Editorial

Charalampos Karagiannidis and Sabine Graf, Co-Editors
Davinia Hernández-Leo, Guest Editor

Welcome to the Bulletin of the IEEE Technical Committee on Learning Technology, Volume 14, Number 4, October 2012 issue.

This is the first issue which implements the decisions made in the last board meeting of the Technical Committee on Learning Technology during the 2012 International Conference on Advanced Learning Technologies (ICALT) in Rome. In particular, the name of the publication is changed to *Bulletin of the IEEE Technical Committee on Learning Technology*, the formatting of the articles is modified to comply with IEEE guidelines and the length of the articles is extended to 4 pages.

This issue is edited by Guest Editor Prof. ***Davinia Hernández-Leo***, and includes articles on ***Technology-Augmented Physical Educational Spaces***.

The issue also includes a section with regular articles (i.e. articles that are not related to the special theme). In this regular section, So & Lam describe a study which examines how Facebook is being used as a platform to communicate and to foster participation and interaction between students and other parties. Vu & Fadde describe a study which examines what characteristics, factors, traits, and classroom behaviors make an effective instructor in an online learning environment.

We sincerely hope that the issue will help in keeping you abreast of the current research and developments in Learning Technology. We also would like to take the opportunity to invite you to contribute your own work (e.g. work in progress, project reports, dissertation abstracts, case studies, event announcements) in this Bulletin, if you are involved in research and/or implementation of any aspect of advanced learning technology. For more details, please refer to the author guidelines at http://www.ieeetclt.org/content/bulletin.

Special theme of the next issue: "Eliminating boundaries: innovative learning environments to integrate formal, informal and on-the-move learning experiences"

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Deadline for submission of articles: December 15, 2012

Articles that are not in the area of the special theme are most welcome as well and will be published in the regular article section.

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Special Issue on Technology-Augmented Physical Educational Spaces

The introduction of technologies in physical educational spaces has brought new possibilities to education that are transforming the learning scenarios. Computational artifacts have moved from being conceived as a means to support distance communication to be elements embedded in augmented physical spaces that can enrich face-to-face learning experiences [2, 5].

Augmented physical educational spaces go beyond the desktop computing by using interactive artifacts and technological facilities derived from: tangible interfaces, mobile and ubiquitous computing, and augmented reality. In tangible user interfaces a person interacts with digital information through the physical environment. This type of interaction involves explicit contact with the computing artefacts [1]. Ubiquitous computing deals with situating and embedding devices (RFID, QR codes, location-aware services...) within a space so that computational power is available everywhere (wearable devices, roomware, mobile phones, ...) and the interaction with the devices is mediated through this space [3, 4]. These devices can also facilitate augmented reality scenarios, overlaying digital information to real objects to enhance the learning benefits.

The special theme of this issue focuses on the improvement and application of information and communication technologies to augment physical spaces for teaching and learning purposes. It includes 13 papers with authors of 8 different countries: USA, Canada, Israel, UK, Greece, Finland, Norway and Spain. The majority of the papers describe current research on specific technological approaches (tabletops, augmented reality, mobile learning, affective computing and backchannels) that enhance educational physical environments, while two papers call for reflection about teacher training/adoption challenges and the need of further advances in learning theory to understand the nature of our interactions with technology-augmented physical spaces.

In "A glimpse to the ambient classroom," Asterios Leonidis, Maria Korozi, George Margetis, Stavroula Ntoa, Margherita Antona and Constantine Stephanidis present several different technological solutions (an augmented desk, a study table, a tabletop for mini-games,…) that augment physical educational materials traditionally used in a classroom setting: books and paper cards. Similarly, Fotis Liarokapis describes a low cost Augmented Reality technology to provide students with an interactive augmentation of teaching material focused on computer graphics principles in his paper "Augmented Reality Interfaces for Assisting Computer Games University Students." With the

additional aim of promoting creativity, Michail N. Giannakos, Letizia Jaccheri, and Ioannis Leftheriotis in "Learning and Creativity through Tabletops: A Learning Analytics Approach," use tabletop applications in workshops to learn geometry in a creative context. Their approach includes the collection of extensive data that can be triangulated to offer a deep understanding of the learning behavior.

The integration of activities supported by augmented reality technologies with other types of activities is the focus of the paper "Orchestrating TEL situations across spaces using Augmented Reality through GLUE!-PS AR," by Juan A. Muñoz-Cristóbal, Luis P. Prieto, Juan I. Asensio-Pérez, Iván M. Jorrín-Abellán, and Yannis Dimitriadis. GLUE!-PS AR allows the automatic deployment of activities defined using multiple learning design authoring tools in widespread Virtual Learning Environments and Augmented Reality browsers.

Full-body motion as an integral means through which students express thoughts and meanings is studied by Zacharoula G. Smyrnaiou and Chronis Kynigos in "Interactive Movement and Talk in Generating Meanings from Science," where they apply kinaesthetic recognition of movement to enable bodily expression interaction with a collaborative digital game.

There are four papers in this issue centered on mobile learning. In "Routes of geolocated questions in formal and informal learning contexts," Patricia Santos, Mar Pérez-Sanagustín, Davinia Hernández-Leo, and Josep Blat describe three educational scenarios placed in different contexts that use the QuesTInSitu tool to design, enact and monitor interactive routes of questions for learning and (automatic) assessment in situ. From a perspective of game-based learning, D. Kohen-Vacs, M. Ronen, and S. Cohen in "Mobile treasure hunt games," introduce a mobile learning application that enables teachers to geolocate clues that can direct the students to specific places and activities. M. Pérez-Sanagustín, A. Martínez, and C. Delgado Kloos present a more general solution that supports the design and enactment of mobile learning scenarios based on digital tags (QR codes, NFC) in their paper "etiquetAR: a tool for designing tag-based mobile augmented learning experiences." Finally, design and quality issues of mobile learning activities are discussed by Abdalha Ali, Abdelkader Ouda, Luiz Fernando Capretz in "A Conceptual Framework for Measuring the Quality Aspects of Mobile Learning".

To enrich educational settings, the MAMIPEC project aims at applying devices for affective computing that can enable more inclusive personalized activities. Olga C. Santos, Jesus G. Boticario, Miguel Arevalillo-Herráez, Mar Saneiro, Raul Cabestrero, Elena del Campo, Angeles Manjarres, Paloma Moreno, Pilar Quiros, and Sergio Salmeron explain the project in "MAMIPEC – Affective Modeling in Inclusive Personalized Educational Scenarios." The integration of a classroom discussion backchannel is the objective of John M. Carroll, Honglu Du, Hao Jiang, Mary Beth Rosson, who in "ClassConversations: Keeping The Learning Conversation Going," describe how they combine a real-time chat among students that is publicly displayed during the class with an asynchronous knowledge-building forum.

Elisabeth FitzGerald in "Towards a theory of augmented place," inspires debate around the theoretical perspectives underpinning research into technology-augmented educational spaces, and the engagement by students with blended environments/spaces. This discussion is complemented by the paper "Facing Challenges with New Teachers' Use of ICT in Teaching and Learning" authored by Teemu Valtonen, Kati Mäkitalo-Siegl, Sini Kontkanen, Susanna Pöntinen, and Henriikka Vartiainen, who present a realistic view of challenges and needs for teachers' skills development to promote the use of technology-enriched spaces in pedagogically meaningful ways.

On the whole, this collection of papers represents an overview of different approaches where ICT can be used to enhance learning by augmenting reality or/and enabling complementary or richer activities in classroom and open spaces. The technologies are available and their potential is clear, now research challenges rely on a deeper understanding of their interactive and learning value. This profound understanding would enable the refinement of these technologies, the associated pedagogical methods, and the required teachers' competence development actions.

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A Glimpse into the Ambient Classroom

Asterios Leonidis, Maria Korozi, George Margetis, Stavroula Ntoa, Haris Papagiannakis, Margherita Antona, and Constantine Stephanidis, *Member, IEEE*

***Abstract*— Ambient Intelligence is an emerging field of research that has to potential to enrich educational environments. This paper discusses a line of research targeted to investigate and introduce innovative solutions for efficient learning in smart environments through integrating AmI technology in the learning process. The overall concept of the Student-Centric "Ambient" Classroom and the related hardware and software components are described.**

***Index Terms*—Ambient Intelligence, Educational technology, Computer applications, Human Computer Interaction.**

I. Introduction

AMBIENT Intelligence (AmI) is an emerging field of research and development that has the potential to enrich educational environments and enhance the notion of "Learning with the use of ICT". It can play an important role in education by increasing students' access to information, enriching the learning environment, allowing students' active learning and collaboration and enhancing their motivation to learn [6].

The AmI Classroom activity of ICS-FORTH investigates the role of Ambient Intelligence technologies in the educational context and in the classroom environment and provides intuitive and seamless tools to improve the learning and classroom experience, adopting a learner-centered approach that involves small groups of young learners throughout the entire development lifecycle of the various activities.

'AmI classroom' is used as an umbrella term meaning that classroom activities are enhanced with the use of pervasive and mobile computing, sensor networks, artificial intelligence, robotics, multimedia computing, middleware and agent-based software [4], [5]. In this context a set of "intelligent" facilities is developed to enhance the educational process by seamlessly integrating the physical and the virtual world both inside and outside of the classroom.

The hardware infrastructure includes both commercial and custom-made components that address the space and layout limitations of such challenging environments, and introduce innovative interaction methods that extend beyond the current desktop and menu driven paradigms [15]. The software infrastructure exploits the hardware layer to monitor the classroom environment and augment the learning process to benefit the learners. The AmI Classroom features sophisticated context-aware mechanisms that monitor and assess students behavior, provide user related data to the classroom's services and applications, assist the teacher to adjust the learning activities, deliver personalized content that addresses individual student's learning needs and promote collaboration. In the next sections the developed artifacts, setups and application frameworks are presented.

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II. The "Augmented School Desk"

In the context of AmI, the classroom is a challenging environment. In practice, there are severe space and layout limits to the introduction of AmI equipment, which should be unobtrusive, hidden or embedded in traditional classroom equipment and furniture. It is very important that such equipment can be installed smoothly and easily moved around in the environment, and that space requirements are as limited as possible. This implies several constraints on how the AmI classroom environment can be developed. To address this issue, the Ambient Classroom project has adopted an artifact-oriented approach, by stepwise introducing independent AmI augmented artifacts in the environment.

The first such artifact is the augmented school desk (Fig. 1), where an additional piece of furniture has been designed to fit typical school desks of standard dimensions according to EU normative[1]. Such an 'add-on' provides a custom plexiglass 27 inches diagonal wide screen whose inclination can range from 30° (with respect to desk surface) to completely horizontal. It embeds almost invisibly all the devices required for the operation of the AmI applications, and has a width of 40 cm, thus requiring relatively limited additional space with respect to the standard desk.

An important consideration in the design of the augmented school desk was that AmI in the classroom should be compatible with the school of today, as the anticipated transition to the paperless classroom did not appear so imminent. Therefore, as a first step, the augmented school desk and its educational applications smoothly integrates ambient interaction as well as digital augmentation of physical paper (e.g., [14]) by supporting paper-based learning materials and the use of handwriting. For that to be achieved, the desk

[1] EN 1729-2:2006 Furniture. Chairs and tables for educational institutions. Safety requirements and test methods.

integrates on its front side a camera that captures images of the conventional desk and a smart pen, while behind the screen two cameras implement a vision-based back projection multi-touch that avoids ceiling mounted or hanging projectors and cameras and ensures gesture interaction quality under variable lighting conditions.

Fig. 1: 3D model and materialization of the Augmented school desk

III. II. The "Ambient" Software

The software architecture of the "ambient" Classroom follows a stack-based model where the first layer, namely the middleware infrastructure, serves the interoperability needs of the classroom. The next two layers, namely the ClassMATE and the PUPIL frameworks, expose the core libraries and finally the remaining layer contains the educational applications.

The ClassMATE [11] framework is an integrated architecture for pervasive computing environments that monitors the ambient environment and makes context-aware decisions in order to assist the student in conducting learning activities, and the teacher with administrative issues (Fig. 2). ClassMATE features a sophisticated, unobtrusive, profiling mechanism that facilitates the classroom's students behavior monitoring and assessment, in order to provide user related data to the classroom's services and applications.

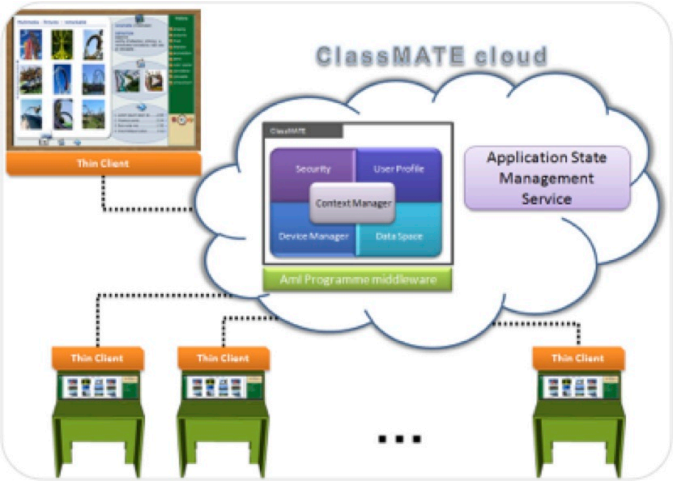

Fig. 2: ClassMATE pervasive computing and collaborative application infrastructure

The learners' record repository keeps track of every individual student's learning status by combining runtime information captured during interaction with semantic information coming from the context of use (e.g., a particular learning object) and produces statistics for the teacher that can potentially drive adjustments to the learning procedure. Besides monitoring, user profile is extensively used by the educational content classification and archiving mechanism to achieve personalized content delivery that addresses individual student's learning needs. Finally, taking into consideration that collaborative learning offers both a better learning experience and knowledge gain [7], ClassMATE simplifies the orchestration of such activities.

The PUPIL framework [9] facilitates the design, development and deployment of pervasive educational applications. Within ambient environments, and in particular inside the "intelligent classroom", user interfaces expand way beyond their static nature and become dynamic components able to react to contextual changes. In such environments every application can be launched, manipulated and migrated at any intelligent artifact.

PUPIL equips designers with a GUI toolkit targeted to support the development of user interfaces for smart classroom applications (Fig. 3). Each of the widgets contained in the toolkit can be appropriately adapted to achieve optimal display on various classroom artifacts maintaining their usability. The collection of widgets incorporates both common basic widgets (e.g., buttons, images) and mini interfaces frequently used by in educational applications (e.g., bookViewer), as ready-to-use modules. The designer can either (i) combine and customize widgets from both categories to build an interface just once, or (ii) build and incorporate it as a custom-made mini interface in the collection for future reuse.

PUPIL additionally introduces a collection of workspaces (namely Classroom Window Managers [10]) tailored to each artifacts' characteristics, that aims to deliver a sophisticated environment for educational applications hosting. A common look and feel is instantiated across the various classroom artifacts, thus transforming the classroom into a unified environment rather than a group of isolated units.

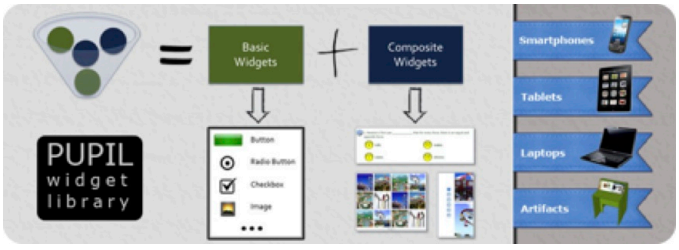

Fig. 3: PUPIL framework offers a widget library that incorporates common basic widgets and mini-interfaces frequently used for educational applications

The software applications for enhancing learning experience through the augmented desk build using the aforementioned frameworks currently include: (i) an individual personal area summarizing the current delivery status of all assignments, (ii) a dashboard for temporal storage, (iii) an exercise viewer that offers contextual help, (iv) a dictionary-thesaurus application, (v) a note-taking application, (vi) an application for viewing course related multimedia, and

(vii) language-learning games.

IV. SESIL

The SESIL system [12] introduces an augmented reality environment that provides seamless, context-aware support to students by unobtrusive monitoring their natural reading and writing process. This environment does not require any special writing device in order to monitor the student's gestures and handwriting, as it is able to perceive interaction with actual books and pens / pencils (Fig. 4).

Fig. 4: SESIL system in action

Through OCR techniques, the system recognizes words pointed by a student on a physical book and provides additional context-aware help in a near-to-the-student display. SESIL can thus enhance the learning process by unobtrusively and naturally providing additional information related to the current student's activity.

For example, it can be used in the context of learning a foreign language, or while learning one's mother language as a young student as the software provides:

1) Word preview, including up to three definitions for the given word, five representative images and five related videos
2) Dictionary data, including all the definitions available for the word, as well as synonyms and examples for each definition
3) Related to the specified word images and videos
4) Visited words history

V. AMI PLAYFIELD

AmI Playfield [13] is an Ambient Intelligent (AmI) environment for learning which offers an innovative approach, emphasizing the use of relatively low-cost kinesthetic and collaborative technology in a natural playful learning context, while also embodying performance measurement techniques.

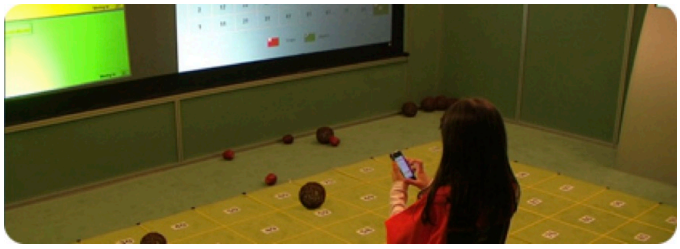

Fig. 5: Using the Math Controller to target a position

AmI Playfield is composed of the following modalities:

1) A vision-augmented playfield, capable of tracking the players' moves;
2) Various graphical user interfaces that illustrate game action dynamically from different views on a dual back-projection display;
3) A game manager used as a general remote controller, handled by a touch-screen;
4) A couple of controller interfaces, accessed through mobile phones
5) Sound facilities

A math game has been designed to help young students learn the four fundamental mathematical operations, using numbers from 1 to 100. The playfield consists of a carpet displaying 100 squares, some of which have an apple. Children are separated in two groups: the first group aims to collect as many apples as possible and the second one aims to catch their opponents. Children can move between squares by correctly calculating the mathematical operations (Fig. 5).

Output is provided multimodally with visual information displayed on a large screen for the whole class to view, and auditory feedback available for each player individually. Students' activities are monitored in order to provide appropriate personalized feedback, guidance and useful statistics. Currently, new kinesthetic games are being designed and implemented on the playfield infrastructure, including a multimodal memory game.

VI. THE "EDUCATIONAL TABLETOP MINI-GAMES"

The "Educational tabletop mini-games" [8] combine learning, entertainment and ambient intelligence to enhance the learning experience [1], [2], [3] and motivate learners through modern technology-enabled applications. Two games have been developed: (i) a multiple choice quiz game, and (ii) the "Place the landmark" geography-related game. Both games use physical cards as the primary interaction source. The computer orchestrates the game by monitoring the surface of a table for cards through a simple webcam and searching for potential matches.

When a known card is thrown on the table, an image recognition algorithm [12] finds the appropriate match. Subsequently, the game extracts, interprets and executes the corresponding command (e.g., select the answer of that card, place a virtual pin that represents the selected landmark on the digital map at the same location).

The "Multiple choice Quiz", as its name indicates, is a regular multiple-choice game in which players are asked to select the best possible answer out of the choices from a list. Instead of selecting an answer or a category using a traditional input device (e.g., mouse, keyboard, touch screen, etc.), players perform the same actions (e.g., selecting an answer or picking a category of questions) by throwing a physical paper card on the table; three different types of cards are contained in the deck: (i) cards that represent quiz categories and are used only for quiz selection, (ii) cards that represent answers and display the corresponding symbol (e.g., A, B, C, D), which can be used only during an active game session, and finally (iii) special-purpose cards (e.g., hints, back to menu, etc.) that can be used at any time.

Fig. 6: The "Place the landmark" customized for the island of Crete, Greece

"Place the landmark" was developed as a game that students could use to sharpen their geography skills (Fig. 6). This game engages students in a collaborative activity where they learn through experience and will retain that knowledge for longer. The player's objective is to identify and correctly place a number of landmarks at their right location on a map. For that to be achieved, the player has a deck of cards at his disposal, where each one represents a landmark (e.g., monument, sight, town etc.), and should be placed on the physical map mounted on the table.

When the player picks a card and places it on the physical map, a virtual pin that represents the selected landmark is placed on the digital map at the same location. While the player moves the card trying to spot its correct location on the map, the virtual pin trails its movement on the virtual map. As soon as the player places the card over the correct location, the virtual pin is fixed at that point, and visual cues notify the player about his right choice. The game provides two alternative types of assistance to the players. When a player throws a card on the map or selects a landmark, related content (e.g., multimedia and text) about that landmark is presented, while the player is able to browse through the provided information and explore the studied area in a more interactive and content rich way. On the other hand, if a player delays to identify the correct location of a landmark or keeps searching in the wrong direction, the appropriate part of the virtual map is highlighted indicating the whereabouts of the landmark.

