Editorial

Sabine Graf and Charalampos Karagiannidis, Co-Editors

Welcome to the Bulletin of the IEEE Technical Committee on Learning Technology, Volume 17, Number 3, October 2015 issue. This issue focuses on topics related to **mobile, ubiquitous and pervasive learning** and consists of four articles discussing cutting-edge research on this topic. Furthermore, one article is included in the regular paper section which focuses on diverse topics on learning technologies.

The first paper on the special issue on mobile, ubiquitous and pervasive learning is written by Müller, Fehling and Urban, and discusses the design, implementation and evaluation of a training application enabling trainees to explore complex machines via 3D visualization and augmented reality, and to work on learning contents together.

The second paper, written by Terracina and Mecella, introduces a mobile game that combines the advantages of virtual learning environments and intelligent pedagogical agents to provide learners with a quest-based game to encourage students in problem-solving activities.

In the third paper, Garau, Boratto, Carta and Fenu present a case study that introduces a novel educational model at an Italian Primary School. The paper focuses on presenting different types of educational technologies used in the project and how they were adapted to be used by young children.

The fourth paper, written by Cárdenas-Robledo and Peña-Ayala, proposes a cybernetic method to deal with cognitive load in u-learning environments (CMCLU-LE). This method aims at helping students to self-regular their learning process through metacognitive strategies.

In the regular paper section, one paper is included. In this paper, Orooji, Taghiyareh, and Nasirifard present DoosMooc, an integrated social learning environment that facilitates learners' communication and collaboration through a series of modified or redesigned actions, interfaces, representations and workflows. The system was evaluated with 18 students, demonstrating the benefits of DoosMooc.

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 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/authors-guidelines .

Special theme of the next issue:

Serious Games and Gamification for Technology Enhanced Learning

Deadline for submission of articles:

November 20, 2015

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.

Social Augmented Learning

Andreas Müller, Christian Dominic Fehling, Bodo Urban

***Abstract*— This article provides an insight into the design and implementation of a training application enabling trainees to explore complex machines via 3D visualization and Augmented Reality, and to work on learning contents together. The application has been developed within the Social Augmented Learning project and supports an effective use of mobile devices, Augmented Reality and communication via social networks for professional training. It also supports Trainers in easily creating new learning content. First experiences in the print and media sector prove the applicability of this application and demonstrate the potential of the digitally extended learning environment.**

***Index Terms*—electronic learning, educational technology, augmented reality, social media, social learning**

I. Introduction

The Social Augmented Learning project focuses on an interdisciplinary approach to combine the fields of social, mobile, and augmented learning into a new, technology-supported way of teaching and learning. Within this context, a learning application has been developed and implemented, as well as tested and evaluated for vocational training for the *media technologist for print* profession.

This profession is losing more and more of its attractiveness due to the difficult economic situation of the sector [1], [2]. At the same time, it is characterized by an increasing complexity resulting from technological progress and converging professional fields. In this course, the operation of printing is of great relevance: highly precise instruments allow only tiny tolerances at high processing speeds in order to reproduce a perfect print image. During professional education, the operation of these machines can no longer be taught in a sufficient way, as trainees only get to know the machines available in the respective professional school and company, but in their later professional lives have to work with a variety of machine configurations.

On the other hand, modern printing machines are normally closed systems, like black boxes. As processes taking place on the inside and cause-effect relationships are not directly comprehensible, learning at the machines becomes more and more difficult. This also leads to the fact that the potential of modern machines is no longer completely utilized [3]. Furthermore, even smaller maintenance tasks have to be carried out by the manufacturer.

Conventional learning devices, such as books, scripts, or figures, are no longer suitable for the descriptive representation of complex relationships and mechanisms. Whereas in the past, practical teaching was possible, e. g. by opening or partially dismantling the respective machine during operation, today this might not be the case and new ways to do so have to be found.

Therefore, the need for innovative methods for knowledge transfer is great in order to adapt the level of education and training to technical progress in the sector.

II. Related Work

Augmented Reality is defined as the extension of reality by adding virtual objects. It is characterized by the three-dimensional reference between virtual and real objects, as well as by interaction in real time [4]. In [5] the use of AR systems in education is subdivided into 5 important subsections:

1. AR books: By implementing AR markers into common books, texts and illustrations can be complemented with dynamic and interactive contents via smartphones or tablets [6]. Several tests have already indicated a better understanding of contents, as well as a higher acceptance, even without preliminary instruction [7].

