practice	Yes	No	No	Yes	Yes	Yes
Games	Yes	Yes	No	No	No	Yes
Composition	No	Yes	Yes	Yes	Yes	No
Collaborative	Yes	Yes	Yes	No	No	Yes
Contents' flexibility	H	L	L	L	M	H
Teacher's required ICT knowledge	M	L	L	L	H	L
Children-oriented graphical interface	No	Yes	Yes	Yes	No	Yes
Adaptability to primary schools' curriculum	L	M	M	M	L	H

to incorporate an unrealistic character integrated with the whole application design as an onscreen trainer, which makes students to learn better [12]. The character is active only for the explanations (lectures), not participating in games or in activities. This is the best approach to not distract the learners attention, i.e., to not interfere negatively on the learning process, but at the same time fostering learning [13]. The characters included in PLAIME are simple, 2D, as preferred by children [14]. On the other hand, for the designs used to show the positions of fingers over the recorder, we use a more realistic approach, since they try to “reflect” the student’s hands.

Lectures have been developed following an example of Spanish music curriculum for primary education. Accordingly, PLAIME comprises seven theoretical lessons. The structure of a lesson includes an explanation (whose content can be read by the character), examples, and practice (see Fig. 2). Contents include: recorder history, recorder structure, basic techniques regarding tongue and finger position and breathing, practicing how to play the recorder, and reading and writing scores. In a traditional classroom environment, the teacher explains and then the pupils play (physically) the recorder. From the disabled pupil’s perspective, the practice section of each lecture provided in PLAIME allows him to perform virtually with the advantage of being in the classroom with the other students. Being with their peers has social benefits for children with disabilities. Moreover, children with peer interaction skills are more likely to be accepted by their peers, and are less likely to experience the negative effects of social rejection [15].

With PLAIME, students can load activities created by their teacher or even by their parents using a built-in activities content manager. Students can complete these activities at the school or a home, benefiting from parental participation in their education. An activity can include as many exercises as necessary, and exercises belong to eight different types: test, questions, score to note, note to score, recorder to note, note to recorder, score to recorder, and recorder to score. Tests and questions are the traditional exercises to evaluate theoretical knowledge. The work with notes is divided into six different exercises that increase in complexity, from the simplest “score to note” to the toughest “score to recorder” (see Fig. 2). The platform is designed so that solved exercises can be saved in the computer, printed, or sent by email to the teacher. Handing in the answers in any of the available methods (e.g., email) is the way to get personal feedback from the teacher, and to obtain an explanation on why the exercise is right or wrong. Observe that feedback is often the weakest link in educational software, often offering nothing more than an indication of whether an answer is right or wrong [16]. The activities content manager is an additional built-in program that allows the teacher or the parents to create a new activity or to open an existing activity for edition.

Games have been included in PLAIME because they can be effective teaching and learning tools and the incorporation of multimedia stimuli and games is a motivational factor for children, enticing them to use the software [16]. Moreover, by using these games, pupils (handicapped or not) play with



Figure 1. Character screen.



Figure 2. Example of explanation and practice.

their peers in the classroom (or at home) favoring the creation of an inclusion environment, which will have a positive effect on their social and educational behavior [15]. PLAIME contains six games, each one designed to develop a specific music skill, such as writing and reading scores or performing a score with the recorder (see Fig. 3). It is also possible to play with two players in the same local area network using Peer-to-Peer (P2P) technology. All games provide feedback on the learner’s performance, thus he progresses at his own pace.

#### IV. INITIAL EVALUATION APPROACH

A first experience on children acceptance of this tool was carried out in the Information Society fair for citizens, which takes place annually in the Autonomous Community of Murcia (Spain). During two days, we presented our platform in one of the stands and let children use it. More than 20 children between 6 and 11 years old accompanied by their

parents showed spontaneous interest in PLAIME and decided to use it (see Table II). More than 90% of these children found it fun and useful, spending in average 14 minutes using it. Their parents also found the platform as very useful. Nevertheless, only 75% rated it as easy to use mainly because of the use of the activities content manager. This is only an initial observation, and a deeper study is needed to collect teachers' experience and measuring the effect on children's music and social attitudes.

V. CONCLUSION

PLAIME is a multimedia platform designed to promote the integration of children with special educational needs in music classes. With this software tool, we create a common ground for music learning that allows differentiation requirements, but at the same time is compatible with a traditional music curriculum approach. The platform is highly flexible, allowing the teachers to customize contents and exercises, so that all students can learn at their own pace. PLAIME provides several games to be played by one or two players becoming a collaborative environment that benefits social inclusion. Special needs of handicapped children within music classes are not covered by other known applications because they are not designed as supporting tools for the primary education curriculum. From the initial evaluation, PLAIME is a competitive multimedia platform whose content's flexibility and design make it a potent tool to integrate traditional learning with innovative learning.



Figure 3. Example of games.

TABLE II. RESULTS OBTAINED IN A PRELIMINARY SURVEY (X=MEAN; S=STANDARD DEVIATION; (1)=CHILDREN; (2)=PARENTS)

	Children		Parents	
	mean	std_dev	mean	std_dev
Age (years) (1)	8,25	1,79	--	--
Spent time using PLAIME (min.) (1)	13,9	4,72	--	--
Useful (yes/no) (1) (2)	90%	--	100%	--
Fun (yes/no) (1)	95%	--	--	--
Easy to use (yes/no) (1) (2)	90%	--	75%	--

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# From Lecturing to Apprenticeship

## Introducing play in museum learning practice

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**Abstract**— Analysis of museum learning practice, and related work, have revealed that communication of historical processes resembles school teaching, eventually hindering children's participation in museum learning activities. Starting from this issue, a new playful installation is being designed, actively involving a group of primary school children. Results from this process suggest that museum learning practice could be enriched, by moving toward a more non-formal learning approach, in which children and adults could engage in shared problem solving activities. Play is envisioned as an effective framework to support shared problem solving, also allowing for a symmetric dialogue to emerge between children and adults.

**Keywords**-non-formal learning; historical process; apprenticeship; object-mediated interaction.

### I. INTRODUCTION

Museums are currently facing a challenging innovation process, including re-shaping of, for example, their way of communicating historical and cultural knowledge to visitors. Many researchers have dealt with this challenge from different angles, from an institutional perspective [15] or from the visitors' perspective, either looking at what they do [6] or proposing new design solutions to enhance museum learning practices [14]. Despite these many contributions, these re-shaping processes are short off a clear direction toward innovation [15]. This situation has implications for museum learning practices, which still keeps a traditional and formal approach.

Conducting a Participatory Design (PD) study with a group of 25 Danish children around 10 years old, aimed at designing a playful installation to enhance museum-learning practice, a main issue was identified in the communication of historical processes. According to our study, museum practitioners consider guided activities as the most valuable learning method. Hence they tend to communicate historical processes through lectures, primarily in the form of one-way communication, based on chronological sequences of events, with the consequence of neglecting their actual complexity and embedded meaning.

Moreover, observations of primary school children attending a guided tour suggest that they perceive museum experience as another class to attend, in which the guide acts

like a lecturing teacher as they walk through the exhibition space. As a result, the guided tour mainly elicits a form of static interaction mode, similar to traditional school lectures, in which children are supposed to listen quietly and raise their hands whenever adults ask them questions.

Therefore, starting from the data collected through the PD process, it is being suggested that museum learning practice could be enriched by introducing playful and shared problem solving activities, in which children could participate more actively in a form of apprenticeship [25]. Learning experiences concern active participation in activities, leading to knowledge and skills [25, 21]. In this way, the intention is to initiate and enhance a dynamic communication, in order to foster a symmetric dialogue between children and adults during guided museum tours. This, in turn, is supposed to allow for a more effective communication, including a richer understanding of the actual meaning of historical processes.

In the next section related work is presented, then, in section 3 research methods and an analysis of museum learning practice are discussed, focusing on the communication of historical processes. In section 4 the design outcome and implications for museum learning practice are presented, finally in section 5 conclusions and future works are discussed.

### II. RELATED WORK

Different studies have been published in the past 20 years, about the use of interactive technologies in museums. The first solutions to be proposed were “kiosk-based computer exhibits” [14] showing audio and video material. Nowadays, more interactive interfaces have been created, promising a more engaging museum experience.

An interesting approach is represented by interactive environments, in which technology is hidden. Hence the visitors can simply interact with the exhibitions space and the objects available, focusing on the interaction itself, its output, and the exhibition content. The Kyla installation follows this approach. Designed to enhance visitors' experience of an exhibition about archaic culture from Karelia, Finland, the installation is a dark exhibition space, where the visitors can look at old paintings, while walking through the space with a candle. Sensors are hidden close to the paintings, so that whenever the visitors approach a painting with the candle, an old Karelian music is played

[12]. Observations show that the installation elicits interest and emotional responses among the visitors. A similar setting is proposed by Hall and Bannon, exploring how ubiquitous computing could enhance children's experience of museums [8]. The setting has been tested in the Hunt Museum in Limerick, Ireland, dedicated to the memory of archaeologist John Hunt, who donated his collection to the people of Limerick. The exhibition is conceived as an RFID-based interactive space, in which children can interact with copies of the collection objects. For instance, they can leave their feedback about the exhibition, by talking to a phone and listen to others' activating a radio [8].

Multi-touch tabletop interfaces for museums seem to have a similar approach, in providing an interactive setting with a valuable affordance for social/playful interaction among the visitors [11], hiding the technology and enhancing content. These kinds of interfaces are often represented by interactive navigation systems, allowing visitors to access information in a different way, compared to traditional brochures or audio-guides. For example, "Tree Life Table" displayed at the Museum of Natural History in Berlin and "Kurio", where the first installation is a multi-touch interactive surface, allowing visitors to search for information navigating through popping up bubbles, containing questions about different species. Ethnographic observations, conducted in the museum, reveal that people might engage in playful interaction, experimenting with what they could do with their hands, e.g. tapping with more than one finger at the same time, or caressing the surface with a flat hand [11]. Kurio [20] proposes a similar approach, but introducing play more explicitly, in the forms of shared problem solving, to enhance families' museum experience. Kurio is a hybrid system including tangibles, a PDA, and a tabletop display. The visitors are invited to play the role of time travelers, stranded in the present time, who have to collect information about their current time, in order to go back to their own time.