VII. Conclusion

This paper briefly summarizes part of the work conducted for the AmI classroom environment in the context of the ICS-FORTH AmI Programme. Overall, the results of the conducted studies are very positive and confirm that AmI technologies have the potential to enhance the classroom learning experience. Ongoing work aims to fully support the initial concept. Applications targeted to the teacher are currently under elaboration, while mobile devices are considered to be excellent candidates for incorporation in the classroom. Finally, following full implementation, a full scale evaluation experiment is being planned, aiming not only to assess the usability of the proposed environment, but its actual impact in the educational process as well.

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Augmented Reality Interfaces for Assisting Computer Games University Students

Fotis Liarokapis, *Member, IEEE*

***Abstract*— This paper proposes the use of augmented reality (AR) interfaces for the construction of educational applications that can be used in practice to enhance current teaching methods as well as for the delivery of lecture material. The interactive AR interface has been piloted in the classroom at an undergraduate module of a Bachelor of Science (BSc) degree in Games Technology at Coventry University, UK. An initial evaluation was performed with fifteen students and qualitative feedback was recorded. Results indicate that the adoption of AR technology is not only a promising and stimulating tool for learning computer graphics, but it can also be incredibly effective when used in parallel with more traditional teaching methods.**

***Index Terms*—augmented reality, computer graphics, human-computer interaction.**

I. Introduction

Although current teaching methods work successfully, Universities are interested in introducing more productive methods for improving the learning experience and increasing the level of understanding of the students. The emergence of new technological innovations such as the Internet, multimedia, virtual and augmented reality technologies, was able to demonstrate the weaknesses of traditional teaching methods but also the potential for improving them. This evolution allows educationalists to make good use of a number of multimedia technologies to demonstrate phenomena's or explain complex theories to the students in a different way than the traditional methods can, thus overcoming some limitations.

Augmented reality (AR) has the ability of enhancing the real world by using computer-generated information that is projected onto the user's virtual environment. Users can visualize the superimposed information with a selection of display technologies and can interact with it in a natural manner by employing software interfaces, physical markers and hardware interaction devices. One of the earliest examples of research that applied AR to an educational context is the 'Classroom of the Future' [1], which conceptualizes how it could be possible to enhance interaction between instructor and students by employing AR technologies. Another example is the higher education collaborative AR learning system for mathematics and geometry education Construct3D [2] that allow teachers and students to interact through various scenarios. An alternative experimental education application demonstrates the AR enhanced teaching of undergraduate geography students about earth-sun [3]. In a similar AR application educators use AR to explain to students how specific parts of a computer could work in practice [4].

In another study researchers have compared the use of AR and physical models in chemistry education [5] and results showed that some students liked to manipulate AR by rotating the markers to see different orientations of the virtual objects whereas others preferred to interact with physical models to get a feeling of physical contact. Moreover, two modules, 'Solar System' and 'Plant System', were developed for mixed reality (MR) in the classroom, "providing support for classroom teaching and self-learning" [6]. This study was influenced directly by its perceived usefulness, and indirectly through perceived ease of use and social influence, and preliminary results seemed to indicate the participants' intention to use MR for learning. Elsewhere, researchers have studied the integration of physical objects that are computationally-augmented to support and encourage face-to-face interaction between disabled students and virtual objects [7]. Initial results indicated the importance of inclusion in novel technology enhanced learning approaches for science education.

In collaborative AR environments, multiple users may access a shared space populated with digital information and thus maximizing the transfer of knowledge [8]. A good example is the use of a real physical book for the development of a visually augmented reality book, however with drawbacks that include the affordances of the book resulting in book-like interaction by the users, which creates challenges in terms of technology deployment [9]. Another collaborative approach for teachers and trainees is an AR system that simulates a web-based training and teaching environment for distance education and training. AR may be used successfully to provide assistance to the user necessary to carry out difficult procedures [10] or understand complex problems. Demonstration in lecture and seminar rooms is one of the most effective means of transferring knowledge to large groups of people [11].

The main advantage of AR over more traditional teaching methods is that learners can actually 'see' and 'listen to' supplementary digital information. Additionally, students can intuitively manipulate the virtual information, allowing them

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to repeat a specific part of the augmentation as many times as they want. One of the main aims of this research is to contribute in resolving the perceptual discontinuities [12] initiated by scattered sources of information during the learning process. To better understand these discontinuities we have developed a prototype AR learning system focused on higher education with a particular interest in computing courses. The basic idea is an AR table-top learning environment that integrates the real teaching environment (i.e. lecture theatre) with virtual learning scenarios in a student-friendly and engaging manner. Tangible interfaces are the medium used to allow students examine and experiment with the virtual teaching material in a natural manner.

This paper describes the use of a high-level AR interface for assisting teaching at University level of 2nd year computer science undergraduate students in computer games technologies. Three-dimensional information can be superimposed in a student-friendly manner into the learning environment. The interactive AR interface has been piloted in the classroom at Coventry University at fifteen undergraduate students and they were asked to comment on the effectiveness of the system and whether it should be used as an additional tool for teaching.

The rest of the paper is structure as follows. Section II describes the method of operation of the AR interface. Section III illustrates different case studies of teaching in AR. Section IV presents initial evaluation results while section V summarizes conclusions and future work.

II. Method of Operation

The technical details of the interactive AR interface have been previously presented [13], [14]. The AR interface allows for the natural arrangement of virtual information anywhere inside the interior of the classroom (lecture or laboratory) or any other type of indoor environment. An overview of the system in operation is illustrated in Figure 1.

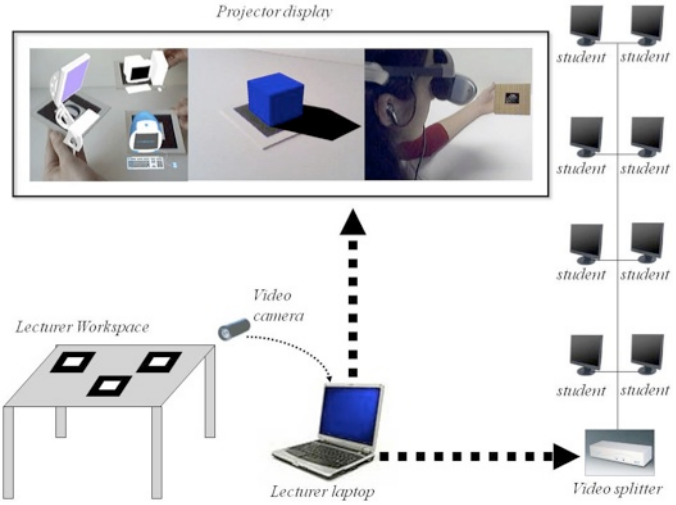

Fig. 1. Operation of the system.

In this configuration, a laptop computer with a USB web-camera, a video splitter, a plasma screen and a set of trained marker cards were employed. Depending on the capabilities of the splitter different configurations can be supported depending on the level of immersion and collaboration required. In terms of software technologies, the interactive application consists of a set of C++ classes which are in charge of controlling the tracking, visualization and interaction. In particular, the AR environment uses the vision tracking libraries of ARToolKit [15] while the graphics operations are built on top of the OpenGL API.

The lecturer can control the sequence of the AR presentation in a table-top environment according the student's pace. Pre-designed three-dimensional models can be selected and superimposed in the table top environment and students can either interact in their desks or in a collaborative environment (Figure 1). It is worth mentioning that this technology is used in conjunction with the traditional methods used (i.e. lecture notes, PowerPoint presentation, etc).

III. Teaching in Augmented Reality

The scenarios proposed are focused on enhancing the teaching and learning process for higher education and in particular for a Bachelor of Science (BSc) degree in 'Games Technology'. With this purpose in mind, computer graphics AR scenarios for a module called "3D Graphics Programming" have been designed to assist the lecturer to transfer knowledge to the students in other ways than traditionally has been the case. The AR interface offer the ability to use sophisticated techniques to achieve better user interaction with teaching material and complex tools. The provision of an interactive augmented presentation allows students a high degree of flexibility and understanding of the teaching material. Moreover, students do not need any previous experience to operate the AR interface technology successfully. To prove the feasibility of the application, different teaching scenarios from computer graphics theories have been investigated and implemented, including: *shading*, *transparency*, *hard shadows* and *environmental mapping*.

Shading in computer graphics is used for determining the pixels' color based on lighting computations [16]. There are three basic types of shading including flat, smooth and Phong shading, but only the first two were implemented because they are directly supported by OpenGL. In flat shading (Figure 2, a) the color of one particular vertex is duplicated across all the primitive vertices. This method is very simple and works very fast but it does not give a smooth appearance to curved surfaces because all pixels in the polygon as shaded the same. On the other hand, smooth shading, also known as Gouraud shading (Figure 2, b), is one of the most popular shading algorithms which interpolates light intensities across the face of a polygon using values taken from its vertices [16]. Gouraud shading is slower than flat shading but it produces a smoother appearance across polygons as it can be illustrated from Figure 2.

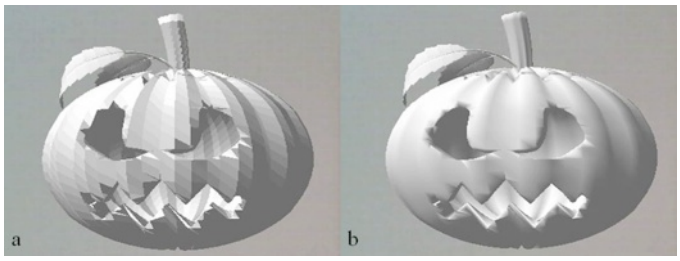

Fig. 2. Shading in AR (a) flat shading (b) smooth shading.

Texturing is used in computer graphics and modern games for increasing realism. Figure 3 illustrates the same textured object with different levels of transparency. Figure 3, (a), shows a 3D model with the alpha value close to unity (80% or 0.8) blending while Figure 3, (b) presents the same 3D model with alpha value close to zero (20% or 0.2) blending. This effect is very useful when occluding 3D objects are overlaid in the real environment. Similarly, to 3D games, using transparency it is possible to make the virtual object that occludes the others so that all objects are visible.

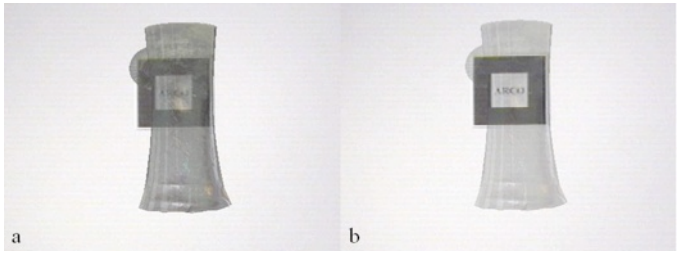

Fig. 3. Transparency levels in AR (a) less transparent (80% alpha blending) (b) more transparent (20% alpha blending).

Shadows play a very important role for the generation of a realistic scene in computer games. In reality, all objects have their shadows so augmented objects should have them as well [16]. In this work, only hard shadows were implemented. Two example screenshot that illustrate a 3D representation of the shadows generated from a simple AR cube (Figure 4, a) and an AR tree (Figure 4, b) are illustrated in Figure 4.

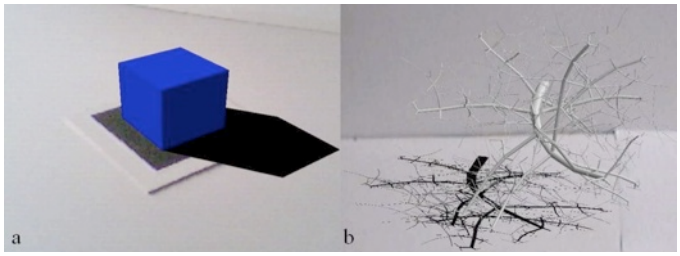

Fig. 4. Hard shadows (a) Canonical shape (cube) (b) Non-canonical shape (tree).

Environmental mapping (also known as reflection mapping) is a simple and effective method of generating approximations of reflections in curved surfaces [16]. It is usually classified as category of texturing technique and can be considered as a simplification of ray tracing [17]. The main advantages of this technique are that: (a) it is simple to implement and (b) it provides a rough estimation of reality. Two example screenshots illustrate how spherical mapping can be applied on a textured 3D model (Figure 5).

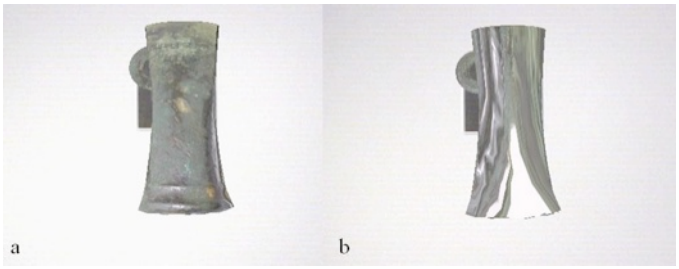

Fig. 5. Environmental mapping (a) simple texture mapping (b) sphere mapping.

Figure 5, (a), illustrates an augmented 3D model with simple texturing applied, while Figure 5, (b) illustrates the same 3D model with sphere mapping.

IV. Initial Evaluation

The AR application was presented to fifteen second year undergraduate students, studying the "Games Technology" degree at Coventry University. Different graphics scenarios were presented during lectures and laboratory sessions and feedback was recorded. This can be categorized into three types including: *visualization experience*; *interaction and movement*; and *usefulness in learning*.

As far as 'usefulness in learning' is concerned, all students agreed the presented technology is very promising and should be applied in the classroom. Most students were impressed with the capabilities of AR and liked using it for exploration and learning. In particular one said "by far the most interesting lecture I have ever had and made me want to explore more and more". Three students mentioned that 3D perception in a classroom is much better than 2D because it helps to visualize the atmosphere in a better way and looks closer to reality. Another said that the system sometimes was 'jumpy' and this could cause problems to people with visual impairments.

However, the feedback received for visualization and interaction varied. In terms of interaction, the majority of students were impressed with the interactivity of the AR tangible interface and noted that this provides an exciting means of collaboration between the lecturer and the students. Most of the students mentioned that interaction seems to be very easy a very enjoyable compared to other software tools (i.e. Flash, Authorware, etc) and one said that it is "the most interactive interface that I have experienced in the classroom". One stated that it is much better to interact with 3D objects using markers in AR rather than interacting using the mouse and keyboard. Another student said that it is better than traditional methods since it is closer to reality. Only, one student said that the interaction is confusing and suggested to use other manipulation aids (i.e. mouse or keyboard).

On the contrary, for the visualization experience feedback was mixed. In particular, for shading and environmental mapping most students preferred other multimedia technologies (i.e. videos, online tutorials) and they found that AR could be distracting to use. In the case of shadows and transparency, they all agreed that this is definitely an excellent

visualization medium. One particular student pointed out that the use of AR technology is the best means of teaching computer graphics principles since it makes it easier to understand the underlying theories and concepts for three-dimensions.

V. Conclusions

In this paper a low-cost AR educational and interactive environment for assisting teaching in higher education was presented. The main novelty of the system is that it can provide students with an interactive augmentation of teaching material focused on computer graphics principles in a compelling and engaging way. Three-dimensional objects illustrating some basic concepts of computer graphics and computer games were presented to both lectures and laboratory sessions.

The AR application was presented to fifteen second year undergraduate students, studying the "Games Technology" degree at Coventry University and initial evaluation results indicated that it is very useful to be able to 'see' and 'interact' with related computer graphics in three dimensions in some cases but not in all principles of computer graphics. Although some students were skeptical about the technology, the majority mentioned that this is a very promising technology for the future.

In the future, more computer graphics scenarios will be implemented and another study will be performed. In addition, the AR interface will be piloted for more computer games modules such as artificial intelligence and physics for computer graphics. Finally, the AR interface will be ported in mobile devices allowing students to enjoy the interactive AR presentation in alternative locations (i.e. their homes).

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Learning and Creativity through Tabletops: A Learning Analytics Approach

Michail N. Giannakos, Letizia Jaccheri, and Ioannis Leftheriotis

***Abstract*—The article presents the under progress project, Learning and Creativity through Tabletops. A series of workshops targeted to primary education students are being performed. In these workshops students enrolled with creative context and geometrical tabletop applications. Through these activities researchers are capturing a wide range of learning analytics data (surveys, observations, performance tests, interviews). These learning analytics provides an increased understanding of the learner behavior when he is enrolled with technology intensive creative activities.**

***Index Terms*— Art and technology, educational activities, educational technology, computer-supported collaborative learning (CSCL), Student experiments.**

I. Introduction

THE use of tangible tabletops in education has increased in recent years [1]. In addition to educational institutions, many businesses organizations, and government agencies use tabletops for a variety of purposes, from advertising, informing to collaborating.

While previous research has studied tabletops as a platform for efficient learning activities, only a few research studies have looked at the learner behavior with tabletops through learning analytics. For example, one of the pioneer projects named NIMIS used in elementary schools for reading instruction [2]. Another tabletop environment allows users to build a concept map by moving pieces of paper [3]. These and many other projects have demonstrated interesting results in the area [1]; however a learning analytics approach will shed light in the understanding of learners' behavior.

In order to cope up with the above challenge, we created a mixed reality based tabletop application to facilitate geometry learning for primary school children. Also we organize a series of workshops with a creative context, where students' engaged in the tabletop application. With students' engagement in the activity, we obtained a wide range of learning analytics data. By analyzing these data we aim to explore students' learning and behavior in a tabletop environment.

This work was carried out during Michail Giannakos tenure in the ERCIM "Alain Bensoussan" Fellowship programme. The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement no 246016.

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II. The Learning and Creativity through Tabletops Project

The Learning and Creativity through Tabletops project is based on a series of workshops targeted to primary education students and enroll them with Information and Communication Technology (ICT) media with an emphasis on tabletops. These workshops are successors of the Art and Technology (ArTe) workshops [4], which aimed to increase excitement and visibility of ICT among children.

The workshops (Figure 1) are being held at several places throughout the year (i.e., ReMida Center, IDI NTNU) and most of the times are linked to bigger events and meaningful context, concretely Creativity, Art and Technology.

The workshops are based on the Reggio Emilia education philosophy[1] of materials use and creativity. Each group was given the task to create a 3-dimensional character of materials and import digital images of these into the tabletop Geometry application (Figure 2).

Fig. 1. Snapshot of a Learning and Creativity workshop

In particular, the workshop program started with a development of a physical character by students (Figure 2, left), continued with capturing and editing cutout images (Figure 2, middle), and completed with students' enrolment with the application guided by their physical characters (Figure 2, right).

[1] http://zerosei.comune.re.it/inter/index.htm

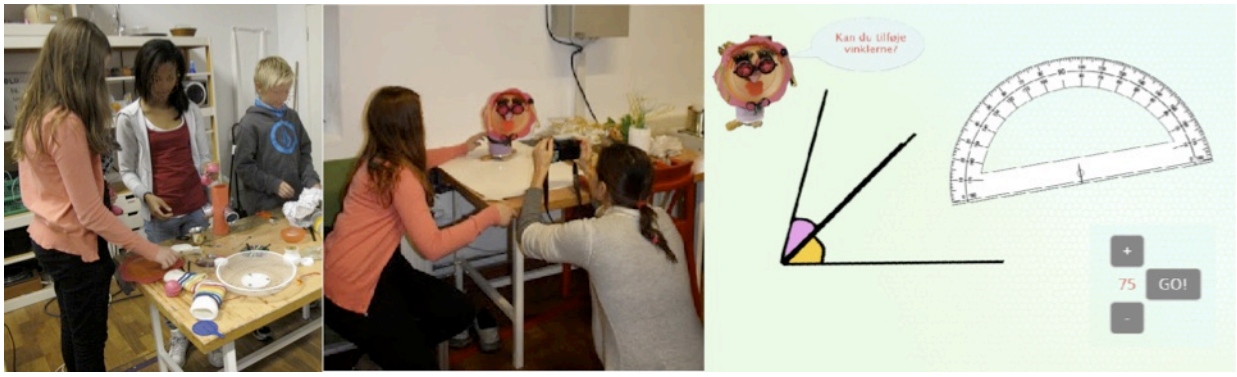

Fig. 2. Students' creating (left) and capturing (middle) the physical character; and the physical character guide them in the tabletop geometry application (right)

Geometry software applications enable learners to explore the dynamic behavior and capabilities of a geometrical construction, i.e. what remain fixed under given constraints. Other studies [5] have identified that students appreciate the ability to repeat a geometrical construction and measurement and play it step-by-step as allowed by software applications.

In our approach we attempt to take advantage of the above benefits and to expose students to constructive notions (i.e., algorithmic thinking, spatial abilities), which are useful for their reasoning skills. In addition we aim to exploit the visualization capabilities [6] of technology-enhanced environments and interaction capabilities of the tabletop [7]. As such, we selected to obtain learning analytics data through a tabletop application in geometry for constructing (Figure 3, up) and measuring shapes (Figure 3, down).

III. DATA COLLECTION AND ANALYSIS

A wide range of learning analytics data is being collected to address the research goal of this project, including log files, performance tests, surveys and interviews. In particular:

Interactions: One of the main data collection methods is the interactions (log files) of the students with the tabletop.