2. AR games: These lead to an increased joy of learning and encourage the learner to interactively deal with abstract or complex contents via trial and error. Various studies show that AR games may significantly increase the speed of learning, as well as the enthusiasm of the learners [8].

3. Exploration-based learning: AR technology allows the annotation of different objects or places, like excavations [9], with additional digital contents. The learner does not know which objects are connected with the respective contents in advance and thus is motivated to explore objects and environment. The motivation to autonomously deal with new topics is thus increased [10].

4. Object modelling: Via AR applications, learners are also able to model objects. These objects may be studied and moved in space and immediately analyzed for the effects of modification in the construction process. Thus, the imagination

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of the learners is promoted, and at the same time their motivation is strengthened [11].

5. Training of skills: AR systems are especially suitable for instruction-based learning in which the learners are directly confronted with the consequences of their actions without putting themselves or the machine at risk. According to [12], applications with collaborative aspects, like in [13], are especially successful in sustainable knowledge transfer.

Based on the explanations given above, it becomes evident that the use of Augmented Reality is suitable both on a technical and a learn-theoretical level to transfer complex knowledge faster and more intuitively.

III. Approach

With the help of the Social Augmented Learning application, the learners get an insight into complex processes and the functioning of printing machines. Relevant content gets aggregated: small assets (e.g. text, graphics, 3D models) are summarized in single slides which are the building blocks of learning modules. Each learning slide consists of a title, a text-based explanation of the depicted content, 3D models of the respective machine elements and, optionally, further 2D illustrations (See Fig. 1). The 3D models can be moved freely in space, animated, complemented by three-dimensional pointer objects, and parts of the model can by highlighted by inking.

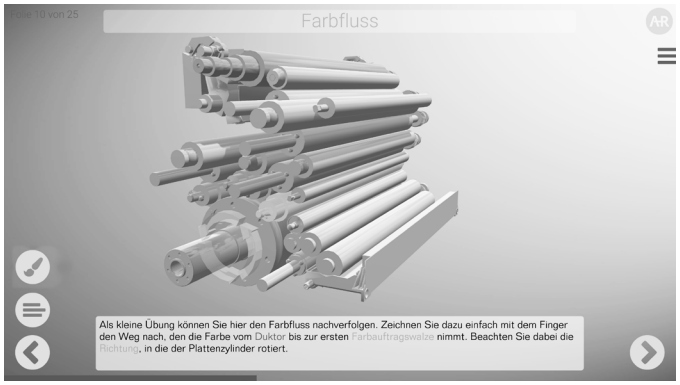

Fig. 1. A slide showing a 3D model of several print cylinders, a pointer object and a textual description.

The content can be explored independently from the real machine using the 3D visualization of the machine components. In Augmented Reality mode, which is commonly used on a tablet, the camera capture of the real machine and the 3D contents overlay one another (See Fig. 2). The printing machine is "opened" at defined sections so that the learner can see the inside through a virtual window. In this course, the virtual machine components have the same position as those inside the real machine. With the help of this visualization, learners can understand complex cause-effect relationships by exploring the 3D model and moving through Augmented Reality, a learning space that is enriched via slowed down animations, additional digital assets, or complementary annotations.

Fig. 2. Using the Augmented Reality mode the learner can see the insides of the machine through a virtual window.

The application has two different modes, which can be used for teaching and learning. In the self-learning mode, learners can autonomously work with the contents, either at home or at the machine. In the presentation mode, an instructor guides a group of learners through the contents. The electronic devices of the learners are connected to the instructor's device via Wi-Fi. He takes control of the application while the group is standing in front of the machine, watching it via the AR mode. He can synchronously skip the slides on all devices, can give further remarks, show and hide additional 2D illustrations, and annotate machine components. Annotation takes place using simple touch gestures on the visualization of the machine. A circular highlight appears in the 3D space (assigned perpendicular to the 3D object) and a three-dimensional line can be drawn onto the machine with a drag gesture. Via these annotations, the instructor can highlight facts (e.g. color gradients or positions of certain machine components) or ask questions (e.g. *"where is the first ink application roller located?")*. The annotation function may also be activated for the learners. They can use it for answering questions or to ask questions themselves, such as which function a certain component has.