Exploration of the domain of interactive technologies for museums is wide. These cases have been selected as they attempt to introduce playful interactions, to enhance learning in museums. Similarly, this study explores the possibility to use role-play and cooperation, as a way to acquire knowledge and experiencing historical dynamics.

### III. MUSEUM LEARNING PRACTICE

#### A. Methods

This study is based on ethno-methodologies, such as participant observations, situated interviews, and participatory design (PD). Each session of field study and design process has been documented through video recordings and/or pictures, when possible, and field notes, to be available for qualitative analysis [26].

The project is conducted in cooperation with the Viking Museum in Ribe, in South-West Jutland (Denmark). This museum has been chosen because of its interest in communicating the story of the local community and its development. This form of complex historical processes is the focus of our study. The Viking Museum in Ribe is placed

in the oldest town in Denmark, Ribe, which was originally a seasonal market place. In 700 King Godfred turned the market place into a permanent settlement, dividing the land into smaller lots, which could be rented or sold to merchants and craftsmen. Hence, Harald Bluetooth, in 900, developed Ribe into a town, mostly by having fortifications placed around the settlement it [7].

The story of Ribe represents a typical case of urban development, unfolded through an intertwining of sociomaterial practices, such as: production of goods, technical and economic innovation, and political decisions. The political aspect was expressed through manipulation of the territory, mainly in the form of infrastructures placement and maintenance, as discussed by Akrich [1].



Illustration 1: Free visit in Ribe.

A field study has been conducted, so to reconstruct museum experience from the perspective of all the "users" involved. Hence museum practitioners were interviewed and a group of 25 children around 10 years old were involved in a PD process, to gain an understanding of their values and dilemmas about museum learning practice. This particular target group was selected as they have already started to learn about history in school, they have probably visited several museums, and they are able to provide well-formulated accounts about their previous experiences.

The PD process was held at an after-school institution in Denmark, which became a *design collaboratorium* [5]: a space for co-design activities, where the prototypes could be stored for future investigations. In the beginning the children were interviewed about their previous experience of museums, supported by a few tasks. For instance, the children should write on a sheet of paper the museum they last visited and an adjective to describe how this visit was. Afterward their comments were shared in a joint conversation. Later the children were asked to comment upon pictures showing objects displayed in Ribe Museum. In the following session the children were invited to freely visit the museum, which offered opportunity to observe how they engaged, verbally and non-verbally, with the exhibition space (Ill.1). Finally the children were invited to co-design a game about the Viking Age and were provided with design materials: Lego bricks, modeling clay, colored pencils and

papers (III.2). All the participants in the co-design session engaged in a material brain storming, where ideas for the game were expressed through the creation of game pieces, which were tested and played with. Hence several artifacts were produced and, furthermore, a cardboard prototype was created and tested twice. Currently, a working prototype is under development to be tested in situ, at Ribe Museum (Table 1).

Table 1. Process Diagram.



Illustration 2: A participatory session.

### B. Learning Practice and the Diachronic Perspective

Exhibitions have always been the main communication mode between museums and their public. Besides, publications, guided tours and other activities are offered to young visitors, so as to support them in gaining knowledge about the exhibition in question. The objects displayed, and the way they are being displayed, play a central role in museum learning practice, as this creates conditions for the ways learning, as well as social interaction, might emerge. The exhibition and the displayed objects constitute resources for communication enacting different functions:

- ideational (enacting “what goes on in the world”);

- interpersonal (enacting relations between the visitors and between the visitors and the exhibition); and,
- textual (enacting the combined whole – the exhibition) [9].

Museum tours, guided or not, are a form of object-mediated interaction [10]. The exhibition is created to convey knowledge from the museum to the visitors, and for visitors to communicate with each other, verbally and non-verbally, through the exhibition space and the objects displayed [17].

Furthermore, despite that many tangible or interactive exhibition settings are being proposed by museums and researchers, a gap has been identified in relation to communication of history from a diachronic perspective, which deals with historical processes through time. It seems that such settings aim specifically, at providing an immersive experience, about how it might feel to be in a specific point in time, from a synchronic perspective. Somehow they represent an attempt to shorten the time distance between the past and the present. Interviews with museum practitioners reveal that tangible representations of the diachronic perspective are seen as an interesting possibility, but also as difficult to achieve. Instead, lecturing and story telling are seen as the most suitable communication mode, because of their sequential nature.

Generally, the only tangible representation of a diachronic perspective is the exhibition configuration, which starts with the oldest findings and ends with the most recent. Hence the museum tour acquires the shape of a walk through time. This is to say that complex historical processes, such as urban development, socio-cultural change, or technological innovation, most often are conveyed through lectures and written publications or, more briefly, through explicative signs. Our study suggests that this approach may have implications for learning and social interaction conditions, in the museum context. In this way, the real complexity of historical processes is hidden. By historical processes it is intended socio-material interaction among a group of people, within and through the natural environment and its affordances, as it emerges from historical [7] and anthropological studies [1, 13]. These processes embody sociopolitical thinking and have strong impact on emerging communities, so that they become part of their identity. Similar cases are discussed by Ingold [13], who specifically studies how humans relate to their environment, and Akrich [1], who discusses how infrastructures placement might embody complex political agendas, such as developing rural areas. The story of Ribe provides an interesting case of such dynamics, as urban development took place through socio-material actions, such as land partition into lots, development of the market place, and construction of defensive walls.

A tacit awareness about this kind of dynamics would be beneficial for young visitors’ understanding of history, as well as for their social and cultural identity formation. Therefore, it was decided that the design outcome, from the present study, should aim at supporting learning of urban development, through playful and tangible interaction.



## IV. MICRO-CULTURE

## C. Social interaction in museums: guided versus free tours

Observations conducted during our field study and related work, show that emergent interaction among children and adults in museum, may assume different forms.

According to our data, during free tours some children explore the exhibition space divided into small groups, looking and commenting what they see. They may also be quite active physically, while others prefer a quiet walk by themselves. Furthermore, studies conducted on families visiting museums, suggest that many children have already learnt a lot by themselves about a specific topic, before coming to the museum. These children tend to comment the exhibition with their parents, showing off what they know, often criticizing the written explanations provided by the museum as incomplete or even wrong [6].

Instead our field work reveals that guides see their job as telling a “nice” story, that could be informative but also engaging for the children. They also would like to actively involve the children in the story telling process. The guides have developed a few strategies for that purpose, such as: to compare past and present, or to ask the children questions about the displayed objects to keep their attention alive, or even they try to “look at what they are looking at”, so to dynamically shape the story according to the children’s interest [17]. However, it is hard to understand if these strategies are as effective as desired, only a few children in fact seem to respond as expected. Most of them remain silent, wondering around the exhibition in small groups. This may happen because guides are perceived as authorities giving a lecture, and not as more equal facilitators.

Considering the analyzed dynamics, it seems as guided tours facilitate a static form of interaction, while free visits seem to afford a more playful exploratory interaction style, allowing for individual needs to be expressed, such as: chat with friends or enjoy a bit of calm. However, guides’ notion of story telling seems worth to pursue. It may also benefit from introducing play and/or playfulness, which could provide a safe and relaxed atmosphere, for children and adults to communicate as peers. Therefore, we propose to enhance children's museum experience, by introducing forms of tangible play, as a communication mode: so to provide a playful-material grounding to understand the complexity of historical processes and to provide an informal environment, facilitating the emergence of a symmetric dialogue between adults and children [22].

The scenario proposed in this study, is that museum learning practice should become a form of sociomaterial participatory apprenticeship. According to Rogoff [25] apprenticeship is a learning practice, in which individuals and their social partners are engaged in situated activities together, as an organic unit within the activity [25].

## A. Design concept

A playful interactive installation has being conceived through the PD process, in the form of low-fidelity prototypes. It is intended for the children to experience, through play, the meaning of historical processes as sociomaterial interactions, specifically in relation to urban development and placement of infrastructures on the territory. The installation is called *Micro-Culture* to suggest a biological metaphor, in which the children are supposed to observe cultural phenomena in act, as biologists do with bacterial culture. Hence the children are expected to get a clearer picture of the dynamics behind urban development and of the implications of placing infrastructures, on land and people's everyday practices.

The game is designed as a mixed reality tangible installation, in which sociomateriality in play is being emphasized. In this way, children's attention should be focused on the learning content and the game. Furthermore, since social interaction and participation, in experiencing historical processes, is the central element of the game, the setting is intended to facilitate eye contact among the players, eventually resembling a mixed reality board game. Ideally the players should engage with an interactive surface projected on the floor. In this way, there would be no chairs and the playing surface could be wide enough, to afford free participation from anyone. Moreover, physical engagement should emerge without fear of breaking anything. But for practical reasons, a screen will be used for the test, placed horizontally on the floor. On the screen a simulation of a population and a landscape is being showed from above.



Illustration 3: Test of the low-fidelity prototype.

The population includes people at different ages in lifespan; they can be newly born, move around to different environments, grow up and have children of their own, and, then, grow old and die. This lifespan aspect allows to make the population more realistic and to take advantage of children's interest for human bones, and their instinctive sympathy for stories about people from the past [18]. Moreover, since we are dealing with a diachronic

perspective, the succession of generations, coming and leaving the world one after the other, can be used to provide a representation of time passing by. After a few generations, it should be possible to decide that an age is over and, consequently, move to another time. Hence the people could build different houses, wear different clothes, and behave differently.