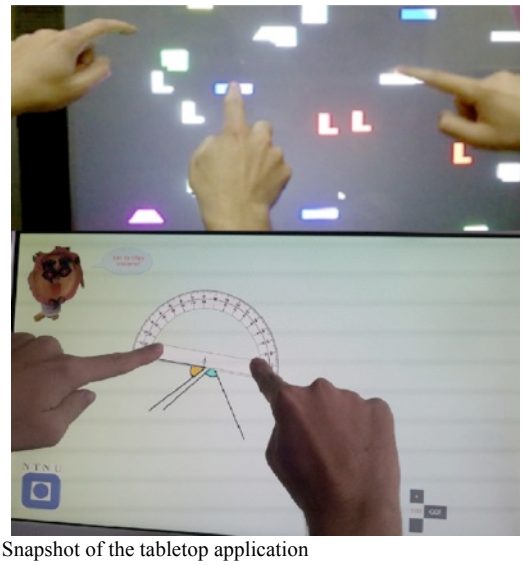

Fig. 3. Snapshot of the tabletop application

With the assistance of those user data we will be able to address several issues concerning the learner-tabletop interaction.

Interactions like: number of touches per task, distances of the touches and types of gestures (i.e., rotating objects, moving) are being captured; and analyzed through descriptive and correlation analysis. This data analysis might allow us or others to add proper pop-up quizzes or scaffolds, in the near future.

Performance: Data related to the learning performance of the students are being collected in order to investigate the relationship between the use of tabletop (in contrast with non-use) and students' knowledge acquisition. Performance tests, which are related with the tabletop geometry application, are used at the end of each workshop and provide an insight to students' progress.

Students' performance will be measured in order to analyze how the process of understanding and knowledge acquisition was affected by: the degree of (i) difficulty, (ii) interaction capabilities, and (iii) visualization capabilities on each one of the Geometry topics.

Perceptions: In addition to testing the performance of the students, students report their beliefs regarding the system. On that direction, surveys with attitudinal questions are being used.

Students' perceptions like: easiness-to-use, attractiveness, adoption, and usefulness will be captured through surveys and interpreted with students' game elements of the tabletop application (i.e., time, success).

Emotions: A qualitative approach is being adopted in order to study the emotional [8] situation of the students when they enroll with the tabletop. In addition to the video and photo capture of the students; semi-structured interviews and researcher observations are being undertaken during and at the end of the workshops.

In the captured videos and photos, content analysis based on students' emotions will be carried out. The signals (i.e., mouth smiling, eyes damp, lips pinched) of the emotions will be served as a guide for the coding. The sound and the images of the videos, as well as the verbal communication, will be used. Ekman's [9] emotional categories (i.e., anger, anxiety, happiness and sadness) will be used to assess emotions of

perspective students. In particular, the video-photo content analysis procedures will be consisted of the following three stages: (1) studying the emotions protocol (signals) and viewing several example pictures, (2) viewing the collected photos and videos several times, and (3) documenting the emotional situation of each participant of the video and photo. The data from the study will be coded independently by two researchers who have experience of learning technologies and emotions coding and based on the reliability testing (i.e., Cohen kappa) we will be able to understand which emotions are dominating in the enrolment of students' with the tabletop application.

IV. Discussion and Conclusion

In accordance with BECTA ''The question is no longer if technology helps learning, but what kind of learning and how" [10]. In our approach we aim to explore "what kind of learning" and "how" tabletop applications help students'. By investigating the aforementioned four learning analytics aspects, we will be able to improve learners' tabletop: a) experience, b) performance, c) adoption, and d) positive feelings, which are vital for successful learning (i.e., [11]).

We present a workshop program where children are engaged in creating artworks by using physical materials. We aim to explore the potential of this physical/digital combination as a means to increase students' interest in technology and to introduce them to become creators of new media expressions. One of the ideas underlying our work is to combine the physical use of materials and the digital aspects of tabletop capabilities to motivate and excite students.

The Learning and Creativity through Tabletops project attempts to provide an enrichment of the current knowledge regarding learners' behavior when they enroll with tabletops. The empirical data are being obtained from students (or learning analytics) are emerged as a necessity in the future of education, as clearly articulated by Siemens and Phil [12]. The outcomes of this project are expected to have a transformative impact on both the educational and the scientific communities. The communities will benefit from the learning analytics, which advance the understandings, potentials, and limitations of the usage of tabletops on education to yield the best practice and effective use thereof.

The combination of creativity and technology is a promising way to promote digital literacy among novice as young children. In current work we seamlessly incorporate a creative activity with a tabletop application in the area of geometry. By doing this we are able to collect wide range of data through a playfulness environment, analyze them and provide insights for students' learning through tabletop applications.

In the current phase of the project we have already conducted a series of creative workshops [4] with the open source software Scratch. In these workshops, we validated the procedures and extended our knowledge on learning in creative context. In addition we have completed the experiment methodology and we have planned to introduce the tabletop into the workshops at the end of October 2012.

Acknowledgment

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Orchestrating TEL situations across spaces using Augmented Reality through GLUE!-PS AR

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Abstract— **TEL situations may occur in multiple physical and virtual spaces, beyond a physical classroom or a VLE. Teaching in this kind of situations may become very complex, since the learning activities may occur across different spaces and times using diverse technologies. In order to help teachers in the orchestration of these learning situations, we propose the GLUE!-PS AR architecture. GLUE!-PS AR allows the automatic deployment of learning situations defined using multiple learning design authoring tools, and involving multiple physical and virtual spaces, in widespread Virtual Learning Environments and Augmented Reality browsers. A prototype is presented as a proof of concept, explaining the usefulness of such a prototype in a concrete learning scenario.**

Index Terms—**Augmented Reality, orchestration, Technology Enhanced Learning, ubiquitous learning**

I. Orchestrating ubiquitous learning through Augmented Reality

LEARNING, and especially Technology-Enhanced Learning (TEL) does not only occur in settings such as a classroom or a web learning environment (e.g. Moodle). Rather, learning takes place anywhere, throughout formal and informal learning spaces (e.g. at home, in field trips, in virtual 3D worlds, etc), thus leading to the notion of "ubiquitous learning" [1]. The acknowledgement of this ubiquity and the increasing variety of learning resources and tools has made the coordination of such learning by teachers a very complex task. Researchers refer to this coordination of multiple learning activities, tools, and contexts as *orchestration* [2].

Augmented Reality (AR), as a technology that displays virtual data along with the physical world, can be used to ease the transition of educative artifacts between learning experiences happening in the physical space and in other spaces, such as the Web or a 3D virtual world. Indeed, there is evidence hinting that the use of AR can provide learning benefits for students [3]. However, such research normally considers the AR-based learning activity in an isolated way, disconnected from the rest of the curriculum and the everyday life of authentic educational settings. Moreover, current applications of AR to education are usually ad-hoc systems, specific to particular scenarios, activities or pedagogies [4]. Thus, a practitioner desiring to implement AR activities across the whole curriculum would be forced to learn and master multiple authoring and enactment ICT tools. In conclusion, *current AR systems seem to pose strong orchestration challenges* in formal educational settings.

We present below a novel technological approach that enables teachers to orchestrate multi-space learning scenarios that include AR, by integrating existing and widely used sofware tools, including generic learning design authoring tools, mobile AR browsers, existing learning platforms (e.g. Moodle), as well as an extension of the GLUE!-PS infrastructure [5] to use AR artifacts (GLUE!-PS AR).

II. An approach to orchestrating learning across spaces using general-purpose AR browsers

The architecture of the GLUE!-PS AR proposal is shown in Fig. 1 (see also [6]). The main idea behind this architecture is to have a central set of services that allow for the deployment and run-time management of teachers' activity ideas (expressed in any learning design language) over multiple Web and AR environments. Learning design authoring tools for different pedagogies already in use, widespread learning environments (such as Moodle or Blackboard), and different freely available mobile AR browsers, are all made interoperable by this intermediate layer. In order not to increase the technological complexity faced by teachers, the proposed architecture reuses widespread existing applications and systems. Thus, blue clouds in Fig. 1 represent currently existing technologies, that GLUE!-PS AR integrates.

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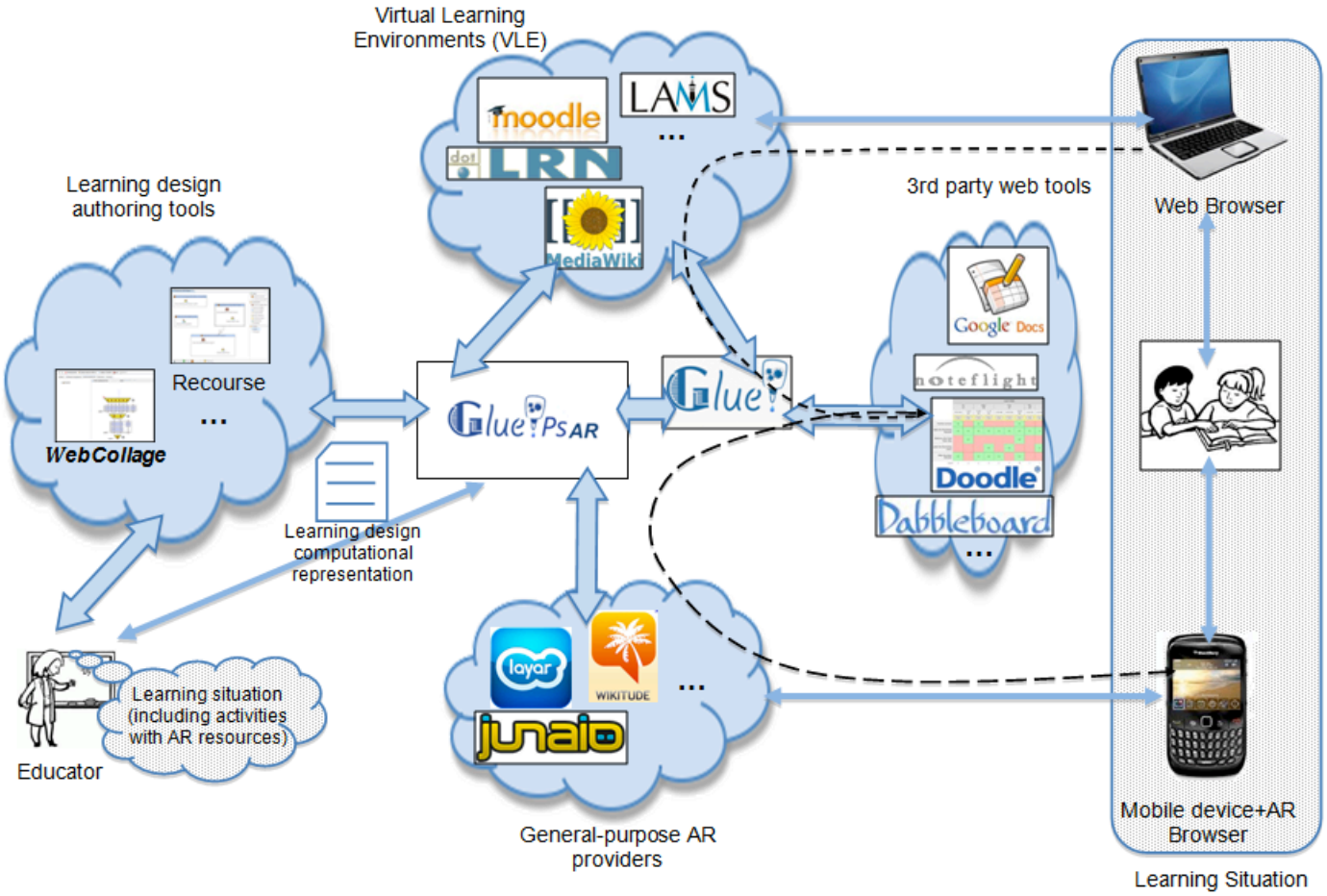

Fig. 1. General architecture of the GLUE!-PS AR proposal

Additionally, the proposed system also includes a Graphical User Interface for the teacher to particularize and/or modify the original pedagogical ideas according to her specific context, including the activities, students, groups, and very especially the location of AR resources in the physical space (e.g. by geoposition or tagging). Once the original design ideas have been introduced into a learning design authoring tool (left cloud in Fig. 1), the learning activities are automatically set up for the teacher, linking the activities in the virtual space (top and right clouds in Fig. 1, e.g. in a Moodle environment that integrates GoogleDocs documents in it) and in the augmented physical space (bottom cloud in Fig. 1, e.g. making the previously mentioned GoogleDocs available to certain groups of students through the AR browser, only in a specific location).

As we can see, this approach enables teachers to translate their pedagogical ideas (expressed through any learning design authoring tool that she sees fit) into the ICT infrastructure needed for her students to enact them, including not only web tools, but also other virtual artifacts available in physical spaces through AR. Also, the proposed system enables other important pedagogical affordances such as the sequencing and monitoring of activities and their resources, or collaborative techniques such as small groups communicating and accessing/generating different artifacts from different spaces.

A proof-of-concept prototype of this approach has already been developed. In Fig. 2 we can find a concrete example of the kind of multi-space learning scenario that can be made available to non-expert teachers through this prototype.

This scenario aims at promoting university campus knowledge in first-year undergraduate students through location-based collaborative activities, inspired in the scenario described in [7]. The activities follow the well-known jigsaw pattern, including also peer review activities.

From the point of view of the teacher, learning activities can be designed using *generic*, easy to use authoring tools such as WebCollage[1] [8], and then, through GLUE!-PS AR, the location of each resource (in the Moodle web environment or in a physical location) can be defined. Finally, the ICT infrastructure for the scenario is automatically deployed and accessible for both students and teachers (e.g. for monitoring purposes) across the web and augmented physical space (e.g. visible through an AR browser such as Junaio[2] in a tablet). Thus, the orchestration load of the teacher (compared with setting up such learning activities manually across the different ICT systems involved) is greatly diminished.

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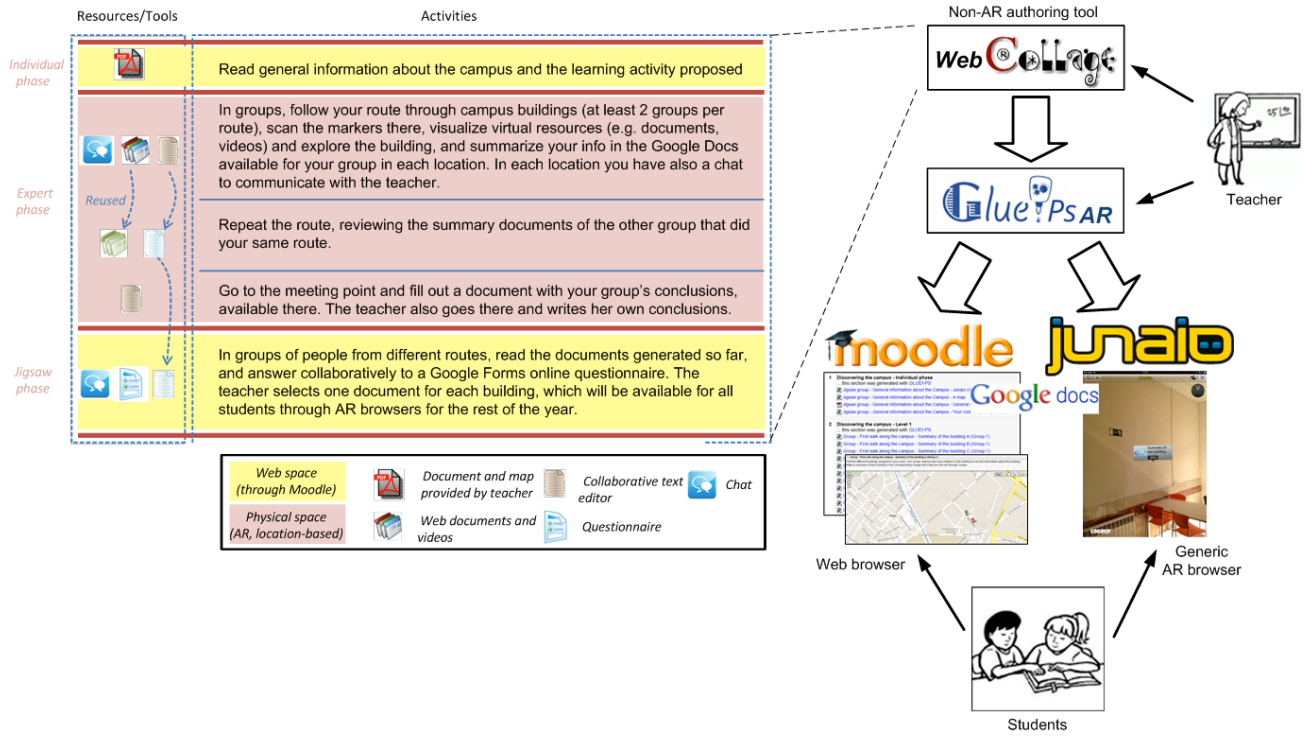

Fig. 2. Location-based learning scenario combining web and augmented physical resources, and screenshots of its implementation through the GLUE!-PS AR proposal

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Interactive Movement and Talk in Generating Meanings from Science

Zacharoula G. Smyrnaiou, and Chronis Kynigos

Abstract—In this paper we study language and full-body motion as an integral means through which students express thoughts and meanings when they interact with a set of collaborative digital games which we designed. The games rely on bodily expression based on the kinaesthetic recognition of the movement. Analyzing students' interactions as they played with a game we called "The Apples", we focused on their strategies expressed verbally in order to make sense of the scientific concepts embedded to the game. We also identified non-verbal strategies that enhanced the meaning generation process and were based on the use of different semiotic systems.

***Index Terms*—Meaning generation, students' strategies, body movement interaction, kinesthetic interface**

I. Introduction

In this paper we study language and full-body motion as an integral means through which students can express thoughts and meanings when they interact with a set of collaborative digital games we designed. These digital environments, which creatively involve interactions trough bodily movement, are set in an interactive educational gaming centre in Athens Greece, http://www.youtube.com/watch?v=d8AJwADKd90, called *Polymechanon*. The games rely on expression with body motion based on the kinaesthetic recognition (i.e. silhouette, location, gesture, bodily shadow, weight and position recognition) of the human body. The Polymechanon center includes eleven such collaborative games which embed scientific and mathematical concepts and are based on human control and interaction with digital and mechanical technologies. In designing these games, we wanted to move away from the individualistic and interactionist metaphors of kinect-like games and adopt a social collaborative paradigm for movement recognition games. We perceived verbal communication, body movement and the use of digital screen representations as semiotic systems used by children to communicate gaming parameters and explain the simulated phenomena on the screen.

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We were interested in the role that this language would play in this multi-semiotic environment including body motion.

Within science education and mathematics, there have been attempts which focus on the consequences of a semiotic system on others or on the connectivity different semiotic systems. For example in the field of mathematics, Morgan put emphasis on one semiotic system, language, and in the ways in which it may serve as a crucial window for researchers in the processes of teaching, learning and doing mathematics> She focused particularly on situations where mathematical learning activities are conceived of as socially organized, that is, not only taking place within a social environment but structured by that environment [1]. On the other hand, Kynigos suggests that the ability to combine, interweave, and play with different connected representations (e.g. graphs, text, movement) supports the understanding of the underlying concepts and helps in their construction [2]. In the field of science, Smyrnaiou et al stress the importance of natural language for the understanding of scientific relations in [3]. Their research led them to suggest that if the student is not able to understand the transformations relationally, in natural language, s/he is unable to do it with formal systems. There have also been interesting approaches to address body, motion and senses as representational means with which humans express ideas and reasoning [4]. The question that we addressed in our study was how to employ such frameworks in synergy in order to approach the design of kinesthetic interfaces for learning, by addressing all these representational means for human expression in a holistic way.

Several experiments have been conducted on how children learn as they interact with tangible interfaces of learning environments for children [5], [6] in order to express mathematical and scientific meanings [7], [8]. There have also been interesting attempts to use gesture by students and kinesthetic interfaces [9], [10], and [11] when the manipulation and movement of tangible artifacts affects digital representations.

The distinctiveness in the learning game discussed here is that it requires students to collaborate while they move about in order to interact with the digital medium and play the game. In studying how students play this collaborative kinesthetic game, we were interested to understand what meanings they developed through full body-movement, language and embodied interaction with the games' digital representations and how these meanings related to the science meanings embedded in the game.

II. DESIGNING INTERACTIVE LEARNING ENVIRONMENTS BASED ON EMBODIED THEORY - A MULTI-DISCIPLINARY APPROACH

Following socio-cultural approaches, interactive environments do not exist in isolation to the real-world but rather belong within a context where actors use common-sense practices to produce, analyze and make sense of one another's actions. “Situated actions” unfold in situ where participants act and interact within an environment [12]. It draws attention to the character of an informal interaction of people with technology in social settings rather than focusing only on the cognitive processes. Practice [13] is something more than doing, it is a process during which one investigates, acquires experience from the world. Collective practice relates to the shared experience and embodied interactions of individuals within a community of a common interest [14].

Following a psychological perspective, activity is a cycle that begins from the brain and, through the body and the world, returns back constituting knowledge. The power of cultural structure can lead to the transformation of the problem solving activity [15]. The way that a group of learners interact with each other and with the technology could lead to new forms of gaming and learning activities which the designers have not anticipated.

Embodied interactions [4] in technological environments, where metaphor theory [16] is put into use, associate actions of the entire body (as inputs) with auditory replies (as outputs). Results have shown that embodied interactions in an auditory environment improve the ability of using the environment for both adults and children [17]. However, other factors, including discovery, perception of feedback and duplicity of structural isomorphism can mediate for these benefits.