Fig. 3. Social media connected to the virtual model by tags.

Social media content can be connected to the virtual model or via Augmented Reality to real objects by tags (See Fig. 3). These may refer to blog articles, forum posts, or wiki entries. Instructors and learners are thus enabled to add questions, tasks, and hints related to learning content, as well as to real or virtual objects. The information is located within the 3D space on the machine. Each user can create markers on the machine via drag-and-drop and connect them to content in the social media system. This gives learners the ability to participate in the education and train quickly and easily in a way they are familiar with.

Fig. 4. A WYSIWYG editor is used to create the learning content.

The WYSIWYG editor is a major component of the solution presented in this paper (See Fig. 4). It helps instructors and trainers to easily and intuitively create content for Augmented Reality. This is realized in three steps.

In step 1, the 3D model of the machine is created. The person responsible for this either has to have access to the construction data or has to be experienced in the use of CAD systems to remodel or create the needed 3d model.

In step 2, the virtual windows for Augmented Reality tracking are configured. In our application this is realized by marker posters. This has to be made separately for each machine and each virtual window.

In step 3, the learning contents themselves are created with the help of the WYSIWYG editor. Based on the 3D model and the defined virtual windows, the instructor can create slides with all the necessary information. He can import text and images and can also modify the 3D model by certain actions. Components can be shown or hidden, highlighted with colors, animated, and annotated by labels or 3D pointer objects, such as arrows.

While step 1 is rather complex, steps 2 and 3 can be done easily by persons without any technical affinity. Thus, instructors are able to autonomously create various learning modules on the basis of a single machine model.

IV. Implementation

The application uses the Unity Engine [14] for rendering. Thus, it can be deployed on a great number of platforms, like Windows, Mac/OSX, Android, and HTML 5. Graphical effects, such as shadows or global lighting calculation, are individually adapted depending on the respective computing power.

A. 3D data

The project partner Heidelberger Druckmaschinen AG [15] has provided the CAD data of a printing machine for the implementation of the learning content. As this data consisted of several millions of triangles, the model was reduced to approximately 150k polygons. Two approaches were tested in this course. In the first approach, a complete remodeling was made by hand, taking about 12 working hours. In the second approach, a semi-automatic remeshing was carried out. The model was transferred into a volume representation, cavities inside the model were filled, and the ISO surface was extracted and tessellated. This resulted in a mesh which was then reduced in its complexity via special processing. Subsequently a normal map was calculated for the reduced mesh with the help of the original model. The semi-automated approach brought satisfying results, but still could not reach the quality of remodeling.

B. Tracking

Augmented Reality tracking is carried out on the basis of the Metaio SDK [16] – either marker-based or SLAM-based. SLAM tracking works on the basis of features and does not require visible markers. Nevertheless, it has got a decisive drawback: it has to be configured separately for each printing machine. Due to the fact that there exists a great number of printing machines from different producers, which have to be configured and assembled individually for each customer, marker-based tracking is commonly applied in the Social Augmented Learning project. As to sustainable implementation in vocational schools and training enterprises, the attachment of special marker posters is significantly easier than the complex configuration of SLAM tracking on the basis of local circumstances. Furthermore, the marker posters do not require any special materials and thus can normally be produced on-site.

C. Networking

All clients have access to one common server, which controls the storage, versioning, and distribution of the content. Clients can be used without any connection to the server, though. Any modifications of the learning content is saved locally and synchronized during the following network access. Additionally, the server does the matchmaking of the clients during the use of the presentation mode, as well as the conversion of the 3D models during the import of a new machine into the WYSIWYG editor. The server application is compact and can be used without any installation. This enables the educational institutions to set up and operate a local server by themselves, e.g. within the local network. This is of vital

importance as, in some cases, normal internet connectivity in the printing hall does not exist.

D. Social collaboration

The social media content is stored in a Drupal CMS [17]. We use the existing *Mediencommunity 2.0* [18], an established knowledge community for printing and media technology in Germany. Generally, the use of any Drupal system, version 7.0 or higher, is possible. The implementation is based on special plug-ins, which allows the creation and request of the contents and of users, including their roles via a REST interface.