### B. Learning process

The design of Micro-Culture is motivated by the intention to enrich museum learning practice, so to transform it into a participatory apprenticeship. According to Rogoff, children acquire knowledge and skills, by being involved in goal directed activities, together with adults and/or peers, who act as guides through the learning process [25]. Rogoff's main references in this respect are Vygotsky [29] and Lenont'ev [16], who consider children as "active participant in their understanding", while engaged in "shared problem solving" together with their guides. Social interaction is considered to be essential for learning to happen, where adult or peer guidance is necessary in supporting the child to reach the "zone of proximal development", the region of sensitivity where the support from adults and/or peers is required for the child to reach beyond his or her limits [28, 29]. The prototype may act as a mediating resource, facilitating learning and social interaction [21].

The depicted situation has a few similarities with museum learning practice, as children are supposed to learn by coming to museum exhibitions and being guided by adult experts. Play and a playful approach offer a promising framework, when it comes to introduce shared problem solving within a given game. Furthermore, this could leverage on the guides' values, providing play as a communication mode for collaborative story telling. A goal could be directly embedded in the narrative, so as to facilitate individual play, for instance in trying to create a lively village or socially, in stealing peasants from each other.

Therefore, in our studies, play and playfulness may provide a valuable framework to introduce a goal-directed shared problem solving activity, enhancing children's participation in learning and social activities. Play is associated with exploration [24, 27]. Exploration occurs in novel situations where the child asks, "what can this object do?" whereas play occurs in familiar situations where the child asks, "What can I do with this object?"; situations where expressions and actions are experienced as sensations [22]. Accordingly, play consists of a variety of activities that involve manipulation of the environment. Bundy [3], Petersson [21], and Brooks and Petersson [2], have described play as a transaction between the individual and the environment, which creates situations that are intrinsically motivated, internally controlled, and free of constraints of an objective reality. According to cognitive developmental theories play is a cognitive process and a voluntary activity and as such it contributes to cognitive development, problem solving and creative thought.

Furthermore, play develops innovation, flexibility, enhanced problem solving and adaptation [28, 30]. Socio-cultural theories of play emphasize that through play with others, children learn social rules and norms; aspects that are practiced through play [19]. In this study, we address play not just as an activity, but as a state of mind; a playful attitude, and we apply Bundy's [4] Model of Playfulness where playfulness is determined by: the *presence of intrinsic motivation*; the *internal control*; the *freedom to suspend reality*; and *social play cues*.

Initial testing with a low-fidelity prototype showed that, by playing, children could engage in a friendly dialogue with the researchers. Specifically, they started asking questions about the prototype and the purpose of the tangibles. Hence, while engaging into role play or in setting up their village, they often commented or asked us suggestions about what could be added or changed. Moreover, questions were raised by the children about how people died and how they lived in the past. They also asked playful questions, both during design and testing sessions, e.g. they asked if there were lions or snakes in Viking Denmark. This behavior might be facilitated by the different features of the prototype and game play. A board games-like configuration of the prototype and exchange of tangibles facilitated eye contact and social interaction among the players. Moreover, the absence of a set of specific rules, allowed the children to feel relaxed and to explore what they wanted to do without any fear for failure, for example by building a settlement or attacking and teasing each other, as they were rival land lords<sup>1</sup>.

Certainly children's relaxed behavior may also be related to the fact that they became acquainted with us through a one year long PD process. Therefore, a working prototype needs to be tested in the museum, to verify if the same relaxed interaction style can emerge, also between the children and a guide they have never met. Moreover, a test should be performed also with occasional visitors, taking part to a guided or a free tour.

## V. CONCLUSION AND FUTURE WORK

Starting from data collected during a one year participatory study and related work about museum learning practice, addressed to primary school children, this study discusses open issues regarding learning and social interaction in museums.

The main issue identified in our study is the use of conveying notions related to historical processes through lecturing. In this way children's museum experience resembles a lot school teaching, hence children are usually very quiet and it is not clear what they are learning. Moreover, the real complexity of historical processes may be hidden behind nominal sequences of facts.

A PD process has been conducted for one year involving children 8-10 years old; in order to design a playful setting that could support such learning practice. The outcome of the process is Micro-Culture, a playful installation, based on

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<sup>1</sup> A detailed discussion about emerging forms of play will be provided in a future publication.

tangible interaction and augmented-reality, aimed at conveying historical processes through play, emphasizing their meaning and complexity.

This study proposes to enhance learning in museums, by introducing play, so as to move from lecturing to apprenticeship, as defined by Rogoff [25f2]. The proposed approach intends to enrich story-telling practices, already present in museums, through play. Hence children and adults could both cooperate in creating their story, by playing together.

Initial testing seems to reveal that children could engage in play and informal dialogues with the researchers. More testing is needed in the museum, so to evaluate if and how playful interaction could be elicited between children and guides and what would be the learning implications.

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# Integration of Learning Management Systems with Social Networking Platforms

## E-learning in a Facebook supported environment

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**Abstract** - This document studies an e-learning process and its possibilities of integration with social networks. E-learning process, its supporting software and social networks are presented exposing the problem of low level of interaction among users in existing e-learning environments. Social networking tools that could improve the interaction among users in e-learning environments are being considered. As a possible solution to increase the interaction among users in e-learning an integration of learning management system with a social networking platform is being proposed. A working demo of the solution proposed closes the paper with the confirmation that integration of social networking platforms and learning management systems is needed and possible in practice.

**Keywords** - e-learning; social network; user collaboration; user interaction; virtual classroom; learning management system; video lecture.

### I. INTRODUCTION

Social networks are large groups of individuals with custom connections. Nowadays there are numerous on-line social networking platforms with a range of different communication and interaction tools available to the users. Some of the social networking platforms support the integration of custom third party tools – social networking applications. Social networking platforms enable complete users interaction using different communication channels on different end-user terminals.

Through comparison of the social networking platforms with the Learning Management Systems (LMS) it is possible to determine that communication and user interactions in LMS are relatively low. A hybrid e-learning environment using social networking platform tools and LMS features can encourage collaboration and interaction among users [5].

Second section introduces general aspects of the e-learning process and its software (LMS). It exposes the weaknesses of LMS in the field of communication and collaboration among users. A virtual classroom approach is introduced with the basic requirements.

Third section deals with social networks. It introduces Facebook as the world's most used social network with more

than 800 millions of users [9]. Facebook functionalities that can be used to build a virtual e-learning classroom are presented.

Section four explains the idea of a hybrid e-learning environment combining a LMS and a social networking platform. Two options are considered – integration of a LMS into a social networking platform and vice-versa.

Section five presents the results of a practical integration of the Coome LMS system into Facebook platform. Basic architecture and implementation are explained including additional integration of the user progress tracking using an external tracking tool.

Last section explains the main aspects of the practical implementation and integration of the presented solution. It presents benefits and drawbacks as well as some guidelines for future work.

### II. E-LEARNING PROCESS AND SUPPORTING SOFTWARE

E-learning is an interactive process of sharing of information, skills and knowledge by using information and communication Technologies (ICT) [1]. Considering the general requirements of e-learning in schools and universities, e-learning is a process where it is necessary to split users in different groups with different requirements [6]:

- **Learners.** Learners are users who study by using the available content in the LMS. The study process is either standalone or with collaboration of other users.
- **Teachers.** Teachers are users who track progress of learners according to LMS data log and give learners feedback on progress and assessments results.
- **Developers.** Developers are users who are in charge of preparing the e-learning content.
- **Managers.** Those users who create user accounts and user groups and assign the content to users and user groups.

Figure 1 shows the presence and relations of e-learning groups in an e-learning process. Not all groups are required to start an e-learning process. Where there are present and

active all e-learning groups, e-learning process is a guided process.

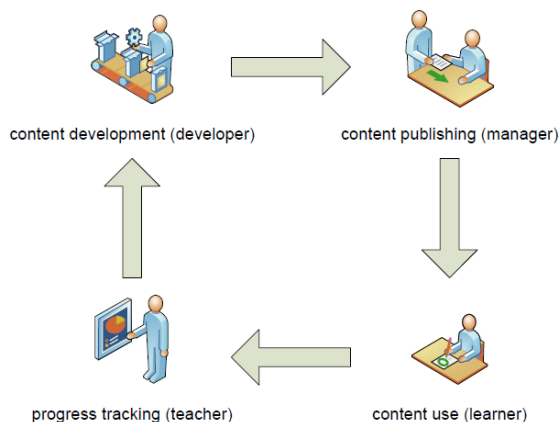


Figure 1 The e-learning process.

The main problem of existing e-learning environments is a lack of communication and interaction among users. There must be more interaction among learners and more communication among learners and teachers. It is expected of e-learning environments to be more like traditional learning, where the interaction among learners and teachers represents a common process. Therefore the goal is to provide the same learning experience as it is possible to achieve in a regular classroom. This is basically an engineering process of upgrading the LMS and a social process of converting the users into e-learning community members, which will start growing.

A. Learning management systems

Nowadays, a vast variety of LMS exist, where most of them mainly correspond to all general requirements of e-learning, like content management, users and groups management, assessments management and progress tracking. LMS completely support the standalone e-learning process based on content consumption and basically support the interaction among users. Learning through collaboration among users in real time is mostly not correctly supported. Nowadays lack is in LMS missing the direct relation between learning content and users' collaboration and in an inappropriate teachers approach towards e-learning. The next step of development of LMS packages is to create virtual classrooms where users' collaboration and social activities will be related.