The subject area of mathematics and science affects the design of interactions, behaviors of digital artifacts and representations. Subject-oriented problems can be embedded in digital games involving connected representations and different kinds of interactions. For example a key element of mathematical thinking is the ability to abstract and generalize. Dynamic manipulation of representations of digital artifacts allows students to directly tinker with generalized objects rather than instances of such objects. Mathematical manipulations [18] have now become popular tools in mathematics since they offer important and creative learning opportunities as stand-alone or embodied in other computing media.

Gaming experiences in virtual multi-user gaming environments (such as Second Life and Active Worlds), as well as online mass games (such as World of Warcraft) provide opportunities to study users' experience with technologies from innovative points of view [2], [19]. The task of genuine integration between game-play and the learning objectives and outcomes is a key challenge for using games effectively [20].

The idea transcending the Polymechanon games has been to put into practice these theoretical principles in order to form a test-bed for exploring and playing with digital extensions to realistic games where representations and interactions embedded scientific concepts and powerful ideas. In the remaining sections of this paper we describe the study that we carried out to explore the kind of meaning sgenerated by the students during play with one of these games.

The digital game in question is an extension of a real ball game played in Greece in the old days where players throw a ball trying to get it to touch their opponents while they try to avoid this by moving out of the way either by moving their legs, jumping or body twisting. The extension to this game is through the digital representations, the bodily interaction and the computer in the role of the ball thrower.

III. A GAME CALLED 'THE APPLES'

We chose to focus on one of the games installed in the Polymechanon embedding concepts from newtonian physics and mathematics and providing graphical and body movement semiotic systems for interaction with the game. The ‘Apples’ game is one of four full-body games based on shadow recognition and one of two integrating concepts from science and mathematics.

In this game, the players try to avoid the graphical shapes they see on the big screen coming from the right hand corner of the screen towards their body shape which is also depicted on the screen. The way to do this is to either duck or jump at the right moment (figure 1). The game however is not a classic wii-style game where one individual interacts with the computer or two take turns. Three players try to avoid the objects in sync, if an object 'touches' one player they all miss a point. The players need to thus negotiate their positions, their strategy, maybe devise a management structure (e.g. one player calls out to the others what's coming or what to do).

Fig. 1. The players try to avoid the shapes moving at different heights.

Each shape moves at a different height. The players need to estimate the speed and position of shapes so as not to be ‘hit’ digitally. If the shape is at a medium height a decision has to be made on the spot whether to duck or jump.

In this collaborative game, the students have to use their whole body and not just their hands in order to win. Embodied interaction and verbal communication among them are vital. The strategies they will adopt play a decisive role. The concepts of time and height (displacement) in such an activity may constitute a matter of consideration for the students.

IV. METHODOLOGY

This preliminary evaluation study was performed at the Polymechanon with secondary school students, spread across the various exhibits in groups. The age of the participating students in the research was 12-15 (junior high school / middle school students). The total number of students who participated in the research and more specifically in the "Apples' game was 47. All students alternated in playing all of the full-body games in groups, while a team of three researchers participated in each data collection session, using video and audio recorders. Background data such as students' worksheets and researchers' observational notes was also collected and all recordings were analyzed verbatim. In addition, post-task interviews were conducted with all participants. No instructions were given to the players before or during their game playing experience.

V. DATA ANALYSIS

Even though all students played with all of the games, for the purpose of this study we limited our observations to students' playing, interactions, and responses concerning the "Apples" game. The questions asked concerned the strategies students developed and used implicitly or explicitly, their understanding of the embedded scientific concepts, and the verbal interactions among them. The students' answers were recorded according to sex, age, school type and school year. In analyzing the data, we first looked for instances where meaning generation processes seemed to emerge as the students interacted with the game. In addition, we paid attention to how they acted as members of a group and interacted with their class-mates and with the motion interface. Specifically, we looked at excerpts of students' play with the mobile interface in which they try to make sense of how the time, height, displacement and other scientific concepts affected their strategies.

VI. STUDENTS' STRATEGIES AND MEANING GENERATION PROCESSES

After the introductory activity in which the main point was to get familiar with the "Apples" game the college students played in teams. We observed that the longer they played the more their verbal interactions changed from action-centered to concept-centered.

The common strategies to avoid the bricks, as expressed verbally by the students during a post-task interview (table 1), are the following: "they jumped as high as they could", "they focused on the exact moment when they had to make the movement to avoid an object", "they focused on the height at which the bricks moved", "they estimated the time from the moment each brick appeared" or they gave no answer. From the students' answers regarding the strategies they implemented, we can come to direct or indirect conclusions related to the way they perceived the 'hidden' concepts.

TABLE I
STRATEGIES MOST COMMONLY IMPLEMENTED IN THE GAME "APPLES"

Strategies (expressed verbally)	%
We jumped as high as possible/ducked as low as possible	34,48
We focused on the height that the bricks moved.	16,09
We estimated the time from the instant each brick appeared.	6,89
We estimated how much time we needed to respond.	11,49
We focused on the instant we had to make the escape movement.	21,83
Other strategy	0,00
No answer	9,19

From the video recording, we also observed other more implicit strategies. Specifically, students moved outside the game area to avoid being hit by the brick and returned to continue, they moved as far left as possible to increase the time of the brick movement and thus have more time to think the type of movement they would make, they lay down on the floor to squeeze underneath the bricks, they formed a triangular shape, they move outside-inside, they accelerated, they did not collaborate at all, they did dance movements or scissor like leg movements, they stood very close to or very far from the interactive interface, they mimicked the player next to them disregarding the bricks, which usually led to a non-timely response, they imposed on each other when and what to do, e.g. grabbed the other player's hand and made him/her jump, they warned the rest when to jump and when to duck and "=of not surprisingly they larked around finding the game too challenging. These strategies influenced the meaning generation processes. The students depicted the kind of movement made by them as uniform (36,17%), no uniform (29,78%), or (21,27%) some other type of movement.

For example, they explained that as players, they moved around constantly since they moved 'continuously and everywhere', in a like zig –zag fashion or "other times to the front, other times to the back" or "an 'out' movement" when they moved outside the game area to avoid being hit by the brick. They explained that the bricks made a changing movement because "they moved continuously and everywhere", "other times high, other times low" and that their "speed changed". We assume that behind these strategies there is scientific content hidden to be found which is connected to the embodied interaction. If not in all, at least in some strategies.

VII. CONCLUSION

The purpose of the study described here was to explore collaborative embodied interaction with connected representations as an integral part of expressing scientific meaning in the use of full-body motion and language. The 12-15 years old we observed in these collaborative activities with

the "Apples" game seemed to perceive full body motion as a natural way to interact with the games without turning their attention away from the concepts and the need to negotiate about them. Analysing the students' interactions as they played with the game, we focused on their strategies expressed verbally in order to make sense of the scientific concepts embedded to the game. The verbally expressed strategies are revisited again and again as the students play and for some of them the rationale changed from action-centered to concept-centered the longer they played. However, it seems that there were many implicit strategies that enhance meaning generation processes and were based on different semiotic systems related to embodied or collaborative experience as the students played in order to avoid the shapes they saw on the big interactive interface. These strategies seemed to feed students' meaning processes, as the students played and observed the outcome of their strategies and reshaped their understandings accordingly.

The study has certain limitations that need to be taken into account when considering its contribution to design. It points to the need for a lot more research into how pedagogical and interaction design techniques can enhance the probability that students may draw added value in understanding the concepts themselves. A seamless integration of body movement and verbal communication as key representation registers added to the screen graphics is a task in itself. In our designs we considered inserting embodied learning in a context where interaction and connectivity with other semiotic systems may give it some added value in generating understandings of the concepts at hand. Our study shows that this issue has potential enough to be studied further.

In this sense, it is only the beginning in a series of evaluation efforts with players of different ages and games of different kinds. It is also a beginning in an exploratory process for identifying the kinds of semiotic systems needed for students and educators and the types of design aids for interaction designers seeking to develop digital games relying on tangible expression based on the kinesthetic recognition of the human body.

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Routes of Geolocated Questions in Formal and Informal Learning Contexts

Patricia Santos, Mar Pérez-Sanagustín, Davinia Hernández-Leo, Josep Blat

***Abstract*— This paper describes three real scenarios framed in different formal and informal contexts and subject matters where mobile technologies are used to augment the physical space for assessment in situ purposes. The scenarios use the QuesTInSitu *app*, which enables the creation and enactment of routes with geolocated questions.**

***Index Terms*—m-learning, smartphones, assessment in situ, context awareness, IMS Question and Test Interoperability**

I. Introduction

Mobile technologies offer the possibility of designing different types of innovative learning activities [1]. Especial interest is being shown in educational scenarios that require the combine used of smartphones and location-based systems (LBS). Current smartphones are equipped with sensors like: QR-Code/RFID/NFC readers, 3G/WIFI, Bluetooth and GPS, functionalities that have made these devices an adequate tool for carrying out location-based learning activities [2, 3, 4]. Authors distinguish between: (1) "*everywhere/everytime activities*" these activities benefit from the ubiquitous mobility that smart phones have; and (2) "*Located/Situated/Context-aware/In Situ*" activities which have to take place in a specific physical space related with the educational resources.

This paper presents three real scenarios where a system, named QuesTInSitu [5], has been particularly used to support assessment *in situ* using smartphones and GPS. QuesTInSitu is a software implementation based on the IMS Question and Test Interoperability and Google Maps to support assessment *in situ* (see Fig. 1). "Assessment *in situ*" refers to a type of activity where the questions of a test have to be answered in front of a related real location (*in situ*) having into account the contextual information of the environment. QuesTInSitu focuses on assessment activities that cannot be practiced without mobile devices and where the educational resources are dependent of specific real locations. During the edition of the route-test each QTI question is associated with a real geographical coordinate. When the student is in an area near the indicated coordinate, the question appears on the screen of the smartphone. Therefore, students need to be located *in situ* in the correct place because, in order to understand and answer the question, they will need to interact with the real environment (observing, touching, talking with people, etc.). In an assessment *in situ* activity students put into practice transversal abilities such as exploration, spatial and observation skills, in addition to the specific knowledge related with the content of the test.

Fig. 1. QuesTInSitu: an app for supporting assessment *in situ*

QuestInSitu provides an authoring tool that enables teachers (or other roles, including students, depending on the educational scenario) to create geolocated questions and tests (routes). Then, students while using the QuesTInSitu mobile *app,* share (transparently, "without knowing") their geographic position. When they are placed in the specific positions pre-defined by the teacher, the questions are visualized automatically. Moreover, teachers can monitor, in real time the students' progress (locations, punctuations achieved).

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II. Scenarios in formal and Informal learning contexts

Diverse experiments have been carried out in different formal and informal real educational scenarios (bachelor, university, and senior learners), in diverse subject matters (urbanism, artistic history, botany, literature). They show how QuesTInSitu activities can be applied in formal and informal learning contexts (see Table 1).

TABLE I
SUMMARY OF THE THREE QUESTINSITU SCENARIOS

Learners	Context	Topic
Bachelor	Formal – Secondary School	Urbanism, Geography, History Art
University	Formal – University Degree	Botany
Elder learners	Non-formal informal – Lifelong Learning center	Literature

QuesTInSitu has been used with bachelor students of a formal educational context, a secondary school. The teachers designed routes of questions related with the concepts studied in class in the different subjects. In Discovering Barcelona! six routes where created to reflect about the urbanism of six different districts of the city of Barcelona. Students interacted with the environment, talked with the citizens and observed details of the architecture and the street furniture with the objective of solving correctly the questions [5]. In the same educational level, students from other public school did a route created by their teacher with the objective of assessing their knowledge about art history of the city of Girona. In this case, students had to solve the maximum questions (of a total of 70) geo-located around all the old town of Girona (see Fig. 2).

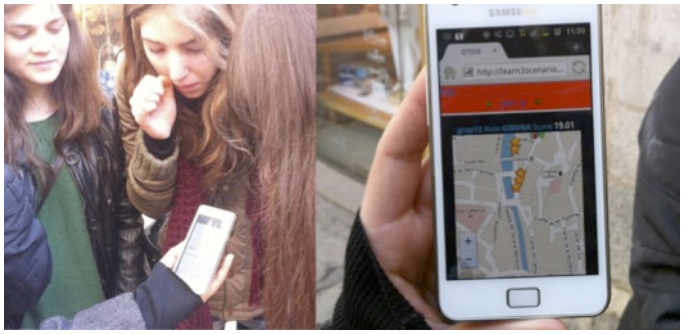

Fig. 2. Discovering the city of Girona

Another example of formal learning is the case of a botany professor who used QuesTInSitu with her university students to answer questions *in situ* observing the Barcelona botany garden. The goal was to facilitate a scenario enabling students to put in practice their skills in a real botany environment. Students' in situ desired actions included finding, touching and measuring specific plants. The students had to identify specific plants and interact with them when questions appeared in specific parts of a botany garden. They could use their class-notes (see Fig. 3), books or Internet web-pages to solve the questions.

Fig. 3. Assessing Botany *in situ*

The last scenario was carried out with a group of senior learners (average of 70 years old) formed by members of a literature group. These learners participate in a lifelong-learning center focused on non-formal learning courses and informal learning activities. Their interest was to use QuesTInSitu to create two routes of questions (answered by two different teams) with the aim of proposing questions about facts of a literature novel set in a district of Barcelona. The activity allowed them to observe with more realism the facts and areas cited in the novel and answer questions created by their peers (See Fig. 4).

Fig. 4. A literature adventure with elder learners

III. Conclusion

The results obtained in the evaluation of the experiments show how teachers were able of assessing specific and transversal higher-order skills, promoting the practice of real-life tasks. The experiments also show that, the combination of: diverse technologies (smartphones and GPS), adequate learning environments (e.g. a city for learning town-planning concepts, a natural park for learning botany …) and the use of enriched information (e.g., the physical objects, web2.0 maps, QTI questions) for representing and interacting with question-items and tests, leads to more authentic and formative assessment scenarios.

As future work, we plan to deeply evaluate the results of these scenarios in order to analyse the educational benefits of this type of activities in different types of learning scenarios, and the factors that teachers have to take into account when designing assessment *in situ* activities and routes.

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Mobile Treasure Hunt Games for Outdoor Learning

D. Kohen-Vacs, M. Ronen, S. Cohen

***Abstract*—We present an effort to provide teachers with a dedicated environment for designing location based games conducted via mobile phones. Treasure-HIT allows teachers to define a set of locations (using Google Maps and Google Street APIs), to attach clues that direct the players to the locations and to offer specific activities for each location. The system is primarily aimed to support the outdoor learning activities of the subject My Village as part of the national curriculum for elementary schools.**

***Index Terms*—Treasure Hunt, Mobile Learning, Location Based Games**

I. Introduction

The recent vast availability of advanced mobile technology offers new opportunities for extending learning activities beyond the traditional boundaries of the classroom [1]. These technologies facilitate seamless learning across learning contexts [2, 3]. Learning applications supported by mobile technology could be adapted to different kind of spaces like museums [4], urban areas [5] and outdoor archeological sites [6].

One of the approaches of combining the outdoor space in learning is by Treasure Hunt type games. In such games, participants are challenged to identify specific sites according to clues and to reach these sites. An additional activity could be assigned at the sites as a condition to advance in the game. The game could be played by individuals or by teams.

Treasure hunt activities represent an old game based pedagogical approach that was traditionally enacted without any technological means [7]. Mobile technology can provide direct support for such games by: tracking participants' locations in real time, presenting the game clues in various multimedia formats, enactment of pre-planned interactive activities related to the sites, collecting and sharing digital information contributed by the participants, communication between participants and with the game's instructor and controlling the activity by the game manager.

Various types of mobile treasure hunt environments were recently developed enabling the authoring and enactment of such games for different purposes.

GeoCoaching [8] is based on GPS enabled mobile devices that also provides constant online communication between participants. The communication component allows participants to share different resources during the game like clues, pictures or general text. Scavenger [9, 10] was developed to create treasure hunt activities aimed for intra-organizational training. Skattjat (treasure hunt in Swedish) [11] was designed to support collaborative problem solving. fAR-Play [12] serves as a framework that supports augmented/alternate reality games, in a treasure-hunt style, using space as the context for communicating information. These environments are not necessarily designed for pedagogical use by school teachers and do not provide cross culture support.

We aim to provide teachers with a dedicated environment for designing location games conducted via mobile phones. Our efforts are specifically directed towards adapting the technological capabilities to the teachers' needs while involving teachers in the design process.

II. The Treasure-HIT

Treasure-HIT represents our ongoing efforts to develop a treasure hunt game authoring environment that supports learning across spaces [13]. The system includes two components: an authoring web environment used by the teacher to create and control activities and the player's application used by the participants (students) during the game enactment.

A. The Authoring Environment

The authoring environment enables teachers to create and share activities. The activity definition includes the location setting for each station, the sequencing of the stations, the clues and activities related to each station and the feedbacks provided to players during the game. A created activity is stored in the activity repository and can be viewed by other teachers then duplicated and changed in order to adapt it to different needs.

The location of a station is set by a simple web interface that embeds Google Maps API, by positioning the marker anywhere on the map. The teacher can also control the

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minimal required distance from the site (Tolerance), within the limitations of the GPS technology.

Fig. 1 presents an example of defining a station in the game

Fig. 1. Using Google Maps by author to mark treasure hunt stations

and the allowed tolerance.

Since the game may require exact sites of interest that may be difficult to pinpoint in a regular two dimensional map, further position refinement could be achieved using an additional interface that incorporates Google Street View API. Fig. 2 presents an example of fine positioning of the marker (symbolizing the station) on a real picture of the environment.

When defining a station the author is required to attach clues that would direct the players to each station. These clues

Fig. 2. Using Google Street view by author to refine stations' position

can be textual, uploaded images or links to websites (like YouTube). Each station has to be assigned with at least one clue.

The author can define whether all players will share the same starting point or the system will auto assign random starting points. The author can also define the sequence of the stations in the game. The sequence could be automatically determined by the environment according to specific requirements like provision of the shortest and distinct path for each of the participants. The sequence of the stations can be identical for all participants or not, according to author's definition.

The author interface provides an ability to attach specific tasks to be performed by the players in each station, as a condition for advancing in the game. The task presented in a station may include quizzes or requirements for collecting different types of information that will be later used for class learning.

The author defines the special feedback that will be provided to players when they have reached the final station ("the treasure"). If the end station is identical to all, this feedback may be related to this specific site. If the players' paths are different, a generic feedback would be used to notify the player that he has completed the game.

The Treasure-HIT technological architecture provides a built in API that supports connectivity of the environment with other learning platforms. This feature enables teachers and students to use learning artifacts contributed in external environments in a Treasure-HIT game. For instance, a prior activity may involve students' in the definition of the sites of interest. Then, students may contribute the data on the location of the stations and their clues in other systems (like LMS) and this information could be imported to the Treasure-HIT author environment.

In the next versions the author environment will also include control and communication facilities allowing the teacher to follow the players' activity and to communicate with them in real time.

B. The Player Environment

The Treasure-HIT player application serves for interaction during the game. It provides the clues for each station, verifies player's location, displays feedbacks and presents additional activities according to the player's performance. The interface was designed according to recent mobile users demand requiring support for cross platform mobile operating systems (MOS) [14]. Treasure-HIT provides support for a variety of GPS enabled mobile devices like IPhones and Android based devices that are commonly available to students.

Prior to activating a Treasure-HIT game for the first time, the user is required to install the Treasure-HIT player application according to the MOS used by his personal mobile device. Then, the user can to log in to the specific activity by entering a unique identifier that was provided by the teacher.

The player is presented with the initial instructions about the game and directed to his starting point. Clues directing to the next station are provided in various forms (text, pictures, and video). The player is challenged to identify and reach the station according to these clues. An example of clues provided to the player is illustrated in Fig. 3. When the player assumes that he has arrived to the desired location, he can verify his position by pressing the "Check Location" button (Fig. 3).

This action triggers the GPS location tracking.

If the detected location is within the tolerance range from the defined site, a confirmation will be provided and the activity will continue according to the author's definition:

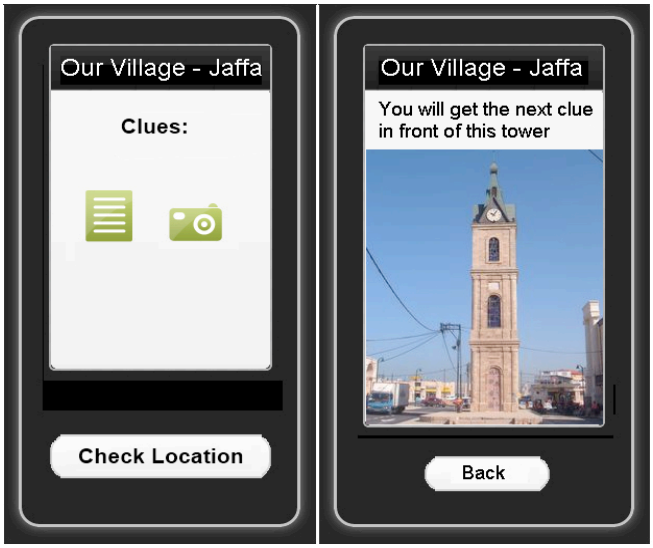

Fig. 3. Treasure-HIT end user's interface

specific tasks related to the site may be introduced and after their completion the player will be presented with the clues for the next station.