V. Results and Analysis

In the course of the project, several tests were carried out in vocational schools, training enterprises, and job training centers. In the first wave of user studies, 72 trainees and 13 trainers participated in a questionnaire with 37 different indicator questions. As part of the evaluation, these were summarized in the following indices:

Form of learning: Summary of questions regarding the technical aspects of technology assisted learning.

Learning module: Evaluation of the quality and presentation of the learning content.

Application: Questions specific to the technical aspects of the evaluated prototype, e.g. usability and functionality.

Learning process: Questions regarding the roles of trainee and trainer and potential differences in these roles compared to conventional learning processes.

Teaching and Learning: Overall impression regarding Social Augmented Learning, learning with mobile devices, and the organization of the user study.

The questionnaire was constructed with an even-numbered scale, with items ranging from “1” for “totally agree” or “very good” to “6” for “strongly disagree” or “inadequate.”

TABLE I
Indices, Evaluation of the Trainees [N=72]

Indice	Median	β	P
Form of learning	*1.8*	*.27*	*< .05*
Learning module	*1.9*	*.24*	*< .05*
Application	*2.2*	*.19*	*n.s.*
Learning Process	*2.1*	*-.21*	*n.s.*
Teaching and learning	*1.7*	*.26*	*< .05*

The quantitative tests show that there is a significant acceptance of the solution by the trainees, as well as by the instructors and trainers. The data collected from the students was further analyzed to evaluate the possible influences of single indices on the overall impression, with the result that the indices “Form of learning,” “Teaching and learning,” and “Learning module” are most influential.

Qualitative testing is to be made on the basis of guideline-based interviews. By the end of the project, all quantitative and qualitative results will be summarized in a comparative study (Social Augmented Learning in comparison with conventional training and learning methods).

VI. Conclusions and Further Work

This paper has presented the concept and implementation of a learning application which makes use of mobile devices, 3D visualization, Augmented Reality and communication via social networks to enhance training for the media technologist for print profession.

The preliminary tests show that there is a significant acceptance of the solution by the trainees as well as by the instructors and trainers. By the end of the project all quantitative and qualitative results will be summarized in a comparative study.

In the long run, the application is to be adapted to further scenarios and sectors, such as the support of repair and maintenance work, the guidance of workers in assembly scenarios, or in documentation during production.

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Game@School: Teaching STEM through Mobile Apps and Role-based Games

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***Abstract* — Dealing with digital native students requires new methodologies of teaching. In this work, we describe an approach and a conceptual architecture of a supporting teaching tool that takes into account two main objectives in new teaching trends: Virtual Learning Environments (VLEs) and Intelligent Pedagogical Agents (IPAs). The main idea is a VLE that in turn is a role playing game. The game structure follows a quest-based game that is deliberately designed as a system of problem-solving activities aimed at achieving objectives, to be successfully addressed in order to progress and eventually win. The emotional behavior of the IPAs has been built by conducting a study on emotions with high school students. Stemming from the study results, it has been built an Android application that uses the IPA as a standalone application to prove the efficacy of the IPA itself.**

***Index Terms* — Intelligent Pedagogical Agent (IPA), Role-playing game, Virtual Learning Environment (VLE)**

I. Introduction

Over the last ten years, the way in which education and training is delivered has changed considerably with the advent of new technologies. Thus, technology should be a prominent part of the learning process and should be intended as a support for teachers and learners. One new technology that holds considerable promise for helping to engage learners is Games-Based Learning (GBL) [1]. The term game is quite ambiguous, that means that researchers, game designers, parents, students, teachers, etc. have a different concept of games. In this work, we intend games as inquiry based laboratories in which participants are able to imagine, engage with, and reflect upon their experiences. Games are intended as scenarios, following [2], which directly refer to the dynamic, future-oriented models for possible actions that are embedded in game designs.

Gaming and schooling have developed into two distinct "knowledge traditions" that often rely on opposing validity criteria for determining what counts and what does not count as relevant knowledge. To avoid that dichotomy, GBL should integrate different aspects that are related to the knowledge itself, to pedagogical aspects, to scenario-based and every day practice [2]. We matured the idea to develop a *serious game* that integrates the most up-to-date technologies in new teaching trends [3]:

- Virtual Learning Environments (VLEs);
- Intelligent Pedagogical Agents (IPAs).