B. Virtual classroom

Virtual classroom is an approach to create the environment, where it will be possible to complete the learning process with a similar user experience as in a standard classroom [11]. Figure 2 shows the virtual classroom approach where by using information and

communication technologies it is possible to achieve a major part of normal classroom experience. Basic requirements of a virtual classroom must be similar to standard classroom with some modifications:

- Entering and leaving the classroom must be easy, but also logged. Learners must be able to find their ways around the virtual classroom easily and be able to invite other learners. First entrance to the classroom must be approved by the teacher.
- Teacher must be able to lead the group through the learning process. Learners must be able to interact among each other and with the teacher. Virtual classroom must support individual chat between single users and chat between multiple users.
- Access to teaching material should be easy and available at any time.
- Learner should be able to share their own materials and comment and share other people's materials.

The goal of virtual classrooms is to make the online e-learning experience comparable to real learning experience.

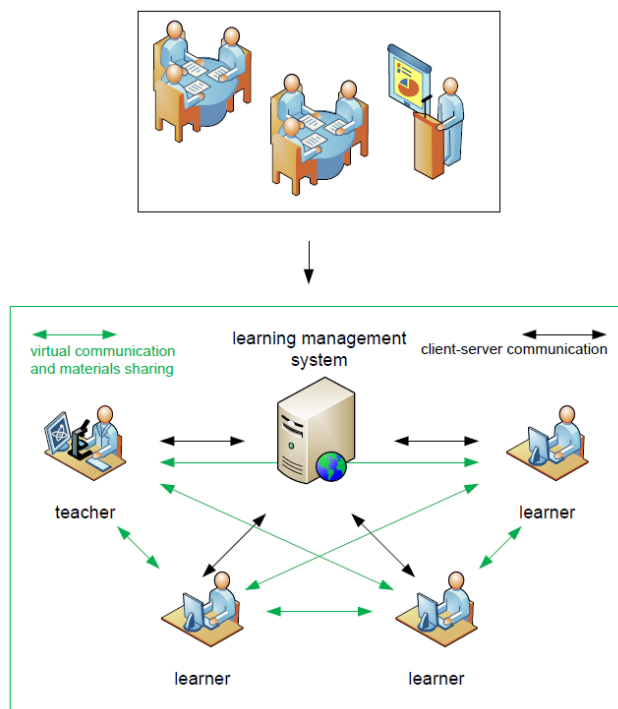


Figure 2 The virtual classroom approach.

To achieve the goal of basic virtual classroom we need to upgrade the existing LMS with social functionalities or update social network platforms to support e-learning processes.

### III. SOCIAL NETWORKS

Social networks are networks of connected individuals who share custom common interests and custom content [12]. The content of social networks is completely provided by the members of social networking communities. Social networking platforms enable various tools of interaction and communication among users and various tools for grouping of users.

Facebook is the biggest and most known social network with more than 800 million subscribers. The Facebook social platform includes various social-connection tools that can enhance interaction among users in an e-learning environment [4]. Selected tools have been considered as useful for integration with the virtual classroom for e-learning:

- **User profile.** Facebook user profiles consist of user's data, user's pictures and user's wall where other users can append multimedia messages. Profile walls are good for general public communication, which can also be used for messaging within the e-learning process.
- **Users groups.** Users can create custom user groups and invite other users to join the groups. This feature can be used for management of LMS users and groups as well as for the control over content access.
- **Custom pages.** Users can create custom pages. Pages have the same preferences as user profiles. Pages can be used as information points for e-learning courses or groups of courses through the support for discussion boards as well as through custom third party control extensions.
- **Chat.** Facebook supports different types of chats. Text, audio and video chats are available to the users. Users can start many individual or group conversations. Use of chat is essential for real-time collaboration.
- **Like and comment functionality.** Users can comment on other users' shared content and/or set an "I like it" flag on it. This can be used to rate and comment the content of courses.
- **News feed.** Facebook news feed is an individual information feed shown in Figure 3. It consists of important news regarding a single user and its relations where news selection is done automatically based on the user's interaction with other users.



Figure 3 Facebook news feed.

### IV. MERGING OF SOCIAL NETWORKS WITH LEARNING MANAGEMENT SYSTEMS

LMS are supportive software for management of users and content for e-learning. Content creation and distribution is well supported in many LMS, while interaction and possibility of active participation of the users in the e-learning process is not. On the other hand there are social networks with excellent support for interaction among users and creation of communities without any support for e-learning. Nevertheless there are social tools that can be used for e-learning and can improve the e-learning process [10], they are not widely used as they are not integrated with LMS. The opportunity here is to integrate social tools of social networking platforms to LMS or vice-versa. Both types of integrations can be done via open application programmable interfaces (open APIs), which need to be supported at the social networking platform and at LMS. As LMS have a good support for users' progress tracking a hybrid system must support tracking of users' collaboration. This way users' collaboration can be considered to be a part of users' final success, forcing the users to collaborate actively by increasing their' motivation.

The first step is a choice of the social network, which fits the required e-learning needs and offers all necessary open APIs to integrate it with an LMS. In case of the pilot implementation, described later in this paper, the Facebook social network has been selected as it comes out as to be the only reasonable choice due to its best support for third party controls and numerous active users. In the field of LMS selection there are several choices available. In general there are no LMS with open APIs available. The possibility is to choose one of the open source LMS and upgrade it with custom open APIs. In both cases the social networking platform is being used as a backend for social tools and LMS is being used as a backend for e-learning elements.

#### A. Integration of social networking platform tools to a learning management system

Social tools are essential tools of social networks. Some social networks offer easily understandable open APIs that allow usage of selected social tools in custom applications. The focus is on upgrading of an existing LMS with the social tools. If all the steps of an upgrade are achieved, the selected

LMS can support a basic virtual classroom. This option is mostly not considered as it requires more social networking APIs to be available – for all the needed social tools.

**B. Integration of a learning management system to a social network**

Integration of a LMS to a social network is possible only when social networking platform supports third party controls to be added for custom users. In this case a new interface of an existing LMS with a look and feel of the selected social networking platform must be created. As the complete process is depending on the social networking platform, all social tools available in the platform can be used.

**V. SOCIAL NETWORK AND LEARNING MANAGEMENT SYSTEMS IN PRACTICE**

In practice the integration of the LMS Coome with the social networking platform Facebook was made. Facebook was selected due to its large user base, support for third party applications, good development documentation and provisioning of all social tools needed to complete a basic virtual classroom. Coome is a LMS developed to support the production and distribution of multimedia based lectures and is being used as the tool of online synchronization of videos and presentations [8]. It has been selected as the LMS of choice due to its support for multimedia lectures.

Figure 4 shows the main architecture of the implemented solution. A custom application was made for Facebook social networking platform and Coome LMS was extended with specific open APIs. Custom Facebook application communicates with Coome LMS and Facebook social networking platform via open APIs. Facebook social networking platform accepts users’ requests and renders final content to the users.

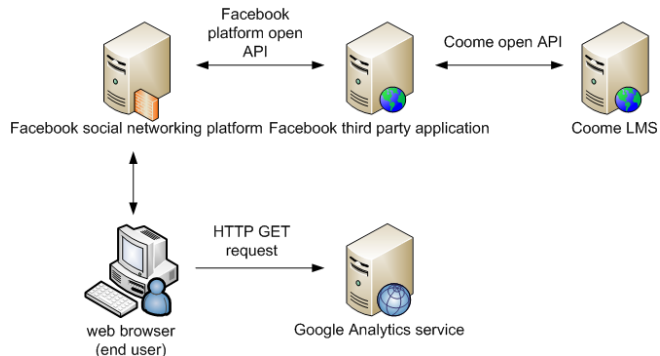


Figure 4 Architecture of the practical implementation of integration of Coome LMS with Facebook.

**A. Coome**

Coome is a multimedia based LMS. It supports creation and management of video lectures synchronized in time with the lecturer’s presentation using Microsoft PowerPoint or

other related tool. Coome is a complete tool for editing and delivery of video lectures. Delivery of video lectures is done in the same way the content delivery is done in other LMS – according to user management and assigned user rights. Figure 5 shows Coome detailed WEB 2.0 based editor tool for video lecturers. The process of final creation of a video lecture is made in 4 steps:

- A lecturer uploads a presentation in Microsoft PowerPoint (PPT) or Portable Document Format (PDF). Coome processes all pages of the presentation and imports them into the data storage.
- Once the presentation has been imported into the system, the lecturer can give the lecture using the Coome system. All transitions of the presentation pages are being tracked and indexed, while the lecturer can be recorded using a standard camera or a webcam.
- After the lecture presentation is concluded, a post production of the lecture recording can be made. The video recording of the lecture can also be replaced with custom video, which can be uploaded or set as an external link. Transitions between presentation pages can be updated or removed.
- Once the editing process is completed the lecture can be published and made visible to other registered users. Lecture can also be assigned to custom categories.



Figure 5 Coome LMS lecture editor.

With the goal of integration e-learning elements with Facebook, the Coome LMS had to be extended with 3 representational state transfer (REST) based open APIs. Authentication of users allows the employment of the APIs through the application key (API-key) method or a validation of client’s internet protocol address (IP address). API-key is a user unique value, which is provided as a parameter of all HTTP requests. The newly implemented APIs are:

- **Search lectures API.** This API enables the search of lectures present in the system. It returns a list of maximum 20 lectures with basic description data.

This API accepts two parameters – search and page. Search is the parameter to be set as the value of a search string and page is the parameter, which determines the ordering of the returned group of lectures.

- **Lecture data API.** This API enables the retrieval of lecture specific data such as video location, lecture presentation location and lecture presentation transitions. Lecture identification number must be provided as the API parameter.
- **Categories API.** Returns categories' data including the number of lectures assigned to each category. API accepts parent category identification number as an optional parameter. If this parameter is not set, API returns top level of categories (those without a parent category).

The development of open APIs is essential for the completion of the solution. Only this way the Facebook application can access the data from the selected LMS. To do this, direct access to database and to source code of the LMS must be available. Thus the development of open APIs is not possible with all LMS as well as the integration with a social networking platform.