A Treasure-HIT activity can be enacted in different modes: as a competition between individuals or teams playing at the same time or as an activity to be performed by students in their time of choice. Younger students may be accompanied by their parents.

III. IMPLEMENTATIONS AND TESTING

The first version of Treasure-HIT is currently tested with sample users in order to ensure technological stability and to verify the usability of the authoring and the player interfaces for the specific target population. Large scale testing with teachers and students is planned for the academic year 2013.

The national curriculum for elementary schools includes a comprehensive unit focusing on My Village. This unit is aimed to familiarize students with their close vicinity, to learn about its history and geography and to be aware of the local sites of interest. The teaching of this unit usually includes various outdoor activities combined with the class sessions and home assignments. The teachers in each school design their own activities, adapted to the specific characteristics of the school locality, according to the general curriculum guidelines. In small villages some of these activities may be shared by several schools.

Incorporating mobile treasure hunt activities in the teaching of My Village unit is part of the effort of the ministry of education to enhance technology supported learning and to take advantage of personal devices available to students for conducting outdoor activities. Training sessions organized by the ministry of education with groups of teachers form 10 municipalities will start in December 2012. Teachers will design treasure hunt activities and enact them with students. A thorough evaluation study will accompany this implementation aiming to identify limitations and challenges and to adapt the system to the specific needs of teachers and students.

We expect, and hope, that teachers' pedagogical creativity will affect and improve the design of the system and will ultimately provide a collection of resources that other teachers can later use as examples.

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EtiquetAR: a Tool for Designing Tag-based Mobile Augmented Reality Experiences

M. Pérez-Sanagustín, A. Martínez, and C. Delgado Kloos

Abstract—**This paper presents etiquetAR, a web-mobile-based tool for supporting the design and enactment of mobile augmented learning experiences based on tags. etiquetAR is based on the idea that digital tags (such as QR codes and NFC), when attached to a particular object or location, add a digital layer of information that extends and transforms physical spaces into digitally augmented spaces. We present two illustrative scenarios that use etiquetAR in combination with smart mobile devices to augment a physical space for supporting a tag-based mobile augmented learning experience. These scenarios are two examples to inspire future work towards the design and enactment of novel mobile learning activities based on tags.**

***Index Terms*—Mobile Learning, Tags, Augmented Spaces, QR Codes**

I. Introduction

The advent of mobile smart devices in combination with electronic and software advances has transformed the way we interact with our physical surroundings. Novel applications propose new forms of interactions that superimpose layers of "digital" information over physical spaces transforming them into *augmented physical spaces*. Learners can interact with these augmented physical spaces using their mobile smart device for connecting anytime and anywhere to remote places, resources and people. These augmented spaces extend the boundaries of the learning experiences offering new opportunities for education.

There are many researchers exploring how to benefit from the *anywhere* and *anytime* capabilities of mobile smart devices in combination with other technologies for creating digitally augmented spaces with learning purposes [1, 2]. However, in this paper, we focus only on those approaches that use tagging technologies such as QR codes and RFID/NFC tags as the means for augmenting reality. For us, these tags facilitate the access to layers of contextualized information over an object or a place.

Recently, several studies have started to explore the learning benefits of using tagging technologies such as RFID/NFC or QR codes in educational contexts for augmenting the space. For example, in a paper by Ramsden (2008) [3] the author proposes different situations in which using QR codes can augment the students' learning experience: for a students subscribing to RSS news feeds, to augment printed learning materials, to integrate an alternate reality game or to provide *just in time* information in a face to face lecture. Liu et al. (2007) [4] use QR codes to superimpose a 3D animated virtual learning partner (VLP) to particular zones for improving students' English level. Another study by Ghiani et al (2009) [5] presents a location-aware museum guide for supporting museum visits based on RFID tags. Other studies show how QR codes can be used as scaffoldings in a paper-plus-smart phone learning context [6], or as the means to reduce the distance between the students and the learning materials [7].

However, and despite of the increasing number of initiatives in this line, the adoption of these tag-based experiences is still very low in education. One of the reasons is the lack of tools specifically created for supporting these types of experiences. Currently, there are several tools for generating QR codes and for configuring NFC tags, but none of these tools has been designed with learning purposes. This means difficulties for both practitioners and students to create novel learning experiences using tags. We need simple and easy-to-use tools for facilitating practitioners and learners the design and enactment of their tag-based experiences.

I. etiquetAR: tagging your learning experiences

This section presents the first prototype of etiquetAR. In this prototype the tags are QR codes, but we plan to extend the application for supporting other types of tags such as NFCs. etiquetAR is composed by two applications: (1) a web-based application for supporting creating, personalizing and managing tags and (2) a mobile-based application for accessing the information hidden in the tags. You can sign up for the first prototype of the tool here: http://www.etiquetar.com.es.

Fig. 1. **etiquetAR Web-based page**. This page can be access at: http://www.etiquetar.com.es.

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A. *etiquetAR Web -based application*

Both practitioners and students can create, personalize and print their interactive tags (QR Codes) into three simple steps: (1) create a tag, (2) link the resources to a profile and (2) print.

(1) Creating a tag: Once signed up the user is redirected to a home page. This page shows the list of tags created by the user and the buttons to create, delete or update a tag (Fig. 2).

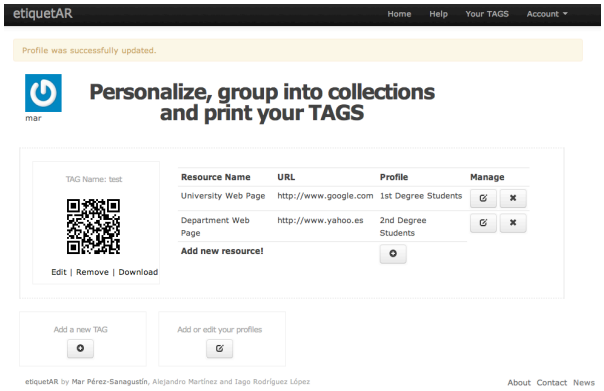

Fig. 2. **User's home page**. This page shows the list of the users' tags. In this page the user can create, update or delete tags.

When clicking on the button "Add a new TAG" the user is redirected to the page *Create a new TAG* (Fig. 3). In this page, the user has to fill in the information about the new tag: (1) the name of the tag, (2) the name of the resource that s/he wants to show in this tag and (3) the URL linking to this resource (text, images, videos…). One tag can be associated to more than one resource. The user can add as many resources as s/he likes using the button "Add new Resource". Once created, the tags can be updated or deleted.

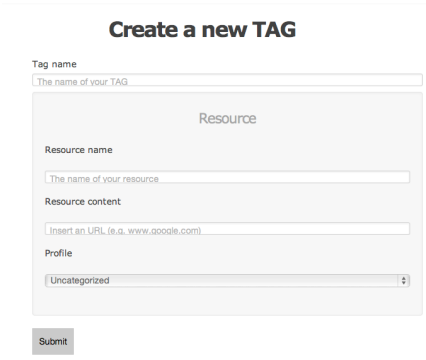

Fig. 3. **Create a New TAG**. The user can create as many tags as s/he likes and each tag can contain more than one resource.

(2) Linking resources to a profile: Each of the resources of a tag can be associated to a particular profile. The profiles will be used to personalize the information attached to the tag. By default the resources are not associated to any profile, but the user can create their profiles clicking on the button "Add or edit your profile" (Fig. 4), i. e. "Profile for 1st degree Students" and "Profile for 2nd degree students". Once the profiles are created, the user can get back to the home page and update a tag relating its resources to a particular profile.

Fig. 4. **Edit profiles**. The user can create profiles and relate them to the different resources for personalizing the information access to a tag.

(3) Print the tags: Once the tags are created and personalized, the user can download them as a *.png* image and print them. The printed tags can be attached to any object to or location.

B. *etiquetAR Mobile-based application*

One of the advantages of etiquetAR is that it does not require any specific application to read the tags. Since the tags are generated using the QR standard [8] any QR Reader can be used to access the tags information. Therefore, if the users have already a QR Reader installed in their smart devices (Android devices have a native application installed by default) users can interact with the tags and access to its associated resources. If the user does not have any QR Reader installed, s/he can download any from the current applications available[1].

When reading the tag, two situations are possible. First, if the tag accessed contains one or more resources but they are not associated to any profile, the user would be redirected to the first resource associated to the tag during its creation process. Second, in case that the tag accessed contains resources associated to a profile, the user would be redirected to a "Profile selector" page where s/he will be asked to select one of the available profiles (Fig. 5). Afterwards, the user will be shown only the content associated to that profile.

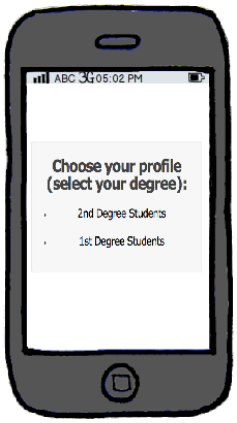

Fig. 5. **Profile selector**. The user can create profiles and relate them to the different resources for personalizing the information access to a tag.

II. TWO ILLUSTRATIVE SCENARIOS USIGN ETIQUETAR

This section presents two scenarios "Discovering the Campus (2012)" and "Discover the kidnapped scientist". Each scenario describes a tag-based learning experience taking place at two different augmented spaces. In both scenarios etiquetAR is used for generating the tags to augment these spaces: an *outdoor* space in the first scenario and an *indoor* space in the second one.

A. *Augmenting outdoor physical spaces*

"Discovering the campus 2012" is the third edition of a learning experience that takes place every year since 2010 at the University Pompeu Fabra with first-year students of engineering degrees [9]. The main objective of the experience

[1] QR Readers List: http://www.mobile-barcodes.com/qr-code-software/

is facilitating students a first contact with the university campus, its services, community, at the same time that they meet other freshmen.

For the experience teachers prepare tags containing information about the different campus services. These tags are distributed in key physical points of the campus buildings. Students use *smart mobile devices* to interact with the tags and access to videos, pictures, sounds that augment the information about the physical spaces of the campus.

In the 2010 and 2011 editions, teachers used NFC tags to digitally augment the campus. However, using NFC has some limitations. On the one hand, a special application based on a J2ME developed is required for recording the contents in the tag. This application is difficult to use: the user has to be physically touching the tag to record any content and, once recorded, the tags cannot be rewritten until the experience is finished. On the other hand, students cannot use their own smartphone because, currently, there are not many devices that include a NFC reader. Also, all students access to the same content, since the NFC tags are not prepared to contain different contents depending on the students' profile.

To solve these limitations, in this last edition of the experience (2012) teachers used etiquetAR to generate the tags. Two different teachers were involved in the tag generation process. Every teacher was in charge of generating content of a different area of the campus. Since the tag does not change depending on its content, teachers could change the content anytime once the tag was generated (before, during and after the experience). Also, teachers used the profile functionality for adding different contents depending on the students' degree: Telematics, Sound and Image or Computer Science. In this way, when interacting with a tag, students could access the content related with their particular degree. Moreover, students could use their own smart mobile devices for interacting with the tags.

In this learning scenario, etiquetAR is used for **augmenting a physical *outdoor*** space and for **personalizing the students' experience** by showing content related with their studies. This experience was enacted on September 2012 and the data is currently under analysis.

B. Augmenting indoor physical spaces

"Discovering the kidnapped scientist" is a tag-based museum experience for primary school students. The experience has been designed for the CosmoCaixa science Museum of Alcobendas (Madrid, Spain). The objective of the experience is to make students reflect and put into practice the science concepts that they learn in class involving them in the generation of the museum contents. The experience is structured into three different phases: *before*, *during* and *after* the visit to the museum.

Before the visit, the students work in groups for reproducing and record some of the experiments that they will find in the museum. The multimedia resources generated in this phase will be the contents of the digital tags that will be used for augmenting the exhibits of the museum. *During the visit* the students have a mission: they have to discover who has been the kidnapped scientist. Each team is provided with a tablet with an application that will guide them through the different exhibits of the museum. In each exhibit, students have to interact with a tag that contains some of the multimedia resources they have generated in the previous phase. Each team will visualize the content generated by another team and answer a question related to the exhibit. Students will have to report the visit taking pictures and writing comments using their tablets. *After the visit*, the students are provided with personalized artifacts such as comic stories using the material collected during the visit. The teacher will use these artifacts in class to make the students reflect about the whole experience.

In this scenario, **both the students and the teacher will use etiquetAR for generating the tags to augment an *indoor* space**, the museum. The contents associated to the tags are resources generated by the students. The profile functionality is used in this case to **provide a different experience for each team**: each team will access to a different content. This experience will be deployed in November during the Madrid Science week.

III. Conclusions and Future Work

This paper has presented etiquetAR, a mobile and web-based application for supporting the design and enactment of mobile augmented learning experiences based on tags. To show how etiquetAR can be used in different contexts for augmenting physical spaces with several learning purposes we have presented two different scenarios. In the first scenario, "Discovering the campus 2012", etiquetAR is used for augmenting an *outdoor* space to support first-year university students in an exploratory learning experience for discovering the University campus, activities and services. In the second scenario, "Discovering the Kidnapped scientist", etiquetAR is used for augmenting a museum *indoor* space to support primary school students in a reflective science learning experience around a museum exhibition.

From these two scenarios we can highlight the main characteristics that make etiquetAR a good application for educational contexts:

1) etiquetAR is easy to use. Any user can generate their personal tags into three simple steps. This simplicity makes that both practitioners and learners can participate in the design of the tag-based experience.

2) **etiquetAR enables personalizing the user experience**. Each tag created with etiquetAR can be associated to more that one unique multimedia resource. At the same time contents can be associated to particular profiles. etiquetAR facilitates creating tag-based personalized to different users.

3) **etiquetAR does not require any special mobile application**. Any QR tag reader can read the tags generated with etiquetAR. This facilitates the enactment of learning experiences designed with etiquetAR since users can use their smart mobile devices for participating in the tag-based experience.

As a future work, we plan to continue extending the application with new functionalities: (1) for supporting the design of tag-based experiences based on other types of tags

such as RFID/NFC and (2) for enabling users to share their tags. We are also working on new scenarios in which etiquetAR is going to be used to support a collaborative process involving students from different countries to augment the urban space of three European cities. We believe that both the first prototype of etiquetAR and the scenarios presented are a good starting point for exploring the potentiality of digital tags for transforming any space into a learning augmented space.

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A Conceptual Framework for Measuring the Quality Aspects of Mobile Learning

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***Abstract*—With the continuing growth of mobile phones outpacing that of desktops and laptops, mobile phones are now the new personal computer. These devices started becoming increasingly sophisticated and extremely powerful. In addition to making phone calls they have the capabilities to perform a variety functions, one of the most important functions is using it as a classroom tool. However, mobile phone applications must be designed and developed with respect to different technology skills, learning capabilities, and language proficiency, in order to be accepted by wide audiences (e.g., students and instructors). Substantial work has been done to measure the quality of mobile applications, and many researchers have attempted to figure out the most important reasons that make those applications fail. A software prototype to assess the quality aspects of mobile learning application has been implemented. Based on the experience with this prototype, we raise some design issues of mobile learning application, specifically the usability issue and its implications. We conclude with some suggestions to enhance the quality aspects of mobile learning applications.**

I. INTRODUCTION

UNLIKE personal computer (PC), mobile phones have some restrictions for displaying content, e.g. screen size and resolution. However in the last two decades, mobile phones and wireless communications technologies have been widely utilized in higher education to deliver different materials because of the availability and accessibility of wireless connectivity. Learning using mobile phones and specifically smartphones, nowadays is highly integrated within education systems in order to support real-time communication and to deliver learning materials. It is used in many universities as a classroom tool to engage and support student in communicative, collaborative, supportive and constructive activities. Also, mobile technologies enable learners to build knowledge, construct understandings, changes the pattern of work activity/learning [1]. Furthermore, the use of mobile technologies offers more opportunities for new types of learning because they change the nature of the physical relations between instructors, students, and the objects of learning.

It is a great way to ensure mobility and ubiquity in learning without technical limitation, time and place restrictions. However, mobile application that are used for education purposes have a very complex user interface with many options hidden. The need to design and develop attractive and user-friendly mobile applications has already become hot topic in order to be accepted by the younger generations who have grown up with the mobile devices in their hands [2]. These applications in order to be accepted by wide audiences must be robust and be of high quality.

Today, most of the applications of the market are difficult to use and learn, difficult to attract or keep users and also difficult to remember. The key component of a successful and acceptable educational application is the usability issues. Thus, when designing user interface for mobile phones, especially for education purposes, we should consider the special user requirements and the capabilities of this type of devices.

This paper is structured as follow: Section II provides some background in the usability issues of mobile learning. Section III introduces a conceptual framework for measuring the quality aspects of mobile learning. Section IV provides analysis and discussion on the Busuu project based on our framework. Finally, the conclusion is stated in section V.

II. MOBILE USABILITY

According to ISO/IEC-9126-1; usability includes the understandability, learnability, operability, attractiveness, and usability compliance sub-characteristics [3]. Usability is known as a qualitative attribute that determines how easy the user interface can be used [4]. It measures the quality of user's interaction to the system environment. In general, mobile applications should be simple, and the input should be easy to insert, simplified by using location aware functions [5] [6]. Mobile applications must have a well designed interface with appropriate color and font sizes because mobile users may not be able to concentrate on the system use [7].

However, recent usability studies illustrate that it is more difficult to read, learn and understand content while using mobile phones than using laptops and desktop computers. For instance, Singh [8], conducted a Cloze test of software user agreements on mobile phones and desktops, and he found that readability and understandability were over 50% lower on a mobile phones than on laptop and desktop screen.

According to Nielsen [9], the difficulty of reading on mobile phones is due to the small screen size and resolution that those devices have which make it harder to understand the content. Users cannot simply scan through text at once, because of the screen size of this type of devices. This enforces them to navigate and scroll to view the entire page, which requires them to remember what they have seen [10].

To overcome this limitation, Iliisky [11] suggested that "it is important to use design techniques that would help users to understand the hierarchy of information on the screen".

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Designers, in this case, must identify the learning material that is important, necessary and then displaying it visually by making it "bigger, bolder, brighter, and more detailed, or called out with circles, arrows, or labels." Otherwise, designers should display less relevant learning material "with less intense color, lighter line weight, or lack of details" [11]. However, educational mobile applications will be embraced and accepted or not based on its features in terms of acceptability and usefulness which include its utilization and usability [12]. Mobile usability issues are considered to be one of the main reasons that make the mobile applications fail [7].

III. A CONCEPTUAL FRAMEWORK FOR MEASURING THE QUALITY ASPECTS OF MOBILE LEARNING

Based on the quality issues discussed, we have developed a conceptual framework for measuring the quality aspects of M-learning [13]. Basically, this framework is a combination of structural factors [14]; it also integrates dimensions of learning context [15]. Fig. 1 shows the design issues of our framework. However, our framework includes three design issues; in addition, to the previous design issues that were identified [16]. These three design issues are: usability, communication and interactivity.

Firstly, all the design issues are linked to the dimensions of learning context. Secondly, the dimensions of learning context are linked to the structural factors. From these two steps we are targeting social skills, new knowledge, team building and improved skills. Key features of the framework are that it identifies the importance of design issues, dimensions of learning context and structural factors in order to address the learning objectives that have a user or a platform focus.

To illustrate, the usability design issue, which includes ease of use, understandability, attractiveness, learnability and user satisfaction, all these sub-characteristics can be achieved if the application meets all the previous features and users were able to use the applications (usability design issues). This also may be performed by using identifier of each user that must be unique in the name-space that is used by the application via a logon system (user name and password, etc.). Identifier can be classified under the (identity dimension of learning context). This will enable the users to perform some tasks such as reviewing the lessons, tutorials, doing assignments and group sessions with other users with the support of mobile devices. This can be classified under the (structural factors: business rules and learning roles).

Finally, the learning objectives will be addressed which may include improving of improved skills, new knowledge, social skills or team building; however, and as we have mentioned in this paper that each design issue may be linked with more than one of the dimensions of learning content.

For instance, the communication, collaboration and interactivity issues can be affected by more than one of the learning contexts community, facilities, time and location, activity and learner. Furthermore, in some cases the design issues can affect each other; for example, the usability issues can be affected by communication, media type or by the wireless connectivity while using the application on the move.

IV. ANALYSIS AND DISCUSSION

Based on the metrics that the (ISO/IEC) provides for measuring software quality in process and use, the analysis of our framework from the quality point of view requires us to put in consideration the boundary between quality metrics that are use focused, from ISO/IEC, and those that are product related.

The relationship between the quality in use, internal quality and external quality metrics is shown in Fig. 2. Based on the analysis of our framework, if we can apply some extensions to the ISO/IEC metrics, we will be able to map these metrics to our framework in order to measure the design issues of learn on the move, user role and profile, media type and usability issues. However, additional metrics are needed to complement the contexts of use dimensions of the quality in use metrics.

To analyze our framework, we are considering a case study and the metrics that (ISO/IEC) provides. The most suitable example that can be analyzed as a case study is Busuu Project [17]; the Busuu Project is an on-line social network application. This application was designed to enable users to set up a profile (quality metric of user role and profile). Developers were careful with the learning content that displayed on the screen, they target as much learning content as possible (existing quality metric of media type).