II. Game@School description

A. Overall design

Prensky [4] coined the term digital native more than ten years ago: "Our students today are all native speakers of the digital language of computers, video games and the Internet". We are persuaded that this term still describes a generation of students that grown up tight to technology and that somehow suffer from the lack of technology in classroom lessons.

The main idea of our research is a VLE [5] that in turn is a role playing game. The role playing game is a social game in which each student becomes a player with her abilities and her tasks. In order to succeed, all the players should work to achieve a common objective/goal. The storyboard is designed in a way that there is an evolution in the role playing game and a progress in the level of learning as well.

The idea of helping students in the process of learning in a different way with respect to the classical approach finds support in many psychological studies and previous work, in particular we refer to Howard Gardner theory (1983): "We might think of the topic as a room with at least five doors or entry points into it. Students vary as to which entry point is most appropriate for them and which routes are most comfortable to follow once they have gained initial access to the room. Awareness of these entry points can help the teacher to introduce new materials in ways in which they can be easily grasped by a range of students; then, as students explore other entry points, they have the chance to develop those multiple perspectives that are the best antidote to stereotypical thinking". In [6], for each of the five entry points theorized by Gardner we provide a link with the adoption of a role playing game and a concrete example of a possible gameplay situation, based on teaching physics (we argue the approach is applicable to STEM in general). Notably, in 1999 Gardner added a sixth entry point: *Social - Use group settings, role-play and collaborative arrangements,* which perfectly complies with our proposed approach.

In the above scenario, students face with numerous learning opportunities and therefore require intelligent support and guidance. The use of IPAs is proposed as support during the game evolution and each student has its own IPA: they act as learning facilitators and guide the learners in the virtual environment, by explaining topics, answering questions, giving feedbacks, helping the learners to collaborate with others,

providing personalized learning support. In fact, as suggested in [7], one of the Artificial Intelligence (AI) grand challenges in education is "mentors for every learner": IPA combines different abilities including intelligence and pedagogical orientation; they are autonomous and not directly guided by users.

The envisioned VLE partly runs on a central server (e.g., an Interactive Whiteboard) and partly on mobile devices directly provided by the school or owned by the students themselves as depicted in Figure 1. For a detailed description of the platform, the reader can refer to our work [8].

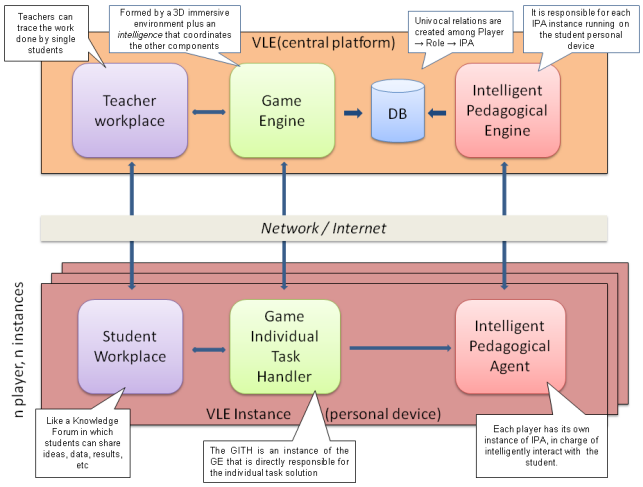

Fig. 1: Platform architecture

B. Use case scenario

As shown in Figure 2, the teacher introduces the scenario to the students and explains the problems that they have to solve during the game. After that, the teacher designates a master that behaves at the same level as the teacher, by following the approach in which a student can "learn how to learn by teaching"; in each session of the game, the master should be a different student, so everyone can experience a role of greater responsibility.

Then, the master with the help of the teacher, can form teams and assign a specific role to each student. The student, from now on, becomes a player with her specific role and her own task as well (depending on the level of the student). In this phase, an IPA is assigned to each student/player that will drive her all along the game. The relation between the student and her IPA should progress all along two paths: the learning aspect (giving tips and advices related to the topics and to the tasks assigned) and the emotional/pedagogy one (the interaction depends on the feelings of the student).

Each student is assigned a task and each single contribution allows her to solve the more general complex problem. The student should solve the task possibly on her own at home (homework) or during classroom lessons, depending on how the teacher would like to organize the work.