### B. Facebook pages

Facebook pages represent a good starting point for the virtual classrooms. Facebook users can decide to follow the newsfeed of the pages by liking them – click on the “I like it” button.

Inside a Facebook page the communication among users is possible through a discussion board or a page wall. All interactions and page changes are automatically set to users news feed. In a practical implementation described in this paper, a custom Facebook page has been created as a starting point of the e-learning process.

### C. Facebook application

Facebook applications are third party controllers that can be integrated into the Facebook platform the way that users' request are always forwarded through Facebook to an external application [2][7]. Facebook application represents a controller with e-learning functionalities.

A custom Facebook application has been made with the goal to integrate basic Coome application functionalities. Before the first use of the application, Facebook users must confirm the installation of the application to their profile and confirm the application rights to access their data – e. g., list of friends. Once the installation is completed and the access rights are confirmed user can use the application and the application can access user data in the read/write mode. This is important to encourage interaction among users by messaging actions to other users' news feeds.

Using Coome open APIs, Facebook application can display two basic screens.

Home screen displays the list of lectures according to user's search input parameters. At the top of the home screen the lecture categories tag cloud is displayed. Lecture list is displayed at the center of the screen with associated thumbnail pictures. At the bottom of the home screen there is a list of selected users of the application.

Lecture screen is used to displays a single lecture as it is shown in Figure 6. A lecture consists of a video synchronized with presentation pages. On the lecture screen there is a video player located on the left, currently active presentation page on the right and a list of all presentation pages below. All presentation pages can be previewed with hover action on the pages list. Users can comment single lectures using a field below the lecture screen.

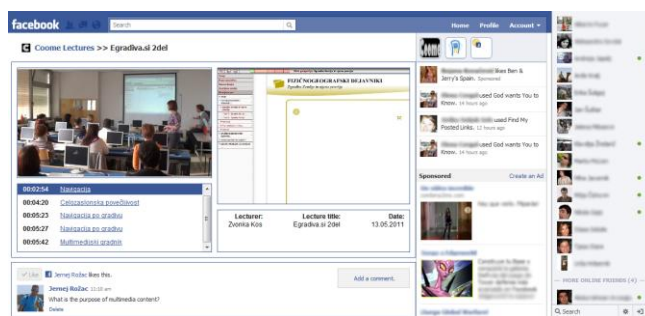


Figure 6 Lecture screen of the practically implemented solution of integration of Coome LMS with Facebook.

As the application is integrated within Facebook, users can use it only if they have registered the application and after they have logged into Facebook with their account.

Read only functionalities can be achieved without the need for registration with the Facebook application. By doing it this way there it is enough to append the Facebook application to previously created Facebook page. Without requiring from users to register with the application it is not possible to access profiles of the users or to read or write user profile data, comments, etc. This is a problem, if tracking of the learning progress is required.

### D. Tracking users' progress

Progress tracking can be performed by sending progress requests to Coome. In this case Coome application needs to be extended with an open API to store progress of the users. In case of the described integration a different approach has been selected. Facebook application has been adapted in such a way that it forwards Facebook users requests to Google Analytics service. Requests of the users are mapped to different virtual permalinks, which are forwarded to Google Analytics as general web page requests. Information included in each permalink is about the user, the lecture and the lecture page. Each user's request is mapped to 4 groups of permalinks:



- **Log tracking.** It covers a complete tracking of access. Permalink includes 3 virtual paths – user, lecture and lecture page. This structure of permalinks enables complete tracking of user requests in Google Analytics.
- **Lectures tracking.** It enables to track lectures views. This is important for keeping the basic statistics of lectures. By using this approach, only the lecture name is tracked.
- **Lectures pages tracking.** By tracking lecture pages we can retrieve information about a single page visit like visit count number and time spent on the page.
- **Users tracking.** It enables calculation of users' ratings according to different parameters such as: number of followed lectures, number of visited lectures, etc. This permalink consist of user related data only.

Google analytics enables tracking of custom permalinks. Permalinks do not need to be valid. All example permalinks are not valid, but are used to track different e-learning statistics.

Users' access data are sent to Google Analytics service directly from users' web browser. By doing this Google Analytics gets all the data regarding the e-learning item being tracked as well all the data present in regular HTTP headers. Google analytics creates aggregated reports according to received data.

In some scenarios transferring access data to a third-party service can be considered as a privacy issue. Only learning object data provided in the URL can be protected by using an encryption method. HTTP requests to Google Analytics service can be done using the secure connection to exclude possibilities of network traffic attacks.

## VI. CONCLUSION

It seems obvious that the existing e-learning processes must be complemented with social networking tools. With the presented pilot implementation we have shown that it is possible to use a modified LMS platform and the Facebook social network as a virtual e-learning classroom. Nevertheless, despite the fact that our implementation has been based on the Facebook social network and Coome LMS, it can be implemented also by using other social networks supporting the implementation of third party controls or using other LMS where the access to source code is available – e.g., open source LMS or self-developed LMS.

Standard web users are familiar with social networks, but not with LMS. Introducing LMS features to social networks enables an immediate start of e-learning process for the end users without the need of understanding the integrated LMS. Other benefits are in use of communication tools, simplified users communication and easier information push to users.

During an e-learning session the users are always able to use all social networking tools. It is not possible to limit the use of unnecessary and undesirable social networking functionalities for e-learning. This is a drawback as users can always use social networking tools for other purposes rather than e-learning.

According to initial feedback of lecturers and university students, the social networks will be used for e-learning in the future. All lecturers and learning data are stored locally on LMS servers. This reduces potential problems with Copyright issues. Use of the e-learning material can be managed according to user accounts and enabled only to selected users.

In the future a real case scenario of social network e-learning will be evaluated on a group of students to obtain the real feedback and thus improve the benefits and reduce the drawbacks of the current system.

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# E-learning for Global Citizenship with Conectando Mundos

## A South African Experience

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**Abstract**—In this paper we discuss the work we have been doing with Connecting World, a global online platform which brings together children from around the world to engage collaboratively, on different topical issues towards finding workable solutions. The project draws on some aspects of collaborative learning to ensure that a rich virtual learning environment is created for learners. Working closely with teachers in their facilitator role, we assist schools and learners from different countries, backgrounds to share their experiences and tackle difficult questions on Connecting Worlds. In this paper, we share our experiences incorporating South African schools on this platform. Through an open ended questionnaire, teachers evaluated the 2010 edition of Connecting World in South African schools on climate change. The teachers also participated in a focus group discussion. From the findings, issues of time, language and technical problems were prominent.

**Keywords**—Connecting Worlds; Collaborative Learning; Climate Change.

### I. INTRODUCTION

Collaborative learning has over the years become a powerful participatory teaching and learning strategy. It enables students to develop critical thinking skills and be responsible for what they learn and what others around them learn [1]. Although it is a difficult way of imparting knowledge as it requires the teacher to be aware of what each student brings to the class and shares with others, its team work approach and learner-centeredness make it a choice for the discussion of topical issues, which are sometimes hard to teach in a normal teaching environment.

In this paper, we discuss Connecting Worlds, an online platform that gives students from all over the world an opportunity to share experiences and learn in a collaborative manner. Central to the learning that takes place is the Education for Global Citizenship drive of Oxfam, which provides for content and topics used for Connecting Worlds discussions.

The first section of the paper focuses on collaborative learning which forms the bases of the work we do with Connecting Worlds. We then move on to describing the project before we discuss the South African experience with Connecting Worlds. A section of this paper is dedicated to the challenges South African teachers faced as they facilitated the project.

### II. COLLABORATIVE LEARNING

Collaborative learning by definition uses teamwork as its main method of learning. It involves joint intellectual effort by students for understanding, solutions and meaning or creating a product [1]. Collaborative learning is about building cooperation and teamwork and getting students involved in the learning process. It is about building learning communities. In a class situation where collaborative learning is used, the teacher takes a facilitator role and allows students to explore content given to them and make sense of it without the teacher teaching or presenting the content. This promotes critical thinking skills in students as they have to engage with the content themselves.

Collaborative learning views learning in five critical ways as outlined by [1]. Collaborative learning views learning as an active, constructive process. In order to learn students must find a way to integrate new information with what they already know. In some cases students might have to reorganise what they already know based on the new information. Learning is depended and influenced by rich contexts. Through collaborative learning students are exposed to challenging tasks or questions which provide a context for which they must use facts and their ideas to tackle the tasks or questions. Collaborative learning also views students as diverse because they bring multiple perspectives to the classroom based on their diverse backgrounds or experiences. Collaborative learning enables students to tap on each other's diversity as a way of learning. Finally, learning is understood as inherently social. Collaborative learning allows students to talk, much of learning happens through talking [2].

### III. CONNECTING WORLDS

#### A. What is Connecting Worlds?

Connecting Worlds is an online multilingual educational platform which allows students aged from 6 to 17 years to work and interact with other students with different cultural, economic and social realities [3]. The work combines classroom activities with networking among students and is carried out in a cooperative manner in working teams of the same age range. Students are drawn from all over the world. Content is available in 7 languages, Italian, Spanish,

Portuguese, English, Galician, Catalan and Basque. Each year, Connecting Worlds tackles a specific issue related to Education for a Global Citizenship such as labour standards, climate change or poverty and there is a different educational topic for each age group. Education for Global Citizenship is an initiative of Oxfam, which argues that due to globalisation, education plays an important role in preparing children and young adults to survive in the world today [4]. The initiative focuses on a number of topical issues which children and young adults tackle using multiple participatory methodologies such as discussions, role plays and debates. The project was designed by four countries namely Italy, Spain, Malta and Portugal. Connecting Worlds seeks to meet its main objective of fostering intercultural dialogue among students belonging to different social and geographic environments via Information and Communication Technologies (ICTs), which enable mutual knowledge sharing, diverse realities and discovering common problems.