Since the application can be downloaded to mobile phones, users are free to use it wherever a network connectivity is available (existing quality metric of learn on the move). In addition, each individual user of this application is not only a student of a foreign language but also a tutor of his or her own mother tongue. Another feature of this application is that the users can select one or more of these languages and work through the self-paced units [17]. From these analyses, we can apply some relevant and appropriate metrics from ISO/IEC (e.g., functionality, scalability, service quality, etc).

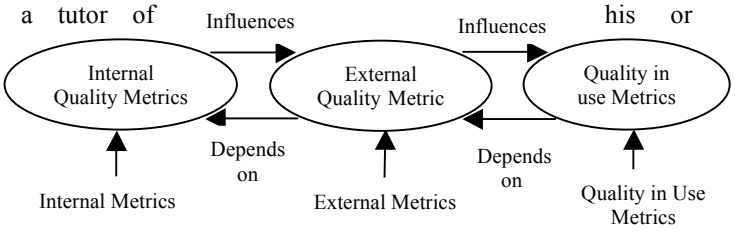

Fig. 2. The relationships between the quality metrics based on ISO/IEC

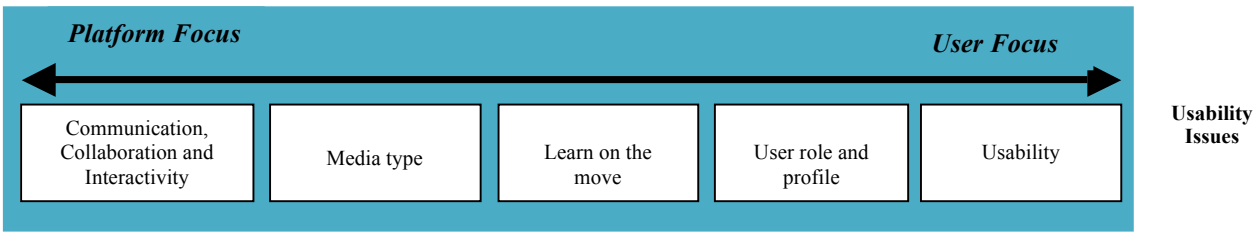

Fig. 1. Design issues of mobile learning based on our framework [14].

Table 1: Analysis of the Busuu project based on our framework

Objectives	Learning experience	Learning contexts	Design issues
Learning new language 1. Exploring, discovering and getting familiar with the software. 2. Communicating, interacting and collaborating with peers by asking and answering questions. By sharing and exchanging information between users, users can obtain new knowledge that will help them to improve their language skills and help them to conduct the following objectives: **1. Team building** **2. Social skills** **3. New knowledge** **4. Improved skills**	**Rules: Business rules, learning roles**: different users meet in the context of a simulation. **Outcome and Feedback:** asking questions and getting answers. **Goals and objectives:** to get familiar with the application. **Conflict, competition, challenge, opposition**: discussing and challenging opinions (team work and new skills) **Interaction: Blogs, wikis, discussion groups, test, teamwork:** One to one, one to many and many to one.	**Identity:** user name and password for each individual user. **Learner:** different users. **Activity:** To engage in participatory simulation of a dynamic system. **Time - Location:** Co-located same time and different time. **Facility:** different mobile devices. **Community:** different user with different background using the mobile devices with the support the wireless connectivity can discuss many different topics in order to improve their language skills.	**User roles and profiles:** New users - few ideas of how to use the application. **Learn on the move:** Mobile devices with the support of wireless connectivity. **Media type:** text, images, comprehensive audiovisual learning material with photos and recordings by native speakers, avoid information overload. **Communication, collaboration and interactivity:** users can communicate, collaborate using text, verbal and video-chat communication support.

Table 1 shows the analysis of the Busuu Project [17] based on our framework, The purpose of this reverse engineering is to see how successful the Busuu Project is and also to know if our framework can be used as a guideline for designing and developing mobile applications.

The result showed that the Busuu project is a successful project. First, each user of the Busuu project has a unique name and password (user role and profile: design issues). Second, once the user downloads the application on his own device he can communicate and interact with other users. Also, the use will be able to share and exchange different types of media with the other users (communication, interactivity and media type: design issues). Finally and more importantly, users can use the application wherever there is a wireless connectivity (learn on the move: design issues). The emphasis here is on the nature of the physical environment in which the learner is placed, and hence the digitally-facilitated that is now possible with mobile technologies that were not possible with a desktop. For instance, while walking through urban spaces, mobile technologies allow users to be constantly connected to the Internet.

Also our analysis shows that mobile learning collectively offers a wide range of learning activities that could be supported through mobile environments; for instance, exploring and investigating (real physical environments) and discussing (with peers, synchronously or asynchronously).

It is clear that the current metrics cover all the design issue except the usability issue. Usability is one of the most important fundamentals of M-learning applications. For example, if the applications have the following weaknesses: i) different to use, ii) user interface that is hard to learn to use, iii) user interface that is difficult to remember how to reuse; iv) learning content structure that is unclear; v) the process's work-flow that is difficult to perform; users will not be efficient, effective and productive. The user interface must be effective and easy to use, which will help the users to focus of the learning goals, learning content and activities instead of how the system works. Furthermore, utilizing design guidelines are vital in developing reusable learning systems and the effective and the most valuable method is evaluating and testing users.

V. CONCLUSION

Without a doubt, mobile phones are the way of the future. Designers and developers of mobile applications need to consider usability issues of those applications in order to be accepted by the new generation. This paper illustrates how the quality aspects can be measured in the context of a conceptual framework for mobile learning applications. A case study has been considered based on our framework; it showed which design issues can be measured using established quality metrics from (ISO/IEC). Also, we suggested that additional metrics are needed to complement the contexts of use dimensions of the quality in use metrics. However, this is not the last result of our research; we are designing and developing a prototype application. This prototype will be tested and evaluated by real students, as well as a questionnaire and statistical analysis will be conducted in order to measure the quality of the user interface. Also, all the usability sub-characteristics including ease of use, user satisfaction, attractiveness and learnability. Appendix A shows the questions that will be used in our survey.

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APPENDIX

Student Name: Student ID: User interface Number:

Section 1: ease of use attributes:

1. I found navigating around the prototype screen to be:
2. How easy was it to find the appropriate icon for information you wanted?
3. How easy was it to scan the prototype in text to find the information you wanted?
4. How easy was it to scan the prototype in graphic to find the information you wanted?
5. How easy was it to understand and to know the purpose of each icon in the prototype?
6. How user friendly is the prototype?

Section 2: user satisfaction attributes:

7. Do you agree that the font size is easy to read and understand?
8. Do you agree that the prototype has all the features required by a user?
9. Do you agree the prototype provides you enough suggestions and prompt you towards the right usage?
10. Are the terminologies that have been used familiar to you?
11. Was the information in the prototype well-organized?

Section 3: learnability attributes:

12. Learning to operate the system is:
13. Remembering names and use of commands is:
14. Understanding the structure of the prototype is

Section 4: attractiveness attributes:

15. Did you find the prototype attractive?
16. How would you rate the flexibility of the prototype?
17. Are the colors and graphics clear and attractive?
18. What is your overall impression of the prototype

MAMIPEC - Affective Modeling in Inclusive Personalized Educational Scenarios

Olga C. Santos, Jesus G. Boticario, Miguel Arevalillo-Herráez, Mar Saneiro, Raúl Cabestrero, Elena del Campo, Ángeles Manjarrés, Paloma Moreno-Clari, Pilar Quirós, Sergio Salmeron-Majadas

***Abstract*—In this paper we introduce the MAMIPEC project. The aim of this project is to explore the application of affective computing to accessible and personalized learning systems. To this end, we consider a user context which includes appliances and devices to enrich user interaction. We describe the research objectives and present on-going work towards understanding the affective support needed in educational scenarios.**

***Index Terms*—Affective computing, educational scenarios, emotions, personalized and inclusive learning.**

I. Introduction

ADAPTATION is a long-standing need in educational/training systems. Adaptive systems are supported by an underlying user model that gathers information about the student´s previous knowledge, preferred learning styles, interaction needs (covering those related to disabilities) or any other factors that may be useful to support a personalized and inclusive learning process. A natural and increasingly demanded extension of current approaches to adaptation is to consider more complex sources of interaction data in order to develop more complete and descriptive user models that support the provision of additional and more precise adaptation functionality. One such source of information is the user's affective state, which features a strong relationship with the cognitive process [1-4].

In this context, the MAMIPEC project (Multimodal approaches for Affective Modeling in Inclusive Personalized Educational scenarios in intelligent Contexts) focuses on integrating cognition with user's emotions, to provide adaptive learning via a comprehensive user model based on available standards and specifications.

In this paper we introduce some related work, present the MAMIPEC project and describe the work in progress since it started 10 months ago.

II. Related works

There is a need for a holistic approach in dealing with accessible e-learning [5] to provide a learning experience that is accessible at all levels, from content via learning paths to overall learning objectives. From the aDeNu experience in the EU4ALL project [6], this holistic approach can be provided by combining two existing perspectives: i) universal design, based on specifications and standards (such as those defined by W3C, ISO and IMS) that model, at design time, the needs and preferences of the learners in relation to the learning needs, and ii) runtime adaptation, generated by using diverse artificial intelligence techniques (data mining, machine learning, user modeling, recommender systems…). In this case, the dynamic support provided to the learner in a given context relies on the analysis of users' interactions and could benefit from the standard-based descriptions of the universal design approach.

In this context, a thriving research field named affective computing reflects a growing interest in improving all aspects of the interaction between humans and computers, and thus, including personalized and inclusive learning mediated by technology. Affective computing aspires to reduce the gap between the emotional human and the emotionally challenged computer by developing computational systems that recognize and respond to the affective states (e.g., moods and emotions) of the user [7]. The basic tenet behind most affective computing systems is that automatically recognizing and responding to a user's affective states during interactions with

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a computer can enhance the quality of the interaction, thereby making a computer interface more usable, enjoyable, and effective, which in learning may lead to a better personalization to the learner.

Affect detection is usually done by means of human observation or by analysis of hardware sensor data, such as facial expressions, posture analysis, pressure on the mouse, etc. [8]. Most of the technology and tools involved in the detection of affective states in the educational domain are common to other affective computing areas: hardware sensors that monitor physiological parameters, and subsequent methods and tools to adequately process and interpret the signals (pattern recognition techniques); machine learning techniques (e.g., Bayesian Networks, hidden Markov models) for predicting affect from user computer interactions (e.g., typing speed, keystroke duration or number of clicks [9]) and sensor data; and qualitative methods (i.e. interviews) or self reported information.

In affective e-learning, the student interactions with the e-learning platform have to be dynamically collected, focusing on data relevant to learning progress and on behaviors that can be seen as affect expressions (e.g., inappropriate task strategies, procedural errors, misconceptions, problem-solving behavior, questionnaire responses, time spent on hints, number of hints selected, etc.). Machine-learning techniques can be used to discover existing relations between affect (e.g., revealed in a post-survey) and observable behavior [10]. In addition to the former particularities, the emotions that are relevant in a particular educational context have to be precisely defined [2-3], according with cognitive principles. Despite the numerous studies focusing on affect detection, it still remains a complex task.

Given the lack of solid and widely-accepted theories, pedagogical interventions are normally based on heuristics defined ad-hoc. These interventions do not only depend on the current emotional status of the student but are also customized for each student and each context via a learner model [1, 11]. As well as including general heuristics, affective e-learning systems often make use of machine learning optimization algorithms to search for strategies to give affective support adapted to individual students [12].

Another related field we are exploring in our research is imaging processing. In a classical classroom based learning environment, students' gesture and facial expressions offer valuable information to the lecturer. Such visual information helps detecting relevant student feelings (e.g. boredom, confidence, interest, excitement or frustration). In a similar way, e-learning systems may use computer vision techniques to support detection of relevant events related to the user's affective state that influence the learning process. Latest developments in facial feature detection, new peripherals (e.g., Kinect) and processing software facilitate low level feature extraction at a low cost. Most emotion recognition methods use appearance-based holistic approaches [13]; or rely on geometrical facial features that represent the shape, relative position and/or deformation of representative face elements, e.g. mouth, nose, eyebrows. In many cases [14-16] these data are used to identify the activation of the facial Action Units (AU) of the Facial Action Coding System (FACS) defined in [17]. Each AU is anatomically related to the contraction of one or a set of specific facial muscles; and the FACS associates certain AU combinations with prototypic emotional facial expressions. The output is generally processed with supervised learning methods and combined with other information sources in an attempt to reliably estimate user emotions [7].

Therefore, there is a need to research how affective support can enrich the learning experience in inclusive and personalized educational scenarios through a proper modeling of the user features, course settings and device capabilities, and making use of appropriate sensors to get data from the environment. Ideally, this information could be modeled and used by the environment to allow a natural interaction with the learner by providing alternative ways of communication based on non-intrusive, gradual and intuitive methods. For this, embedded systems that are context aware, capable of knowing and anticipating the environment requirements, responding with optimal actions, and adapting the environment to the scenery can be used to feel the presence of people to achieve what is called Ambient Intelligence [18].

III. MAMIPEC PROJECT

MAMIPEC is a three-year project, involving a multi-disciplinary team that comprises researchers from different areas of expertise: i) engineers and computer scientists specialized in human computer interaction and artificial intelligence techniques, ii) psychologists with experience in psycho-educational support and emotional management, and iii) engineers with experience in image treatment and data fusion. The first two of these groups are with UNED (the Spanish National University for Distance Education) and the third is with the University of Valencia, both in Spain.

The project aims to explore the application of affective computing to develop accessible and personalized learning systems that consider a user context where appliances and devices are included to provide a richer and more sensitive user interaction. To this end, six research objectives have been defined and are currently being addressed. They are summarized in Table I.

TABLE I.
OBJECTIVES OF MAMIPEC PROJECT

Obj.	Goal
1	Study different approaches based on ambient intelligence for inclusive personalized interaction that include diverse and complex forms of interaction and assistive technologies to provide effective communication and a non intrusive, non-overwhelming, interactive, natural and co-adaptive environment where the student learns by interacting with the environment in their most adequate way.
2	Explore possible applications of affective computing in inclusive learning which includes a) the study of strategies that address the affect detection paradigm by using computer vision as the most informative interaction channel; and b) the use/design of alternative and inexpensive sensors which may provide reasonable accuracy and additional sources of observable information.
3	Design, build and provide access to standards-based models for inclusive and personalized learning that take into account affective states and the enriched environment, and contribute to standards

	the extended descriptions to deal with affective computing, multimodal user interfaces and ambient intelligence.
4	Explore machine learning algorithms and multimodal fusion approaches to feed the models that a) effectively merge the data that they hold to infer useful information that can be used in the learning process and b) are able to trigger a convenient educational action in response to this information.
5	Provide inclusive, personalized and affective dynamic support through multimodal user interfaces in terms of a) personalized services that consider the user affective state, abilities, competences and skills, and b) inclusive and personalized responses that take into account the entire multimodal educational setting.
6	Evaluate the level of learning gain improvement in different scenarios to determine the impact of integrating affective computing, context awareness and ambient intelligence techniques.

To cope with the above objectives from the technological point of view and following previous works in the EU4ALL project, we have proposed an open standard-based service oriented architecture [19]. Fig. 1 shows the main components involved (where the arrows show the data flow): i) User Model (**UM**), which manages information about the learner (e.g. learning styles, learning objectives, accessibility preferences, personality, etc.) ; ii) Device Model (**DM**) which store the capabilities of the device used to access the e-learning system; iii) Emotional Data Processor (**EDP**), which process the data gathered in the environment through the sensors; iv) Multimodal Emotional Detector (**MED**), which combines the different sources of information, including EDP, UM, DM; v) Inclusive Personalized Affective Dynamic Support Component (**IPADSC**), which includes a recommender system, and vi) Emotional Delivery Component (**EDC**), which produces the output to be delivered to the learner through the appropriate actuators.

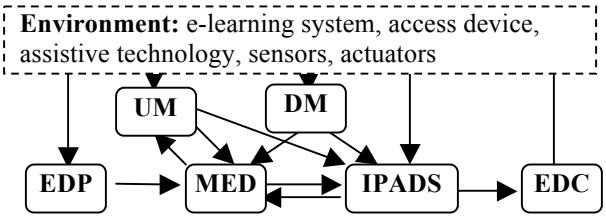

Figure 1. MAMIPEC service oriented architecture

While the learner is working on the educational scenario, the UM processes the learners interactions in the e-learning system and updates the UM accordingly. This processing can be as simple as updating the progress in the course after a questionnaire has been passed of as complex as inferring the collaboration level with machine learning techniques. The UM is also updated with user emotional information computed by the MED (which combines information obtain from the environment by the EDP, the UM and the DM). At a certain moment, the e-learning system asks the IPADSC for some inclusive personalized and affective dynamic support for a given learner in a specific educational (course situation) and environmental context (i.e. device). The IPADSC requests information to the UM, DM and MED, process it and obtains the emotional feedback to be given to the learner.

In the following section we briefly introduced the work that is being carried out to address the above objectives.

IV. On going work

In these first months of the project we have focused on understanding the affective support needed in educational scenarios as proposed in objective 2. In parallel to a review of the state of the art in affective computing for educational scenarios, we have carried out a pre-pilot experiment in July 2012 with two participants to clarify how we could induce emotions and detect them through varied sources of information. In particular, in this experiment we recorded data from different sources simultaneously, namely, eye movements with the ASL 504 eye tracker which also detects the pupil dilatation, face expressions from Kinect, using its SDK to detect position and/or deformation of representative face elements, video from a web cam, cardiovascular events such as cardiac period, and blood pressure (systolic and diastolic values) by means of the PowerLab, breath frequency with a pneumograph and mouse movements and keystrokes. To complement the data gathering through the above devices, several questionnaires were filled in by the participants, namely the Five Factor Model personality questionnaire [20] at the beginning of the course, and Self Assessment Manikin scale [21] after each exercise to measure the caused emotions with the dimensional approach. We are currently processing the data obtained, trying to both automate its processing for forthcoming sessions and its usage as input to machine learning algorithms [22], as afore mentioned in objective 4. The obtained results will be used to build the standard-based models proposed in the objective 3.

In these pre-trial sessions, participants were asked to carry out mathematical exercises with several levels of difficulty and varied time restrictions. Exercises have been designed so that they elicit different emotions. Mathematical exercises have been used because they are useful to produce emotions in the learner, as remarked by related literature [23]. In relation to this, the University of Valencia counts with previous experience in the development of a tutoring system to assist students at learning arithmetic and algebraic problem solving [24]. The availability of such a system provides a platform for testing future developments. Controlled experiments in this type of scenarios may be an accurate source of information and data collection of emotions towards learning for the evaluations proposed in objective 6.

Moreover, to address objective 5, we are currently applying the TORMES methodology. TORMES adapts the ISO standard 9241-210 to guide educators in identifying recommendation opportunities in the experimental scenario that deal with affective issues and aim to produce the personalized affective support needed [19]. Thus, an exhaustive and methodical compilation of heuristics concerning affective learning is being carried out to model, in terms of recommendations, best practices in everyday instruction support. Judging from the current literature on this topic, large parts of this knowledge have not yet been

collected. In our view, the affective support can be provided in different ways: i) modifying the emotional mode of the recommendation to match the affective state of the learner, ii) providing an open learner affective model where learners can be aware of their affective state as computed by the system and iii) offering specific recommendations that support the learners in managing their emotional state (e.g. to reduce anxiety when carrying out certain exercise).

V. Conclusion

In this paper we have summarized the main objectives of the MAMIPEC project, and some of the initial works already undertaken. In particular, possible applications of affective computing in inclusive learning have been explored. To this end, we have run a pre-pilot experiment in July and will carry out a large scale two week experiment in November, where we aim to gather around 200 participants. This large-scale experiment will be carried out in different stages. Each of them will be directed to a different audience type, and therefore with different learning styles, and difficulties facing mathematics: general public, high school kids, high school and college youth. The aim is to obtain a complete database from which to infer learning emotions. This is the first step to building a user model that considers the student's emotions and getting a better personalization to the learner.

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ClassConversations: Keeping The Learning Conversation Going

John M. Carroll, *IEEE Fellow,* Honglu Du, Hao Jiang, and Mary Beth Rosson

***Abstract*—We describe ClassConversations a prototype that integrates a synchronous classroom backchannel with an anchored discussion forum.**

Index Terms—Classroom technology, classroom backchannel, discussion forum

I. Introduction

CONVERSATION has a long tradition in learning. Classroom discussion, and more recently online out-of-classroom discussion are central learning activities in many pedagogical approaches. We are investigating the integration of a *classroom discussion backchannel* (a real-time chat among students, publicly displayed during class) and a *knowledge-building forum* (an asynchronous, threaded discussion to analyze and elaborate themes raised in class or in other course activities that takes place mostly out of class). By injecting one form of discussion into the other and vice versa, we hope to promote continuous reflection and re-integration of content across these rather different conversation contexts.

Classroom discussion backchannels and knowledge-building forums have different conversational and learning affordances. Classroom backchannels are tweet-like, real-time responses to instructor and student classroom interaction; they are often quite social in content; functionally, they are often acknowledgements or requests for clarification. Forums are more widely employed and more diverse; participation is generally asynchronous; content is relatively formal and substantive, consisting of reasoned contributions to critical analysis and debate of issues that may have originally been raised in the classroom. The two communication mechanisms can provoke complementary learning interactions, and may support learning in complementary ways.