The player is invited to share her solution and discuss it with the others. When the team achieves a solution, the master can verify it, and if the provided solution is correct, the game proceeds to the next level.

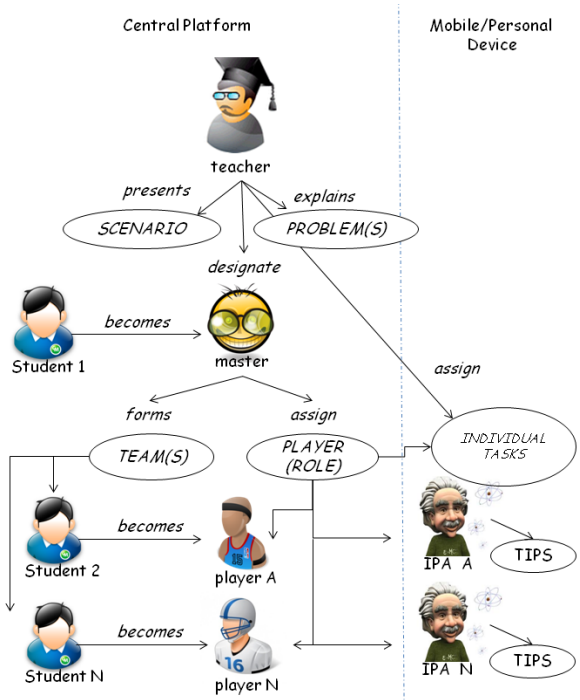

Fig. 2: Use case scenario

C. Game quests and learning patterns

We can consider both games and courses as a system of problem-solving activities. Problem-solving is a process of activities aimed at transitioning from an initial state to a desired goal state, overcoming obstacles, and often developing knowledge [10]. Some types of games explicitly leverage the problem-solving nature of gaming in order to articulate the player experience. This is the case of quest-based games, in which quest systems are used as mechanics to organize game play activities and contextualize them in a coherent narrative frame, defining narrative and activity progression within the game [11][12]. Quest-based games have a primary aim that players must fulfill through achieving concrete objectives associated to quests. Thus, quest-based games are deliberately designed as systems of problem-solving activities aimed at achieving objectives that need to be successfully addressed in order to progress and eventually win.

Gameplay mechanics define the interrelationship and interoperability of the game system elements, the provision of contextual information to the player, and the dependencies between gameplay activities [13].

We have taken the patterns proposed by [14], as base for our gameplay development, and extended them with two more patterns: the quiz structure and the team challenge-based reward as explained in Table 1.

III. EMOTIONAL IPA AS PROOF OF CONCEPT

Figure 3 reports a summary of the state of the art about IPA development in learning context. Two major papers [15][16], from the end of the nineties, introduced the Persona Effect and the concept of the agent like a Social Actor leading to the idea and development of Animated Pedagogical Agent. Most of the recent works try to put together sensor technology (audio/video systems, brainwaves signal, etc) with emotional

TABLE 1: QUEST STRUCTURE AND IMPLEMENTATION

Gameplay patterns	*Explanation*	*Implementation*
Quest structure	The plot is articulated as a sequence of quests. Some parallel/alternate quest choices are foreseen as explained in the *non linear progression* box.	The quest are of three types: 1. Simple problem that should be solved individually (tasks) 2. Complex situation that requires the work of the entire team, coordinated by the master 3. Optional quests inserted by the teacher during game practice
Quiz structure	In some situation the game can progress simply replying to quiz questions with multiple choices.	Students find this structure in some game situation to in which a quick, individual solution is required.
Strategic open-endedness	We provide a series of limited possible alternative strategies to progress in the game. Just one or two strategies are successful while the others are dead-ends.	The diverse possibilities are seen as predetermined doors or choices. When the student select a choice should motivate it, providing a specific answer. If the choice is not correct the student can select an ***Orientation*** tool.
Non linear progression	The non linear progression is not foreseen in the first issue of the game.	Few exception to the linearity of the progression are allowed in some sub-branches of the main plot in which students can choose which stage investigate first.
Orientation	**Big Brain (BB):** is a central brain that contains information and that can be read by the students like a sort of wiki **Simulation Room (SR):** Is a virtual environment linked to the game but external to the game in which the student can practice some game/physics situation **Intelligent Pedagogical Agent (IPA):** when the students seek for short and simple tips can ask to her personal IPA	Each player can: **BB**: Contact the big brain and seek for an explanation **SR**: Enter the simulation room **IPA**: Ask tips to the personal agent **DN**: Do nothing and just try something else!
Individual Challenge-based reward	In each situation points are gained or lost as explained in the next box. Points are gained when the student directly provides the correct answer without using the ***Orientation*** while points are lost when the student use one of the tools.	**BB** → Loose very few points **SR** → Loosing or not points depending on the outcome of the simulation **IPA** → Loose very few points **DN** → Loose more points but have the possibility to arrive faster to the solution
Team Challenge-based reward	In some situation students should discuss (as a team) and provide a common solution to the problem. If the common solution is correct the team gain some points, if the solution is incorrect the team lose some points	Individual and team points are distinct and do not sum. The entity of the point lost/gained depends on the specific tasks and on the ability of the master to coordinate the team. Thus the team score is based on an automatic response of the system (game engine) and on an evaluation by the teacher of the work done as a team.