Teachers are central to the success of this project. As a facilitator of this learning process, a teacher can register a class online and commit to assisting learners throughout the duration of activities. Students work in groups on each activity before connecting with a 'working team' on the internet. Working teams are made up of students from all over the world. Presentations of 'working teams' findings and reflections are made to Connecting Worlds, in Spain by students from Spanish schools.

#### *B. Connecting Worlds in South Africa*

The Connecting Worlds project started in South Africa in 2009. Teacher training started on the 27th January 2009 at Rhodes University, Grahamstown. Learners started activities on 16th February 2009 and finished on 29th March 2009. Schools that are involved are C.M.Vellem, Nombulelo, Nathaniel Nyaluza (all in Grahamstown) and Ngwane in Dwesa. Since the platform used by Connecting World is in several languages, South African teachers and students had to translate the communication they had with students from other countries whose languages are part of the platform. All South African participants communicated in English.

### IV. METHODOLOGY

#### *A. Description of the context and sample*

The four schools that participated in the Connecting Worlds project in South Africa came from a class of 20 teachers who were doing a professional development course at Rhodes University, Grahamstown in the Eastern Cape province of South Africa. The Eastern Cape Province, where all the schools that participated in this project are located, is one of the poorest provinces in South Africa [5]. Marginalised schools in the province are faced with the challenge of basic infrastructure such as decent, secure classrooms [6]. According to the NEIMS report [7], over 6% (395) of the schools in the Eastern Cape Province are mud schools. This figure still stands in 2011 [8]. While over 20% (1177) schools in the province do not have electricity

supply [7], 90% of schools (not including private/special schools) do not have a computer lab [7].

The teachers were all registered for an Advanced Certificate in Education in Information and Communication Technologies (ACE ICT). The course caters for in service teachers interested in ICT and learning how to use ICT in their classes. All schools are in the Grahamstown townships. In the South African context, the term township usually refers to 'the urban living areas (often underdeveloped) that during the apartheid era were reserved for non-whites i.e. blacks, coloured and working class Indians' [9]. Townships were usually built on the periphery of towns and cities.

Over the years the ACE ICT course has catered for teachers from marginalized schools, who do not have the capacity to train teachers in the use of ICT (mainly computers) in their teaching. Marginalization is described as 'occurring when individuals or groups are excluded or in the peripheries of dominant groups'[10]. 'Marginalization has roots in geographic isolation, race, gender, class, nationality, ethnicity, religion, sexual orientation, learning disabilities, etc. It most often brings about reduced opportunities to fully take part in economic, political and social processes' [10]. In South Africa marginalization has roots in Apartheid which divided communities, resources and wealth according to race. Since independence the South African government is trying to redress these past imbalances, but most of the previously disadvantaged schools remain heavily under resourced and marginalized.

Most of the teachers in the course were senior citizens. It is interesting to note that most of South Africa's teachers are on average over the age of 40 [11] as the profession struggles to attract young people due to the low salary and lack of status associated with teaching in South Africa. With our involvement in the teaching of this course we have noted how these teachers struggle to grapple with the course that is very much technology driven.

#### *B. Selection of the sample*

Connecting Worlds project was introduced to the ACE ICT class and the project and involvement of the teacher and their students described. Teachers voluntarily agreed to be part of the project. We must emphasize that we got more teachers who were interested in the project but could not be included in the final number of teachers who participated because their schools did not have computers and or internet connection. Selected teachers met with the Connecting Worlds representative at Rhodes University for training.

#### *C. Data collection*

Data were collected through an online, opened ended questionnaire. Questions were grouped according to five broad areas. Beside questions on the teachers views on the strengths and weaknesses of the project, we asked questions on the knowledge of subject (of climate change), impact of the project on the students, change to students' behavior and the use of the spaces during the activities. Each teacher prepared this evaluation and presented before the class. We realize that asking participants to present their evaluation might be seen as inappropriate. However, for this project, the

teachers were made aware that they were the first group to participate on Connecting Worlds in South Africa and that the purposes of their feedback were to help improve the project and ensure that future participants enjoyed the experience. We found that using this open method was useful as teachers were able to add more to others views and it also helped to trigger fresh thoughts and ideas that would have otherwise not been included in the written report.

This was particularly important during the focus group discussion, which focused on the challenges faced during the project and solicited teachers suggestions for improvements. This provided a platform for an open, honest discussion among the teachers.

## V. FINDINGS

Data analysis was done through grouping findings into the five themes according to how the questions were grouped in the questionnaire. As we continued to interact with the data, we found that two main themes were prominent and these are presented and discussed below.

### A. Valuable lessons from the activity

While computer skills were never the focus of the study, teachers felt that the activity had an added value of increasing student's computer proficiency. Teachers found searching for information on the internet about sources of energy was relevant for students. "It was a good experience to work with the computers...gathering information through internet about the topic". Teachers also said a project like this would help in that it encouraged students to search for information on the internet, once this skill is mastered students will always be able to find the necessary information on any topic and be aware. Teachers shared how students were excited to interact online with students from another country.

For the teachers, the activity was also a learning curve. "We are able to communicate with other people from different countries through the internet. You share ideas with different people. You learn a lot from other people's experiences".

Although it was not possible to talk of real change, as the activity was short, teachers expressed how team work was reinforced. Learners participated quite well in all the activities that were set for them. The project increased knowledge on climate change "looking for information from the internet increase our knowledge, we find out more things about this climate change". However, teachers noted that given enough time for the students to absorb all the information, the project had the potential to form an aware global citizen. One teacher said "my group was between 8 years and 10 years therefore it was not easy for learners to capture the whole information immediately, but they learnt a lot about energy use".

### B. Collaborative learning

Teachers felt that the project through its activities gave their students a platform to share ideas with other students from all over the world. One teacher said "They [students] had an opportunity to see and read what learners from other countries wrote and created". This is one of the main objectives of the Connecting Worlds and collaborative learning, to encourage students to tap into their diversity [1] in a classroom situation in order to enrich their learning. The activity also promoted communication and collaboration among students from different countries.

Learning through discovery as has been seen to work in other research [12, 13, 14] was confirmed in the online learning that took place during the activities. "The learners worked independently, they discovered some skills on their own by helping each other. Activities were learner centered". "They [students] are able to search for information using internet independently",

Group work was the most important of all class work "The actual value of this activity was to develop listening, discussion as well as inventing skills; students were able to share ideas". Another teacher said "group work reinforces working together" and encourages sharing experiences as a way of learning. Allowing for the group work involved all students. "Working in groups taking part in group discussions has involved students in a more participatory and enthusiastic way, because sometimes some children do not feel comfortable working or talking in front of their teacher". "The students know how to work in groups and look for information from the internet".

Teachers found the activities allowed for participatory learning. One stated "Both online activities and classroom activities involved student in a more participatory and enthusiastic way. Creation of a little windmill using different materials was done in the classroom and later it was on the online activity". "In both activities they participated very well because in the classroom activity they move around looking for materials for building a windmill and online activities they were looking for information from the internet".

## VI. CHALLENGES

### A. Language

Language was mentioned as the biggest challenge. Since all the teachers and students from South Africa were IsiXhosa mother tongue speakers, and not proficient in English language, it was difficult for the students to express themselves within the working teams in English. One teacher said "Learners exchanged with other groups, but because of the language problem they could not read other languages, nevertheless they felt encouraged for participating". Teachers were confident though that the experience motivated learners to practice more with English and to strive to have a good command of the language that serves as a lingua franca on the global scene. Another challenge came from the fact that the default language on the Connecting World home page site is Spanish. Teachers

struggled at times to change this to English. As a result, there was a discussion about the possibility of translating the website into IsiXhosa so that teachers and students from South Africa can use a language that they fully understand. Localization of websites is on the increase in African languages [15, 16].

### B. Technical problems

There were several technical problems along the way, chief among them being Internet connection problems. The schools that took part are part of another project at Rhodes known as Eyethu whose aim is to provide internet connectivity to schools in the township [17, 18]. Schools are therefore provided with a limited amount of internet connection quota after which a school can be disconnected. On a number of occasions, schools found themselves without internet quota and were unable to connect to the internet and students had to wait until the school could connect again to search for information and prepare for their activities. In cases where internet was available, students were allocated limited time to browse the web.

### C. Time

Teachers felt that the one day training that they received before the project commenced was too short. There were also teachers who felt the six weeks period of the project was short for the students who participated in the project. More time, it was argued would have given the students time to interact with the data and make meaning changes to their way of thinking. There were also concerns about the timing of the project. The teachers felt that the project fell during times when teachers and students alike were busy at the schools and had to make time during weekends and after schools for the project.

### D. Teacher training and facilitation

The teachers said the guide and instructions for the project were not clear enough for them to follow. Since there was no facilitation from the authors during the actual activities that the teachers and students had to undertake as part of the Connecting Worlds project, the teachers said they faced a number of challenges. These included difficulties with registrations on the website and logging in for activities, being unable to retrieve the training manual off the internet and translations. Teachers were confident that with facilitation some of these minor challenges could have been avoided.

## VII. SUGGESTIONS FOR IMPROVEMENTS

Three critical areas emerged from the data as pointed out by the teachers; these are time, technical problems, and language. More time allocated for the activities was cited as a possible way of improving the project. Teachers also suggested more training time for teachers, now that there are teachers that have undertaken the project, training can now be done for a longer duration and done at peer to peer level. They also stated the need for a contact person in South Africa who can assist teachers along the way if they cannot access the internet to contact Italy.