Integrating these two types of learning conversations could combine their separate strengths, but also engage new synergies: Provocative contributions to a real-time backchannel might be developed and analyzed more deeply in

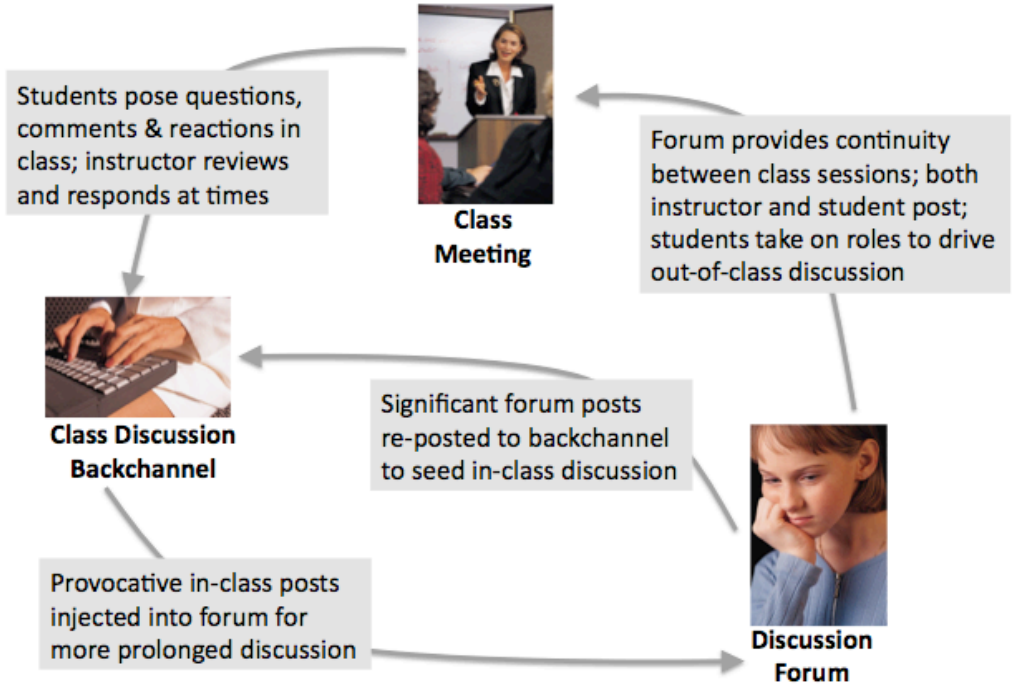

Figure 1. Continuous conversation threads connect in-class and out-of-class discussions, analysis, and course activities

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a forum discussion, while forum contributions that attract substantial commenting or other indicators of interest might be re-raised and addressed face-to-face in classroom discussion, possibly provoking real-time backchannel responses. The result is that students and instructors can raise and discuss issues with each other more or less anytime (Figure 1). Supportive interactions with peer learners and developing mastery of domain concepts and skills are separate and critical determinants of successful learning trajectories; their effective integration may be even more powerful.

II. INTEGRATING ANCHORED DISCUSSION FORUM AND CLASSROOM BACKCHANNEL

There is substantial prior research on the *separate and independent* use of classroom chats and backchannels, and on forum discussion. For example, classroom response systems allow the teacher to present multiple choice or true/false questions; students can then respond to these with specialized handheld "voting" devices, perhaps resulting in a public display of aggregated results [1,2,3]. Such systems provide fairly limited communication channels and need special hardware. Active Class uses PDAs for classroom communication: Students can post text questions to the teacher during lectures, using a handheld device. A teaching assistant may respond to these questions during class, or the teacher may choose to address some questions. In undergraduate computer sciences classes, Active Class helped teachers get timely feedback from the students, overcame student apprehension in large classes, and enabled multiple students to ask questions at the same time [4].

Classroom Presenter extended the concept of a backchannel by allowing students to annotate a slide being discussed by the teacher; the resulting notes are publicly displayed in the classroom. This increased class participation in classes ([5]; also Harvard Live Question Tool [6] and Fragmented Social Mirrors [7]). In prior research, we found that a classroom backchannel can also enhance sense of community in classrooms, and help students socialize with peers, make suggestions for course changes, share information, and seek help [8,9].

Guzdial and Turns [10] documented the benefits of anchored discussion forums in an undergraduate computer science course. They found that when discussion was anchored by key content questions or documents, the sustainability and length of discussions increased dramatically. They also found better learning outcomes for those who participated in anchored versus non-anchored discussions. More recent work by van der Pol, Admiraal, & Simons [11] found that unanchored forums led to more clarification questions than anchored posts. It may be that anchors help to establish common ground for participating students, making it more obvious to whether and how they might contribute.

Our ClassConversations prototype is a web-based toolkit that *integrates* classroom chats/backchannels and discussion forums; it supports *both* synchronous and asynchronous discussions inside and outside of classrooms. ClassConversations uses OpenID (http://openid.net/) for user authentication, which allows students to access ClassConversations with their Google or Yahoo account. There are two modules in ClassConversation. One is the backchannel module, a synchronous *public discussion backchannel* system; and the second is an *anchored discussion forum* (Figure 2).

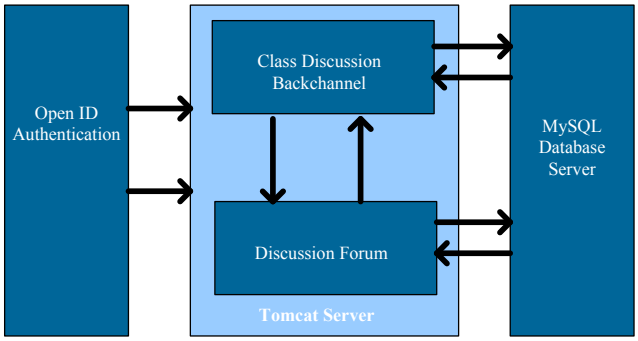

Figure 2. ClassConversations Architecture

III. BACKCHANNEL MODULE

In the backchannel module students can make comments, ask questions and share information during the class while the lecture is going on. Students can also post YouTube videos and images. Figure 3 shows the public discussion backchannel, displaying a stack of messages ordered with the most recent messages at the top.

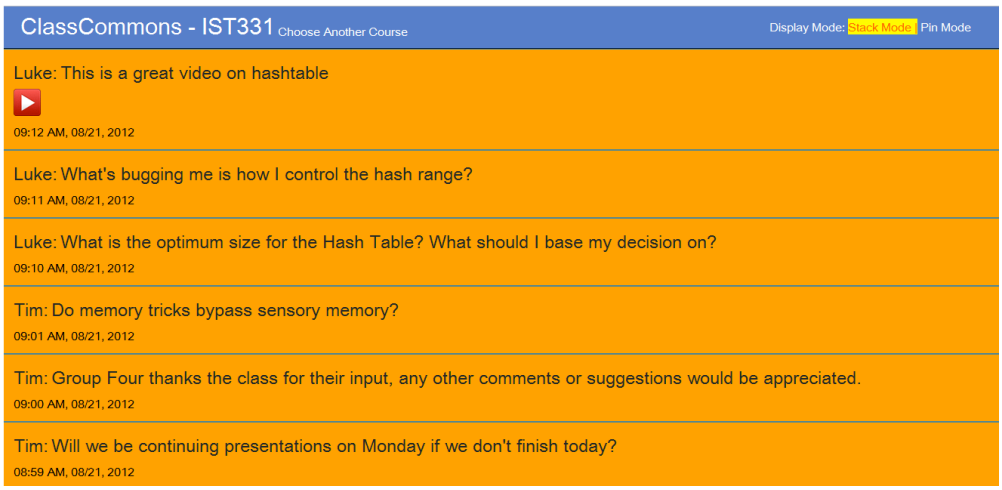

Figure 3. Public display of the backchannel

IV. DISCUSSION FORUM MODULE

The second module is the *discussion forum* module, an asynchronous discussion forum that supports anchored discussion. The discussion forum allows the students to post files as anchors, persistently available to the students, as they engage in discussion interactions. The anchor documents and the discussion threads can be scrolled independently so that discussion references can always be grounded (Figure 4)

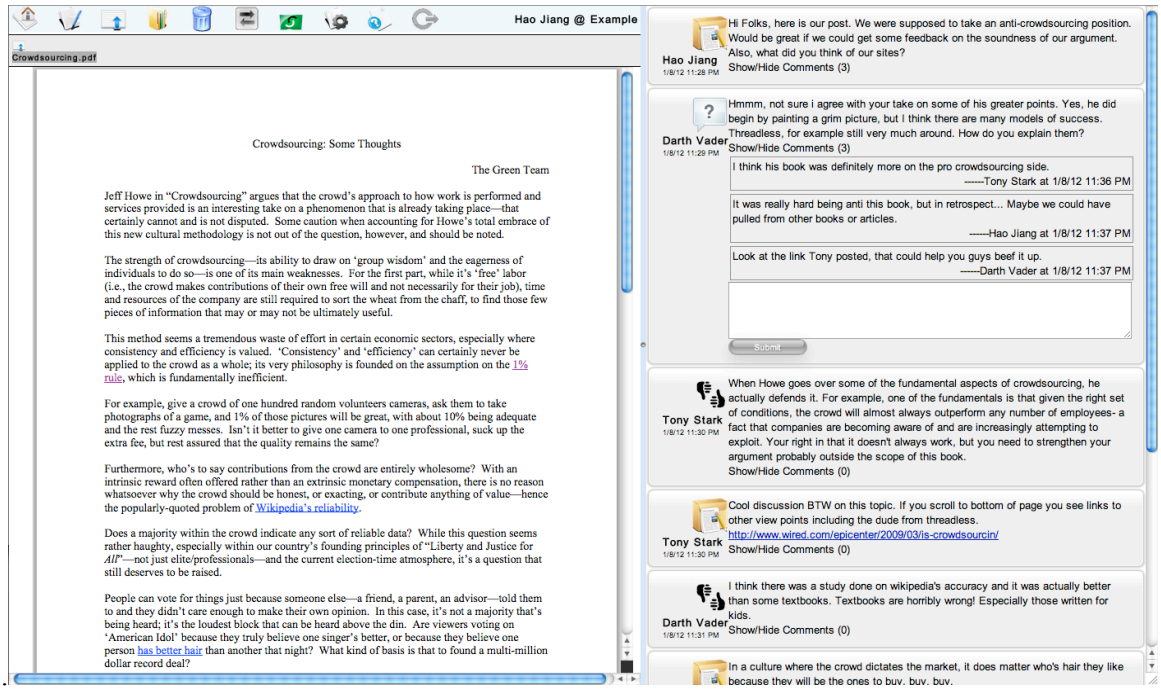

Figure 4. Anchored discussion forum

V. PROJECT STAUS AND PLANS

Over the past school year, we have experimented with each of the two modules in separate contexts, the discussion backchannel used in class and the discussion forum outside class. In our current prototype we have integrated the modules to leverage the advantages of both types of learning conversation. We are currently exploring design options for this integration. For example the new prototype allows students and instructors to port message from one module to another. Using this feature, important or particularly valuable messages that were shared in a classroom backchannel can be discussed further outside class in the asynchronous anchored discussion forum, and points raised in the forum discussion between class meetings can be shared to the classroom backchannel as icebreakers for the start of a class meeting. Our plan is to investigate a range of approaches to integrating content among the two modules and the impacts of the resulting class conversations on students' learning outcomes and experiences.

Clearly, online chats and discussions are not exotic or sophisticated learning technologies. However, they are also far from routine. For example, the discussion forum tool in the CMS used by Penn State (Angel) does not support anchored

discussions, even though anchoring has been shown to be critical for effective knowledge-building (Guzdial & Turns, 2000). The chat tool in this state-of-the-art CMS supports real-time interactions that are directly managed and mediated by the instructor, but does not provide for publicly displayed backchannels appropriated and mediated by students (Du et al., 2009). And there is no integration of these conversation tools, meaning that there is no possibility of mutually leveraging contribution beyond cut and paste. Indeed, despite wide familiarity with chats and forums, and their complementary affordances in learning conversations, no effort has been made to investigate their potential integration and mutual influence. Finally, while it is true that instructors comfortable with managing their own technology can provide their students with both chats and discussion forums, and might even wish to integrate the two, this is not something most instructors do or are likely to do. Teacher adoption of novel technology has long been a topic of concern within the educational community. Thus a second aspect of our proposal is to explore ClassConversations features that might make the new tool more desirable to educators – not only in its provisions for student learning experiences and outcomes but also in its support for the teaching activities that are associated with student learning and will course management activities like student or team evaluations.

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Towards a Theory of Augmented Place

Elizabeth FitzGerald

***Abstract*—This short paper is aimed at inspiring dialogue and debate around the theoretical perspectives underpinning research into learning in technology-enhanced augmented places, and the engagement by such learners with blended environments/spaces. The author argues that current theories do not fully model or explain our interactions with technology-enhanced physical environments and that a new theory that combines aspects of these may be required in order to fully understand the way in which we move, interact and learn within such surroundings.**

***Index Terms*—Context awareness, ubiquitous computing, human computer interaction, cognition.**

I. Introduction

Ubiquitous computing is now commonplace in the developed world, through the use of a wide variety of mobile devices such as smartphones, netbooks and tablet computers. Over the last two decades, researchers working in environmental science and affiliated disciplines have developed innovative approaches to using mobile technologies to assist with field work and *in situ* location-based learning (see e.g. [1-4]. However, these technologies that were once the focus of formally managed, educational experiences are now being used by a much larger segment of the general populace for general information provision and mobile communication 'on the go'. Apps for smartphones and tablets often exploit a user's location and can be used to provide context-aware services such as advertising/marketing; information about local events; guiding a user through an unfamiliar location; or simply for entertainment or leisure purposes.

It is clear that what was once cutting-edge technological innovation has now made the leap into widely-adopted and widely-available hardware and infrastructure. However it is not clear if the pace of our intellectual understanding of these interactions between people, technology and their environment – and they way in which they combine to enable learning – has managed to keep up.

II. Location as context

Context can include many different aspects, such as time, resources, other people, one's purpose in being at a specific place (or goals/interests/tasks) and the interactions that are capable of taking place.

A key construct of technology-enhanced augmented places is obviously the physical environment itself. The environment may be natural or man-made, although this definition itself can be subject to debate, as it can be argued that even 'natural' environments may have been heavily shaped by man. The environment may be rich in visual aesthetics (for example, a grand cathedral or art gallery) or relatively poor (e.g. a desolate grassland or a site containing archaeological remains). What we need is a theory that joins up the physicality of the environment (e.g. buildings; architectural details; landscapes; viewsheds; "what-is-near-me" – visible or not within view; resources – people/shops/facilities etc.) with information and data delivered electronically to augment that environment. Can we – or should we – model these aspects of the environment and if so, how can we use these to frame, document and understand our learning that takes place in these settings?

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III. Theories of place-based learning

Human computer interaction (HCI) has for a long time sought to understand how people engage with computers in their immediate environment. Benyon *et al* [5] also talk about the merging of the physical and digital as 'blended' spaces. Some of the most pertinent theoretical perspectives that attempt to understand or model learning and knowledge construction in blended or augmented locations are described briefly next.

A. Situated cognition

Situated cognition suggests that knowledge is situated within physical, social and cultural contexts and cannot be separated from it. Social and cultural contexts are often well-described, although the physical location is often reduced to 'classroom', 'lab' or 'field trip' (although some researchers have explored notions of 'affordances' and the physical properties of the environment). Research into learning spaces [6] has likewise concentrated on mostly indoor spaces and has not fully explored the richness of outdoor environments.

B. Embodiment

Embodied cognition states that the movements of the body have a direct impact on the mind and related mental constructs. Within location-based learning, this can relate to how individual person moves through a physical space and the way in which they use their limbs, hands, feet etc. However when considering technology-enhanced augmented places, the focus of attention from this perspective emphasizes the role of the person rather than considering other aspects present in learning – in this case the external environment.

C. Ecology of resources

Luckin's 'ecology of resources' framework [7] considers contexts such as skills/knowledge, curriculum, resources, administration, organization and environment and suggests how these contexts are linked centrally to the learner. However, environment is again used as a broad term and a rather descriptive one (e.g. "home"), although a strong point of this model is the way in which environment is strongly interwoven into other aspects of the framework.

D. Other related works

Other viewpoints include externalism (the mind is a product of what is going on outside of the subject) and the related sub-field of enactivism (the mind is dependent on actions taking place in the world). However these are fairly controversial stances and again, have only a vague reference to what we mean by 'external'.

Cook's "augmented context for development" (ACD) [8] is an approach to learning design that consists of several elements, one of which is the physical environment. This is then integrated with the other elements to form a basis on which to frame learning interactions, particularly with mobile technologies. This is probably one of the most promising recent theories, extending Vygostky's Zone of Proximal development, which has considered environment as a core construct, yet it still does not fully consider all the properties inherent to our external surroundings.

IV. A NEW PERSPECTIVE?

Several of the theories mentioned above have been influenced by Vygotsky's sociocultural philosophy, especially when considering the collaborative aspects of learning and knowledge construction. These sociocultural aspects are not discussed in this paper; instead we focus more precisely on aspects of the physical environment. However, none of the most relevant theoretical viewpoints mentioned in the section above, that relate to one's learning environment, seem to model effectively the affordances (or 'properties') of that physical environment and the way in which we can interact with and make use of those affordances for learning.

Perhaps what we should be considering is a new, or extended, theory of learning that considers the resources and affordances contained within the physical environment and the way in which learners can engage with them, extending the work carried out by Dourish [9] into 'space' and 'place'. Evidently such a theory would need to take into account sociocultural perspectives, but it should also give a reasonable weighting to the richness of what surrounds us, turning at least some of the focus externally – a kind of "reverse embodiment" or maybe "embodied physicality". Some promising work has been done in the area of reality-based interaction [10] but this does not seem to have had an educational focus or drawn upon many of the aforementioned theoretical stances.

V. SUMMARY

This paper has explored, albeit very superficially, the way in which we theorise about learning in technology-enhanced augmented places. It has purposefully not gone into detail about socio-cultural aspects and this is a recognized limitation of the paper and one that is hoped to be addressed in a more detailed future publication. Another obvious limitation of this paper is that it has not sought to integrate together many other additional aspects of learning (e.g. organizational aspects/administration or matters relating to policy) with those of the augmented environment.

However, the author has attempted to bring together several related ideas of thought around situated learning, where a primary context is that of the immediate physical environments of the learner as a central resource. It is argued that we don't, as yet, have a way in which we can model the richness of the environment as a core aspect of the learning that may take place within it and that existing theories fall short of being able to integrate this successfully.

It is hoped that readers of this paper will be kind enough to provide constructive comments and feedback to the author in order to progress the thinking in this area. What seems clear is that we don't yet know what kind of impact the effective use of technology-enhanced augmented places may have on learning, and that being able to understand the theoretical basis of learning interactions seems to be a critical aspect of future work in this field.

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Facing Challenges with New Teachers' Use of ICT in Teaching and Learning

Teemu Valtonen, Kati Mäkitalo-Siegl, Sini Kontkanen, Susanna Pöntinen, and Henriikka Vartiainen

Abstract— **This paper outlines challenges that today's teacher education is facing. Information and communication technology holds a central position in today's society posing also demands for today's schools and teachers. Teachers need skills and pedagogical models to be able to take advantage of various information and communication technologies for supporting their students' learning at schools and also outside of schools. Teachers ought to be able to provide their students with the skills for the 21st century. In order to meet these challenges, this paper introduces a longitudinal research plan with preliminary results, where the aim is to explore and support the development of new teachers' use of technology in pedagogically meaningful ways. Also, the aim of this paper is to introduce our aims and ideas for researchers and designers with similar interests.**

Index Terms— **Educational institutions, Educational technology, Student experiments, Teacher training**

I. Introduction

School education has been criticized for focusing on irrelevant skills and knowledge and ignoring the demands of today's world. Today's world has been described as a knowledge society, referring to the fast development of information and communication technologies (ICT) and associated practices [1]. In order to prepare students for this knowledge society they should be provided with what are called skills for the 21thst century. These skills refer to abilities such as critical thinking, collaboration and skills to use different information and communication technologies [2].

From this perspective the use of ICT for teaching and learning along with collaborative pedagogies can be seen very well justified. Also, an ongoing discussion that addresses the characteristics of today's student generation can be seen as adding to the importance of bringing ICT into teaching and learning.

Digital Natives and the Use of ICT in Learning

Today's students have been described as digital natives and net generation [3], [4]. The assumption is that these students have automatically gained skills to use ICT as they have grown up in the knowledge society. Tapscott [4] assumes that the net generation students are ready and willing to study with ICT and that they also prefer discovery-based and collaborative learning practices. Prensky [3] criticizes today's schools and teachers as immigrants in the digital world, suggesting that teachers are using outdated language and methods in their work. He presents that we have to change teaching methods or wait for digital native students to do it by themselves as they grow up "*So unless we want to just forget about educating Digital Natives until they grow up and do it themselves, we had better confront this issue" (p. 3)*.

This idea is tempting but also challenging because in addition to the great expectations there are also doubts concerning today's students. For example, Bennet et al. [5] argue that assumptions concerning the net generation are not based on academic research but rather on authors' everyday observations. Also, it has been argued that even though the net generation students have better readiness to use ICT than the previous generation they still do not know how to use ICT in their learning [6].