model (dimensional, categorical) in order to properly recognize and manage user's emotions. Some papers, e.g., [17], put emphasis on the politeness effect and others, e.g., [18] put more research effort on Artificial Intelligence techniques to better model agents' answers and suggest a combination of AI techniques and sensor analysis.

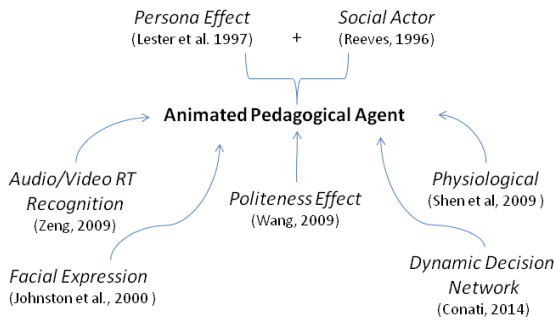

Fig. 3: Schema of the state of the art about agents

In our research, as far as the emotional interaction with students, we adopted a bottom-up approach, by surveying an experimental group of 20 students, from an Italian high school aged 16-17 years (from September 2014 to December 2014), in order to investigate their feeling in a school context. The work done with students has been conducted in collaboration with school teachers from literature and computer science classes. We worked on emotions, starting to analyze what students feel during real school scenarios, like a test session or an oral presentation. Then, for each emotion they express a wished behaviour of the virtual tutor (Pedagogical Agent), a motivational phrase of the tutor, and the facial expression that the tutor should have. A full description of the project and its results are reported in [19]. All the collected emotions have been registered in a database, linked to a possible reaction of the virtual tutor.

Students interact with the IPA via chat expressing their feeling in natural language. Natural language analysis is then performed on students' phrases to detect their emotion. More in details, the developed Android application works as it follows. The student registers to the application and once she is logged, she can choose among a list of topics and available IPAs (with different aspects). Once the topic has been chosen, students can chat with the IPA simulating a natural dialogue about the topic covering pedagogical and learning aspects.

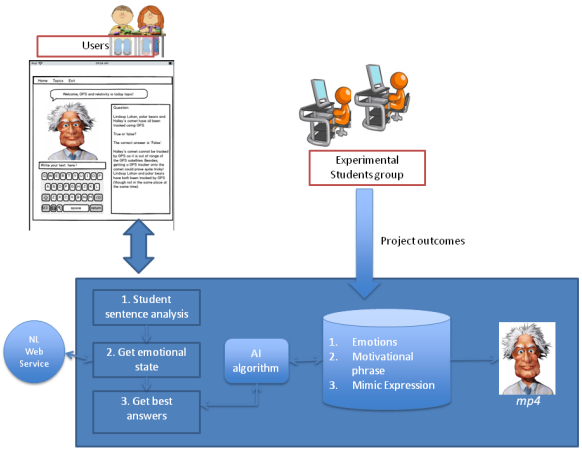

Fig. 4: Android application overview

The system allows the user to freely express her thoughts in textual form. The IPA is able to guess student emotions by exploiting a Web service that analyzes the sentence and returns an emotional state. The user gets back an adequate answer: each possible answer corresponds to a pre-registered mp4 file in which an animated avatar has been modelled following the instructions given by the students in the previous phase of the study (mimic expressions and motivational phrases).