While language was viewed as a critical point as it had implication for the whole learning that was intended to take place during the activities. Teachers made a few suggestions towards curbing the problem of language, teachers suggested an easier translation process on the website as most of them struggled “there was a way of translating but it was not easy to do that”. Teachers were unfamiliar with other languages and did not know which language was which in order for them to translate it. “Countries should try to state their language they use when responding so that it will be easy to do translations”. “We could not identify any foreign language nor could we not read the responses from other countries”.

## VIII. CONCLUSION

In this paper, we described the Connecting Worlds online platform, which brings together children from all over the world to discuss topics around Education for Global Citizenship. We showed how this project draws from collaborative learning as its theoretical underpinnings. The objectives of Connecting Worlds among others are to foster intercultural communication and learning among students from different countries though the sharing of experiences and their realities through ICTs. The main aim of the project is to prepare students who are able to survive as a global citizen, aware and informed of what is happening around them. With the project growing in the European countries we discussed the introduction of South African schools teachers and students to the online platform. In this paper we focused on the evaluation of the project made by the teachers who participated. Teachers thought the project enhanced teamwork through the collaborative and participatory teaching strategies that were used such as group work. Language, time, technical problems and teacher training and facilitation were noted as the main challenges for the South African experience. Teachers suggested way of dealing with these challenges. We are of the view that the same collaborative and participatory learning strategies as those used in the Connecting Worlds project can be used to development students’ critical thinking skills elsewhere.

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## APPENDIX

Questions for teachers: Strengths/weaknesses

1. In your opinion what were the strengths and the added value of this type of activity?
2. What are the main critical points of the activity? What could make it more effective?
3. Which part of the activity did you find more relevant and interesting (input online activities in the classroom - group work/research - or in the territory, the exchange between students of different countries, exchange with colleagues from other countries etc.)?
4. As to online activity, which was the impact and value of the work?
5. As for the work done in class, what were the impact and the actual value of the activity?

Questions for teachers: Knowledge on the subject

6. With regard to learning, do you believe that this activity has increased your knowledge and the knowledge of your class in respect to the subject of climate change?
7. Do you believe that an activity/project of this type is really useful for the formation of an aware, informed and responsible citizen of tomorrow?

Questions for students

8. Which part of the activity (online activities, activities in the classroom) has involved students in a more participatory and enthusiastic way?
9. To what extent has the class exchanged experience with other classes of the group? Have you found that your students have felt encouraged by participating in shared activities with students from other countries and of other languages?
10. Has Conectando Mundos changed the dynamics of student learning (group work, researching materials on the internet)?

Change of behaviour

11. Have you been able to verify a real change of behaviour in class and individual students, regarding the issues studied?

Use of space

12. Did you and your class use other spaces/tools platform (blackboard, forums)? If not, why?

## ***Using Virtual Spaces for Learning Communities to Facilitate Project Development and Collaborative Learning***

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***Abstract***— With the extensive expansion of the Information and Communication Technologies in the learning, business and home environments it is becoming apparent that there is considerable opportunity for increasing collaborative interaction if a framework is developed to coordinate the activities of the individuals across the different sectors. As a possible way of achieving this objective, we present the online Community of Practice developed and presently being in trial at the Institute for Work Based Learning, Middlesex University. In this paper, we describe our approach for developing and utilising of this Community of Practice. We will describe the benefits of the educational software tools we have used in the implementation process. Through case studies we will present two ways in which the online Community of Practice is being currently applied. We will outline the main advantages and some challenges of using the newly created Community of Practice.

***Keywords*** – *online community of practice (CoP); Google Apps; Web 2.0; social constructivism; interaction; collaboration.*

### I. INTRODUCTION

The purpose of this paper is to introduce ways that Google Apps and other Web 2.0 technologies can be used to develop an integrated virtual space for a learning community by putting in place an online Community of Practice (CoP). This project has been developed and is presently being in trial at the Institute for Work Based Learning, Middlesex University with the intended aim to “progress its online learning activities (including an increased use of social media) from individual, Programme-based initiatives to an institution-wide, strategic project which will be core to realising strategic objectives in learning and teaching” [1].

A well designed online learning environment is seen as a means of enhancing the student learning experience: students will be able to engage with a variety of online and

blended activities which will be learner-centred and will provide increased flexibility, choice and support.

The structure of this study is as follows: Section 2 briefly depicts the institutional context of the project. Section 3 outlines possible tools for creating an online CoP and justifies the selected approach. Section 4 describes the overall aims of the project and outlines the development stages. Section 5 clarifies the main technical aspects of the project framework and identifies initial advantages and challenges. Sections 6 and 7 present two examples (case studies) for using the newly created online CoP. The last section summarises the key outcomes of the Pilot project and outlines ideas for future developments.

### II. STATE OF THE ART

The Institute for Work Based Learning (IWBL) has a long history of on-campus and off-campus innovations in e-learning and blending learning, as evidenced by BA Professional Practice (Arts) Programme web-site [2] and a wide range of Institute level good on-learning practices [1].

The way in which ICT was being utilised by the IWBL, whilst being innovative and desirable, lacked a common structure which isolated the different stakeholders. By the integration of a framework and consistent approach, the CoP establishes a wider collaboration and a sharing between multiple stakeholder groups.

In particular, the IWBL staff are seeking developing suitable approaches to address the feedback stated in the university Validation Report, April, 2011: “Consider greater use of social media to engage all students in communities of Learning”[8].

In response, the IWBL envisages that the development of a structured online CoP will have a big advantage in terms of supporting the attainment of key strategic goals in learning and teaching, including:

- Student-centred approaches to learning which address issues of diversity through flexible and varied modes of study;
- Flexible approaches to learning, teaching and assessment which meet the varied requirements of students and of IWBL and academic staff;
- Increasing competitiveness of work based learning courses;
- Increased flexibility in course structures and modes of delivery that provides a greater level of interaction and feedback between tutors, students and employers.
- Development of integrated virtual learning elements, resulting in increased efficiency.

The online CoP aims to expand the effective use of ICT towards fulfilling more of its potential and greatly widen the participation by providing an integrated virtual space for a learning community that will include multiple stakeholder groups [1].

Having developed and established a CoP for staff to which they are now actively contributing the remaining target for the project is to extend it to the other identified stakeholder groups (students and employers) [1].

The CoP utilises integrated Google Apps for Education including the new Google App called “Course Director”. The advantages of this online platform are described in the next section.

### III. RATIONALE FOR CHOOSING GOOGLE APPS FOR EDUCATION/COURSE DIRECTOR FOR CREATING COP

The creation of a suitable virtual online learning space for the multiple stakeholders that we envisage using this facility made the choice of tool for the development and management of the space a crucial one. We aimed to find a tool that was simple, accessible, interactive, collaborative and cost effective.

Detailed discussions between the e-resources consultant, the IWBL management team and staff as well as with the University’s ICT policy makers have taken place. We looked at different Virtual Learning Environments (VLEs) including online learning systems.

As explained in [3], “commercial VLE products, which form the vast majority of VLEs in use in UK FE and HE, are generally characterised as ‘content-centred’, rather than being aimed at encouraging the active learning embodied in constructivist pedagogies”. In addition, we share the understanding that “a VLE cannot be implemented effectively in an institution without addressing a number of management issues, and the complexity of organisational structure within further and higher education is impacting on VLE uptake” [3].

Considering the needs of the stakeholders for open access to e-resources with no cost for administration and the requirement to use an intuitive interface, we have looked at flexible online platforms, such as Moodle and Google Apps that could meet our requirements.

Moodle and Google Apps are not the only flexible learning environments but they are the ones where the flexibility comes at a low cost.

Moodle provides tools for creating courses in a linear form using sites, blogs, online discussion forums, has tools for embedding HTML code and has uploading option for files. It is easy to create online course activities and interactive quizzes, however Moodle requires complicated administration.

Google Apps and Google sites are web-based services with more general structure, and are suited to both business and educational uses. The services are maintained and upgraded constantly by Google.

Considering our stakeholders’ needs, we have made a decision to set up a CoP based on Google Apps for Education and extended by a new Google App called “Course Director”. We have chosen suitable Google Apps/Course Director features to assist the development of the CoP in terms of sharing e-resources, information and archive documents in Google Sites. Stakeholders can jointly submit to Google Docs and there can be discussion groups for each community of practice in Google Groups.

Google Apps/Course Director support social constructivist approaches to learning. Social constructivism creates a learning environment that emphasises collaboration and exchange of ideas [4]. Constructivism gives people ownership of their learning, since they are engaged through questions, explorations, and designing assessments [5]. “Course Director” offers educators a set of tools to support collaborative forms of learning that can encourage publications, multiple literacy and inquiry. As suggested by Williams and Jacobs [4], “learners are able to develop new ideas, and transform their own understanding through reflection by publishing and sharing their work to a wide audience”.

In short, a range of free interactive and collaborative Google Apps has been installed. Google Course Director is the only Google App in the EDUCATION Marketplace to be awarded the TRUST e-Privacy certification. Free online support is available through a series of help, online demos and e-mail advice.

The desirable characteristics we outlined above as well as the fact that we trusted the application were crucial in our final decision to use Google Apps/Course Director.

### IV. DEVELOPMENT AND UTILISATIONS OF THE ONLINE COMMUNITY OF PRACTICE

The development of the online CoP Pilot commenced in September 2011 and has been in trial with academic staff at the IWBL with very promising outcomes.

We are in a process of organising a survey for collecting feedback and will complete the Pilot project evaluation report by the end of January, 2012.

In the next development stage, we are aiming to extend the Pilot CoP involving students and other faculties at Middlesex University, business organisations, and other



stakeholders. Project findings will be presented and discussed at workshops organised at Middlesex University.

In [1], we stated our overall goals “to enhance the interactivity and connectivity involving tutors, students and employers and to achieve greater integration and use of a more diverse range of digital media (i.e., video) and social media (e.g., Blogging, Wikis)”. As suggested in [6], these technologies can “provide new ways for students to collaborate and communicate within their class or around the world”.