In the light of the discussion concerning knowledge society, 21st century skills and net generation, today's schools would do well to place emphasis on using ICT in teaching and learning. In Finland, measures have been taken in an official level as can be seen in the national strategies and curriculums highlighting the role of the ICT in teaching and learning. ICT should be used as part of everyday school work in all school levels from kindergarten to higher education. However, the use of ICT in teaching and learning in Finnish schools is less frequent than expected. Despite the success in PISA studies, Finnish teachers and schools are far behind in the use of technology in classrooms compared to that of several other countries [7].

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Teachers' Beliefs and Skills of Using ICT in Teaching

Recent studies indicate that traditional teaching beliefs that teachers and students hold have a negative influence on the use of ICT in classrooms [8],[9]. This suggests that we should focus on teachers' and teacher students' beliefs of teaching in order to enhance the use of ICT in classrooms. Based on the results of the report, Finnish teacher students may even today graduate without adequate skills for using ICT for teaching and learning [10]. This sets demands for the very teacher education that ought to be regarded as the pioneer in the use of new technology in teaching and research. So far, even the required infrastructure is behind the schools which usually are better embedded with new technology. At the same time, the Finnish National Board of Education and local education administrators are putting pressure on teacher education to better prepare beginning teachers to use technology in teaching.

Technological Pedagogical Content Knowledge

Use of ICT for teaching and learning from teachers' perspective has been studied widely using different theoretical backgrounds. One often referred framework is the technological pedagogical content knowledge (TPACK) model introduced by Koehler and Mishra [11]. TPACK is an extension of the pedagogical content knowledge model by Shulman [12]. According to Koehler and Mishra [11], teachers need knowledge about technology, pedagogy and content in order to successfully support students' learning with ICT. TPACK implies knowledge that extends beyond the three areas. It denotes teacher's ability to combine these areas in order to build and organise environments and situations that facilitate and support students' learning. With technological pedagogical content knowledge teachers are able to utilise a range of ICT to support students' learning. These can be for example students' personal devices such as laptops, tablet computers and smart phones, various online and physical environments and classroom devices such as interactive white boards.

In a review study, Voogt et al. [13] looked at fifty-five TPACK studies and brought up six different types of studies using the TPACK framework: 1) studies focusing on the development of TPACK as a concept; 2) understanding TPACK in subject specific domains; 3) views on technological knowledge; 4) TPACK related to teachers' beliefs; 5) studies measuring TPACK; and 6) strategies for supporting the development of TPACK. From our point of view, the category 'strategies for supporting the development of TPACK' is central. It is important to find ways to support the development of new teachers' TPACK in order to provide them with skills to meet the need of the 21st century. Even though teacher students can be seen as the net generation, we believe that they have to be provided with support and training for developing their abilities to use ICT in pedagogically meaningful ways for teaching and learning.

In the following chapter we present our research and development project which aims to develop teacher education and the use of ICT in teaching and learning in a way that teacher students are better provided with skills required in today's schools.

II. Research and Development Work within Teacher Education

The challenges described above have been noticed at the Department of Teacher Education in the University of Eastern Finland. All the teacher students from kindergarten level to adult education level have obligatory courses which especially focus on the use of ICTs in teaching and learning. Courses contain shared lectures and seminars for teacher students in two campuses supported with practices where students are instructed to design and accomplish lessons that utilize technology and collaborative learning approaches. The aim is to support teacher students to learn to use ICT in teaching and learning in authentic contexts. In addition, the administration of the University is widely encouraging the university teachers to use ICT in their teaching. In this way, we can provide teacher students authentic experiences of pedagogically sound ways about how to use ICT for teaching and learning. Instead of treating ICT as its own and separated subject the aim is to embed ICT in everyday practices. Also, the students who own a smartphone and/or a laptop, are encouraged to use their own devices in their university studies. This way they can have experiences of using their own devices for learning purposes. This is one way to encourage them to think creatively and in what ways their everyday devices can be useful for learning, too.

Three Research Units: Use of ICT before, during and after University Studies

This development work provides interesting opportunities for research focusing on the development of teacher students' skills and attitudes toward the use of ICT. At the moment, we are designing a longitudinal study consisting of three sub-research units using the TPACK model as the main theoretical framework. The first unit focuses on teacher students' use of technology at their previous academic education path and in their non-academic activities. The aim is to outline starting points and background factors where students start to build their TPACK. Research data will be collected using online questionnaires and essay writings. The second research unit continues through the university studies, where the aim is to outline students' use of technology in their university studies and the development of students' TPACK. This unit focuses on the effects of obligatory ICT courses and also the use of ICT during other courses and studies as well as during their teacher training in schools. We will investigate how the experiences of, for example, using wiki-environments as part of biology courses affect teacher students' TPACK and their attitude toward the use of ICT in teaching and learning. During their studies in the university, students will go through several courses were the role of ICT is emphasized as the use of ICT in teaching has been highlighted by the administration of the University. Several different courses with different ICT will be used as case studies that provide possibilities to gather students' experiences of the ICT for learning. ICT used can vary from personal devices such as, for example, iPads to social software and interactive white boards. Also, data will be collected during teacher students' training periods in schools. Teacher students using of ICT in their own teaching will be

observed. Data collected from the courses and training periods will be added to the data from the first research unit. The goal is that the research database will cumulate during the university studies so that at the end of the studies there will be large profiles of each student's TPACK development. This will provide ample material to study the factors related to the development of TPACK. During the second research unit, the data will be collected with a questionnaire, interviews and observations, also the contents produced by students during different courses will be used as research data. This data provides a starting point for the last research unit i.e. the use of technology in their first years as a teacher at school.

The aim of this third part is to provide insight into how the knowledge and attitudes gained in the university studies meets the reality in schools: How new teachers can carry out their ideas and aims of using ICT for their work, how the practices in schools affect newcomers' work and how can a novice teacher influence school's practices. Altogether, this longitudinal study will work as a frame for the research work to be carried out within our department. This frame will contain several smaller studies focusing on different aspects of the development of teacher students' TPACK from novice to the expert. The longitudinal study will take from 8 to 9 years and provide possibilities for researchers but also for students to be part of the research and development work. Students are encouraged to participate in the research by providing them an active role in the research projects (project works, master theses etc.), which might enhance them to improve their teaching practice by developing and studying their own teaching and students' learning (lifelong learning) and even encourage them to continue with doctoral studies.

Teacher Students' Experiences and Ideas on the Use of ICT before Their University Studies

This longitudinal research project is on its early stage. So far, we have collected data in order to gain a preview of our new students' ideas and experiences of ICT in education to outline the starting points for their studies. Based on essays by first year teacher students (n = 149) the results suggest that teacher students have rather limited ideas about using ICT for teaching and learning. Either ICT is mentioned on a very common level i.e. using computers for teaching without any specification, or then ICT is seen mainly as teachers' tool. Students usually bring up ICT as a tool for lecturing type of teaching, such as data projectors and PowerPoint software. ICT for students' use is in a minor role, for example social software and games [14]. Also, students seem to rarely see the possibilities for using ICT to connect school learning to outside school authentic learning contexts. These results suggest that despite the suggestions by Prensky [3], we cannot merely wait that net generation students grow up and fix all the challenges related to today's education and ICT. Instead, we have to provide students with inspiring and motivating experiences of how to use ICT in pedagogically meaningful ways for supporting learning during their teacher education at the university.

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Traits of effective instructors in an online setting

Phu Vu and Peter Fadde

Abstract - This article reports the preliminary findings of a study on traits of effective instructors in an online training program. Nineteen sections from five different courses were ranked to identify a group of five top-performing sections that were then compared to the group of other sections. The findings indicated that instructors in the group of top five sections spent more time in their sections than their peers in other sections. Instructors in the top five sections replied to learners' assignments and inquiries three times faster than instructors of the other sections.

Index terms - E-learning, online learning, effective instructors, effective online courses, traits of effective instructions

I. Introduction

E-learning is more and more popular in higher education because administrators consider it as an effective method to increase enrollment with fairly low cost (Maguire, 2005). However, the emergence of e-learning also poses a pedagogical question. Are instructors fully prepared to teach online?

Traditional learning settings differ from online learning in a number of ways, including instructor and student roles, interaction, communication, and flexibility (Young, 2006). A syllabus, curriculum and teaching technique may be effective in a traditional classroom, but it does not mean that they will also bring about the same established result in an online learning environment. White et al. (2003) held that unless traditional courses were reconceptualized using an interactive learning pedagogy, the results were '*nothing more than a correspondence course via e-mail and that simply transferring a traditional classroom-based course to an online format is doomed to failure*' (p. 172).

Quality of online courses is a growing concern among educators. Frankola (2001) revealed that although there were no national statistics, a recent report in the Chronicle for Higher Education stated that institutions reported dropout rates ranging from 20% to 50% for online learners.

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Several researchers (e.g., Motiwalla & Tello, 2000) have warned educational administrators about rushing to provide online programs, which may enable them to raise enrollments but that can overlook the maintenance or advancement of educational quality.

To that end, this study examines what characteristics, factors, traits, and classroom behaviors make an effective instructor in an online learning environment. The results of this study will help educational administrators develop better policies in evaluation of online instruction and recruitments of online instructors. In addition, this study will help online instructors know what works well and not in the online learning setting in order to improve their online teaching performance.

II. Research Method

Effective online teaching in this study is measured by two components: the frequency of learners' interactions in discussion forums and learners' final scores at the end of each course section. We examined five courses out of seven courses in an online program whose learners were elementary and secondary working teachers. Two courses were not included in this study because each of those courses had only one section. Among the selected five courses, four of them had four different sections and one had three sections. Thus, the total sections we examined in five courses were 19. Nineteen different instructors were in charge of those 19 course sections. Except for the differences in the teaching styles of the instructors, the curricular design of those 19 sections were exactly the same. One hundred and fifty learners used the same reading materials, completed the same assignments and took the same quizzes at the same time. Since each course was conducted on a monthly basis, these learners were randomly assigned to different sections every month.

To select sections for the top five out of 19 sections, one of the researchers conducted a tally of learners' interactions in discussion forums (criterion 1) and computed learners' final scores at the end of each course (criterion 2). We considered each entry in the discussion forum in each section as one unit of interaction regardless of its length and content. All 19 section were scored from 1 to 19 (1 is for the lowest and 19 is for the highest). Similarly, all learners' final scores at the end of each course were averaged and each section was scored from 1 to 19. Finally, scores in criteria 1 and 2 of each section were added up and ranked to identify five sections with the highest score averages of criterion 1 and 2.

III. FINDINGS

With this method of categorization, we could identify two groups in the 19 sections of the online program: a group of top five sections and a group of other sections (14 remaining sections.) Since there was no difference among those courses in term of section designs, course materials, assignments, quizzes and section requirements, the only independent variable that could affect the outcomes of each section was the instructors. Interestingly, we found there were several consistent similarities instructors in the group of top five sections shared. Firstly, under the permission of the administrators of the online program, we could get access to the course logs of each section in the learning management system (LMS) to track instructors' activities. We found that instructors in the top five sections spent more time in their sections than those in other sections. On average, they logged into their sections every two days and stayed there for approximately 20 minutes per login as shown in the table below.

Table 1. Time instructors spent in their section

Descriptions	**Instructors in top five sections**	**Instructors in other sections**
Login frequency	15 times/ section/ 30 days	12 times/ section/ 30 days
Time spent in the section per login	20 minutes/login	12 minutes/login
Total time spent in the section	300 minutes/30 days	144 minutes/30 days

We used a *framework for teaching: Domain 3* by Danielson (1996) to compare the quality of instructions by instructors in the group of top five and the group of other sections and found that there was a significant difference in instruction between instructors in the two groups. While the instruction in top five sections were consistently rated "*proficient*" or "*distinguished*", the instructions in other sections were consistently rated "*basic*" or "*unsatisfactory*". Specifically, "*distinguished*" instruction was defined as "*directions and procedures are clear to learners and anticipate possible learners' misunderstanding".* In contrast, "*unsatisfactory*" was judged for "*directions and procedures are confusing to learners"*

Finally, we compared time of responses to learners' questions or inquiries in the discussion forum between instructors in the top five sections and their colleagues in other sections. Thank to a trackable feature in the LMS, we could collect a time log of when each instructor replied to his or her learners' questions or inquiries in the discussion forum. We found that instructors in the top five sections replied three times faster than their peers. In addition, we used a model of three categories of feedback depth by Glover and Brown (2006) to examine instructors' feedback and responses. According to these researchers, depth of feedback could be divided into three categories: Category 1: An issue acknowledged, Category 2: A correct response provided and Category 3: The reason why a learner's response was inappropriate or why the preferred answer was appropriate.

The results indicated that instructors in the top five sections used feedback and responses in which a flaw was recognized, corrective advice was given, and explanations of the issues and the nature of the correction were provided. In addition, praise or a compliment was also included more often by instructors of the top 5 sections, serving to motivate learners. Instructors in other sections used feedback and responses that directed learners to the fact that a flaw was recognized, but no corrective advice was provided.

IV. DISCUSSIONS AND IMPLICATIONS

The findings of this study offer instructors and educational administrators several suggestions to help improve the quality of teaching and learning in an online setting.

Firstly, the result of this study indicated that effective instructors in the top five sections logged into their sections more often and spent more time there. It may be that frequency of entering the section and time spent there is an easily observed representation of the instructors' commitment to the course or section.

In addition to observations based on interaction "counts" in the LMS and qualitative value of the feedback provided, we also analyzed the instructions that were provided by instructors and found that instructors in the top 5 sections provided clearer guidelines for interaction with their learners. It is interesting that this also holds true in traditional learning environment where instructors are required to provide their learners with simple and clear instructions. Therefore, one of the criteria to rate online instructors' competences should be based on the quality of their instructions.

In summary, this study presents a few of the traits that instructors in the top five sections of an online learning environment exhibited. Although this is not a highly controlled experimental study, it has several features of an experimental study. Firstly, the learners and instructors were randomly assigned at the beginning of each section. Secondly, the contents and designs of each section were exactly the same. The only variable that made those sections different was the instructors. The findings of this study help educational administrators develop several readily measurable ways of evaluating online instructors based on LMS-tracked interactions, feedback provided to students, and posted instructions.

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Promoting Student Holistic Development through Student Interaction in Social Networks

Joseph C. H. So and Siu Yuen Lam

***Abstract*—This study examines how Facebook is being used as a platform to promote student participations in holistic development activities through interaction among students. The platform is used in an on-going student holistic development project run by a tertiary institution in Hong Kong. The study focuses on the ways are being used in Facebook by a group of student coaches to promote student holistic development, and the potential improvements of such implementation. The study aims at evaluating the effect of instant interaction between participants and student coaches via Facebook Group on the effectiveness of promotion.**

***Index Terms*— Facebook, social networks, virtual communication, student holistic development, student coaches.**

I. INTRODUCTION

In the light of the immense popularity of Facebook as the leading frontier among teenagers in secondary schools and tertiary institutions to communicate and interact with peers, educators and even strangers [1]-[3], it is worthwhile to assess and explore its potential as means of communication to foster learning interest among students in different development areas. Some propose to link up online social networks and learning purposes by using Facebook as an interactive communication platform for informal learning experience [4][5], improve their learning outcomes [6], and supportive services such as peer coaching [7].

Such use of online social networks rests upon the assumption that most of the teenagers nowadays belong to the media-savvy, multitasking generation, which commonly possess technological know-how and rely heavily on multimedia in their daily lifestyle. Some describe this generation as the Generation Media, alias 'Generation M' [3] [8]. Thus, a new challenge for educators today is to make use of and explore the learning potentials in multimedia and online social networks of this generation. While Facebook creates energetic virtual communities among the 'Generation M' that can boost learning outcomes in various ways, its potential usage as learning support of self-initiated holistic development among students is yet to be testified.

In this study, we will examine in particular how Facebook is being used as a promotion platform of a student holistic development project run by a Hong Kong tertiary institution, to communicate with participants, to facilitate promotion of activities and to foster participation and interaction among participants. This paper is structured as follows. Section II introduces the background of the student development project of our study. Section III illustrates the ways in which the Facebook Group has been implemented to facilitate interaction between participants of the project. Section IV discuss our reflections on initial evaluation of its impact and Section V presents some future work along with concluding remarks at Section VI.

II. BACKGROUND OF PROJECT SUCCESS – PROJECT FOR PROMOTING STUDENT INITIATED HOLISTIC DEVELOPMENT

In this study, we investigate students from a community college affiliated with a large-scale university in Hong Kong. The college offers 2-year associate degree (AD) and higher diploma (HD) programmes spanning science and technology, communication and social sciences, business and a number of specialized areas for students after their graduation from secondary schools. Most students are between 18 to 22 years of age, who can be described as the 'Generation M'.

The project being studied is called Project SUCCESS (hereinafter, "PS") which is run by the college as an official student holistic development scheme. PS aims to provide a platform which facilitates the students to plan and record their progress and self-reflection in personal development throughout their year-long participation in co-curricular activities. Participants of the project are expected to search for and take part in a wide range of co-curricular activities to achieve a set of milestones, and they are required to submit a portfolio detailing their experience and reflection at the end of an academic year. Several types of services are provided to students in order to assist them in keeping on their progress in the project. During their studies, a wide range of co-curricular activities being run by college and external organisations are promoted via school emails, posters and guidebooks.

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III. USE OF FACEBOOK IN THE PROJECT

Starting from 3rd Oct 2011 when a new cohort of the project commenced, the project has been running with the introduction of two new features: Introduction of student coaches and kick-off of a Facebook Group page. Student coaches aim at providing guidance and assistance to PS participants, as they all have performed well as participants in the previous year. They are responsible for organizing promotion activities, issuing bulletins, updating regularly the contents of the Facebook Group page, and offering advice and guidance when necessary. Seven student coaches are recruited and they work as a team to offer support and advice throughout the academic year. It is worth to note that no coach was assigned specifically to any participants.

The official Facebook group has since recruited 134 participants as "fans" out of the total number of 522 participants in PS. Student coaches have been using Facebook group as a platform to communicate with participants, including updating latest information, promoting activities, distributing bulletins and answering enquiries. Participants do not communicate with the coaches not via email or noticeboard but via Facebook wall, making a collaborative effort to share all the information related to the project. Postings on the wall of the Facebook Group are not being censored or filtered, although the administrators (Project owner and student coaches) reserve the right to remove any messages with indecent, obscene and violent content, a right which has not been required to exercise until now.

IV. REFLECTIONS ON THE USE OF FACEBOOK

Reflecting on the effectiveness of the Facebook group throughout the past eight months, the student coaches generally agree that this is a very convenient way to maintain connection with participants since the project does not hold regular activities and meetings. The Facebook group as a medium of communication offers a more flexible and always-ready channel to facilitate their work anytime they are available: between classes, after classes, during lunch time, at home, and also during their meetings with friends. They can introduce what they have been doing with their schoolmates when being approached; they can upload posters and information of different student holistic development activities via their smartphones whenever they get to know; they can answer enquiries to one person on the Facebook wall and the rest of the "fans" will be able to read them thus reducing the possibility of answering the same enquiry repeatedly throughout the year. "Fans" can also further respond by writing comments, share them, and "like" or "dislike" them. Consequently, the circulation of information related to the project has been boosted by the instant notification of the Facebook function and has reached its readers directly and effectively.

Thus, it is expected that, compared to previous years before the Facebook group was introduced for the project, involvement of participants in college-wide and those organized by external organizations have increased, as the group becomes a reliable source among participants to search for activities as it would be constantly updated with the latest information. Accordingly, it will help students know and explore many NGO and external organisations which they are unheard of before, and they will be more willing to try what students coaches have promoted. This is likely resulted in a higher chance for participants in joining a wider variety of activities.

Participants, in addition, will also make use of such medium of communication to raise questions about the project although their postings may not have been regular, and it is foreseen that more questions will be raised when they start to prepare their self-portfolio for submission in August 2012.

V. FUTURE WORK

With the above project background, we will proceed to assess the overall impact of the Facebook group in promoting student holistic development. A complete review will be conducted when the cohort of the project ends. The evaluation will be conducted on both quantitative and qualitative models. On the quantitative level, we will investigate the effect of the platform on fostering communication and self-initiation on holistic development among participants. The usage among all participants who had joined the group as an indication of the effectiveness of interaction among them will be measured. It is useful, for example, to count the posts being made by different parties, including participants, student coaches and the project owner and response rate of posts with different nature (e.g. activities, enquiries, instructions or notice, etc.).

On the other hand, reflections can be conducted with the student coaches and their feedback can be used as qualitative assessment. The core questions of interviews can be related to whether the Facebook Group was an effective alternative communication platform other than traditional methods such as email or posters, as well as the evaluation of interaction between different parties within the Facebook Group.

VI. CONCLUSIONS

Many educators have argued that we should not underestimate the emerging effect of the Internet and its consequential social networking environments on students' learning experience in formal or informal settings. This study illustrates the ways in which Facebook potentially positively affects the interaction between both participants and activity organizer for co-curricular activities in a tertiary institution, especially when it is related to rapid circulation of information. Interaction among students outside the classroom, especially on the online social networks may lead to a more complex learning procedure for students that can be either rewarding or bemusing. A more comprehensive research would provide valuable insights into the Facebook phenomenon among students as learners in the near future.

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