In the creation of an online CoP, a real opportunity has been given to stakeholders to share best practice, interact and collaborate. The contributions each individual gives to the community will continually refine the CoP and as the contributions and utilisations accumulate it will engage a much wider participation. Throughout the trial, academic staff have been using the online CoP effectively in this manner as will be demonstrated partly in the presented case studies.

In the next development stage, the IWBL is looking to widen the participation in the CoP to include all staff, students and external institutions such as businesses. Past experience has shown that aligning the sometimes very different expectations, priorities and values that pertain to different shareholders, for example, students and employers, can be difficult.

The online CoP approach is considered an effective means of achieving this. The CoP project avoids duplication of effort by bringing the efforts of the key stakeholders together to work towards a common set of principles and guidelines for best practice. The development provides opportunities for improvement of interaction, sharing and collaboration, for developing well-structured e-content, potential cost savings and income generation opportunities.

We are at end of the Pilot stage and we have a number of IWBL staff contributions published within the newly created collaborative CoP web-site.

#### V. TECHNICAL ASPECTS OF THE FRAMEWORK AND CHALLENGES WITH ITS IMPLEMENTATION

Our practical proposal has included the setting up an online CoP for staff, students and employers (based on Google Apps for Education and extended by a new Google App “Course Director”). We have benefited with a free trial for three months followed by a low cost annual subscription fee of 500 EUR.

The main features of “Course Director” include the following:

- Online communities of practice/courses for sharing information between tutors/students and employers in Google Sites;
- Student assignment submission to Google Docs;
- Online tests and quizzes in Google Docs;
- Discussion group for each community of practice/course in Google Group;
- Timetabling in Google Calendar;

- Grading, attendance and report cards (if no needed, these features can be hidden).

We have identified a number of benefits of the chosen solution as follows:

- With “Course Director” users only have to log on to Google Apps not an external Learning management System ;
- Simple user experience - tutors/faculty don’t need to learn a new system, they learn Google Apps which they see as a useful skill. Students already use Google products and learning is intuitive;
- Simple interface - Google Apps offer a range of interactive and collaborative tools that meet most of the teaching and learning needs;
- Data privacy and security – Google Apps is designed to provide the educational institutions with a safe, reliable platform for its data offering better security and reliability than most educational organisations could achieve on their own;
- Greater reliability and more hard drive space - Google offers 7 GB per user for free on Google Apps.

Google Apps administration is very easy and includes the following characteristics:

- Modular structure - turn off/on selected features;
- Import and export spreadsheet data easily;
- Quickly create online communities of practice or courses, then add/remove tutors/students or employers;
- Create standard online templates, but allow tutors to easily customise their community of practice/course themselves;
- Copy recurring communities of practice/courses, together with all files and attachments - no need to recreate courses from scratch;
- Never have to delete information - keep a full history of all your previous communities of practice/courses;
- Automatic password reset.

One challenge in the implementation of the chosen framework is that Google Apps do not support great additional customisation. This may restrict development of more sophisticated software platforms. However, for the purpose of creating communities of practice, using Google Apps is a very good idea due to the great interactivity, connectivity and collaborative tools.

While the initial CoP design and the administration settings took only a couple of weeks, the maintenance of the information flow has been a challenge. The e-resources consultant and the technicians have provided continuous training and support for the IWBL staff in the process of developing of individual and collaborative web-spaces and resources.

At the time being we have thirty –thirty five members of staff contributing e-resources, comments, sharing good practice, building up collaborative knowledge and expertise via the IWBL online community of practice. Five members of staff have designed their own Google web-sites aiming to

enhance the interaction between tutors, students and employers.

A survey and a full evaluation of the Pilot, including both qualitative and quantitative analysis of the collected data will be conducted at the end of January, 2012.

The table below shows some of the benefits and challenges we have identified so far as well as the relevant success factors we have considered.

TABLE I: BENEFITS, BARRIERS AND CRITICAL SUCCESS FACTORS (CSFs) OF THE ONLINE CoP

Benefits	Barriers	CSFs
Enhanced learning Environment.	Perpetuation vs. variety and flexibility.	Good use of Google Apps and other Web 2.0 technologies.
Knowledge sharing.	Culture of independence.	Institutional promotion of the online CoP as a communication media.
Building up knowledge and expertise.	Maintaining the interaction and information flow.	Common values, shared understanding, varied communications.
Feeling of connection.	Read-only participants.	Sense of purpose, sense of belonging, sense of ownership.

We believe that the case studies developed by IWBL staff will help to promote the concept of using online CoP at a wider level and will engage participation at university level and from many more organisations and individuals.

We share the case studies via the CoP web-site in order to support and disseminate good practice and innovations, both internal and external, in online and blended learning approaches, including greater use of social media.

#### VI. CASE STUDY 1: USING THE IWBL COP FOR EDUCATIONAL PROJECT DEVELOPMENT

The online CoP approach provides an ideal opportunity to support projects which have multiple shareholders, all of them aiming to contribute to a common outcome.

The immediate positive of such a tool is practical as it could enable a well structured project approach, make resources and on-going comments available at any time and remotely during the development stage, and would assist researchers and educators to effectively manage the project process, to collaborate and take the ownership of the final product.

At the commencement of a project, we established a suitable Google site (CoP) to develop virtual space where members of staff were able to share resources and

comments. This is work in progress, but so far, we have found that tutors share good practice and consider advice from internal and external advisers.

In addition, colleagues prefer addressing project issues on an ongoing basis through comments on the online CoP rather than reviewing negative aspects after finishing the project when it would be too late to make improvements. The project web spaces are used for reflection on the process of project development, and publishing of relevant project materials.

We have been using the CoP to develop two project proposals – a Joint Information Systems Committee (JISC) - UK bid proposal and a Higher Educational Academy (HEA) - UK travel fund proposal. We are using Google docs as the main tool for developing collaborative material. After achieving the final product we embed it within the online CoP and share it with staff through the CoP site. This creates the opportunity for the team members to learn from each other and to provide peer feedback.

A positive benefit from this collaborative approach was that it overcame many of the spatial and temporal difficulties often encountered when a project requires contributions from a large range of shareholders. The opportunity for very rapid feedback and subsequent development that moves the project on is continuous and uninterrupted by constraints often put upon projects by peoples' different responsibilities and locations.

#### VII. CASE STUDY 2: USING IWBL COP TO SHARE AND DEVELOP A SMALL PIECE OF ACTION RESEARCH

IWBL is increasingly developing programmes of study in partnership with large employers. Some of the challenges of such programmes are that they tend to roll continuously throughout the year and involve large student cohorts. This action research focuses on how we can best operationally manage such programmes. IWBL has considerable experience of supporting learning and assessment in a wide range of work based programmes and we interviewed eleven colleagues for their perspective on this process for this piece of action research.

The CoP is being used in two ways. Firstly, it is an alternative medium to 'writing a paper' about what emerged from this interview data for the IWBL colleagues who are the audience for the research. A Google website not only allows for non-linear representation of information, but for interaction with it. Academic staff can associate the units of information on each page and respond to them in the way they want. We hope this will be a creative stimulus to developing responses to the complexities of managing these large programmes, in a way that the familiar activity of simply reading a copy of a paper might not be.

Secondly, the CoP is being used as an exemplar of how all members of an IWBL programme team might collaborate and share core information about the management of an actual employer programme, for example, by being able to collaboratively develop material

using more types of media than just words (pictures, video clips, etc.) to give a richer picture.

This case study has highlighted that there has had to be a lot of learning for staff to understand what a Google website can do and how this can be made relevant to real and pressing needs in IWBL. For example, embedding Google Docs for colleagues to comment on and using a Google website to organise and display data in ways that are persuasive through their visual representation, are all processes that have had to be learned. Training and support have been crucial for colleagues to help them to master the technical action required to produce certain effects.

We hope that the outcome of this case study will be that collaborative CoPs like this can be used as long-term resources for employer-based programmes, since they allow for the organising, sharing and development of information across a whole 'programme team'.

However, we anticipate that the realisation of this will depend on the time and motivation of academic staff to do the hard graft of learning how to make the most of this new technology. This is costly in time and effort and would need technical support. The extent to which colleagues feel able to engage with the CoP developed for this piece of research will provide one gauge for the future value of this kind of resource in IWBL.

It is envisaged that a future development will be to make the employers active stakeholders. This should help to build the strength of the partnership by providing the employers a more active role and an involvement which will promote their understanding of the academic processes. Also by their comments the IWBL will get a better understanding of the employers' requirements. In other words, there will be promotion of mutual benefits in the partnership. Moreover, as [7] depicted, "Communities among practitioners create a direct link between learning and performance".

### VIII. CONCLUSION AND FUTURE WORK

Considering our initial experience for using the newly created online CoP, we conclude that Google Apps/Course Director and other Web 2.0 technologies offer educators a set of tools to support forms of learning that can be strongly collaborative.

Both case studies illustrate key benefits for using the online CoP: accessibility at any time and remotely, flexibility, collaboration and a sense of ownership of the final product.

We are aiming to extend the online CoP and involve not only IWBL staff, but also colleagues from other faculties, students, employers and other stakeholders to develop and cultivate cooperative relationships by posting and exchanging digital materials, joining project groups, sharing information and building up knowledge together.

The CoP is to be designed to support the development of collaborative resources, to gain access to e-resources and it is needed to protect and increase the value of the content for all stakeholders. We anticipate that the CoP will help to

continuously enhance the professional practices of IWBL staff and collaboration with other stakeholders, and that the coordinated and ubiquitous use of e-resources will provide increased flexibility, sharing, choice and support.

Further refinements of the online CoP should be able to effectively incorporate both existing and future developments in social networking taking advantage of methods of communications frequently used widely by many of the stakeholders.

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