Beside the emotional relation between the student and the IPA, the student is able to chat with the IPA about the subject of study that is explained via textual message: the best answer to learning questions is provided using a specific AI algorithm, starting from [20] and improving it.

This Android application has been presented (after a selection process) at the Science on Stage Festival 2015 (cf. `http://www.science-on-stage.eu/page/display/4/14/0/festival-2015`) and raised a lot of interest from teachers and researchers in the field of new technologies in schools. Clearly this Android application is only an initial step towards the ambitious objectives of our research. It should be enhanced in order to *(i)* allow students and IPA to interact more naturally (e.g., through vocal interaction via ASR/TTS technologies), *(ii)* dynamically synthesize and present emotions to students, and *(iii)* be integrated with the remaining of the VLE (cf. the overall architecture in Figure 1). In addition, our future work includes completing the overall platform, and to validate it through an entire semester in an high-school in Italy, in order to demonstrate its efficacy as a supporting tool for teaching physics.

IV. Conclusions

The research discussed in this paper wants to address several open questions related to the use of new technologies in teaching practice. Good technology can enhance learning? Do virtual tutors make students more confident? Can we support inquiry based learning through the use of games? So far we have evidence, also from other research projects, e.g., [15][17][18], of enthusiasm from the student point of view in the use of games and virtual tutors. But, do we have the same enthusiasm from teachers? Our answer to this question is a new challenge for the future: make teachers able to provide their own content, using the technologies powered by us.

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UP SCHOOL: Introduction of Pervasive Learning Technologies to Enhance Classic Educational Models

Paolo Garau, Ludovico Boratto, Salvatore Carta, and Gianni Fenu

***Abstract*—With the continuous development of new technologies that have been naturally integrated in the daily activities of children, it becomes necessary to include them in the educational programs, in order to enhance the children's learning with tools they are already familiar with. In this paper, we present a case study realized by UP SCHOOL, a new Italian Primary School that introduces a novel educational model, designed around the children to favor their learning. In particular, we will focus on the learning technologies employed in this project, on the motivation that led to their inclusion in UP SCHOOL, and on how they have been designed and adapted for the use by young children in a learning environment.**

***Index Terms*—Computer aided instruction, Computer science education, Educational technology, Electronic learning.**

I. Introduction

In 2001, Marc Prensky defined the new generation of children as "digital natives" and highlighted that the educational system is not up-to-date with the needs of the modern students [1]. Moreover, several studies, such as [2], highlighted that an improvement in the level of learning is directly linked to the capability of the students to make experiences.

In their every day's lives, children use tools and technologies, like computers, smartphones, and tablets. Therefore, one the hand, children continuously make experiences by interacting with the new technologies, while on the other hand, in most cases the organization of the education in schools does not involve any of these technologies.

In order to cover this gap, in this paper we present a novel Primary School concept of education realized by the internal research team of UP SCHOOL[1], whose objective was to realize the school around children. The educational model chosen for UP SCHOOL involves a reorganization of the space and of the teaching methodologies, starting from a flexible and polyvalent environment, in which groups of children get together based on their interests and competences, supported by innovative technologies during the learning process.

In the literature, the introduction of learning technologies in education environments has been analyzed from several perspectives. The studies conducted thanks to the introduction of the "Microsoft Innovative Schools Program" [3] confirmed that the introduction of the ICT is essential in order to enhance the learning of students. Oghan and Johnson recently highlighted that the introduction of learning technologies has to be adapted to the cultural context in which these technologies are employed [4]. Therefore, some studies have analyzed the impact that these technologies had in Russian schools [5], and on the difference that characterize Europe and Asia [6]. The introduction of game-based learning approaches that also involve technologies have been presented [7,8]. In [9, 10, 11, 12], it has been highlighted how the design of the environment in which the educational activities are done is an essential aspect for an effective learning.

With respect to state-of-the-art educational models that involve the use of technologies, UP SCHOOL does not only introduce new technologies as learning tools, but these technologies are integrated in a physical space and educational program specifically designed to exploit them, and enhance the learning of young children and their experience at school. This is the first time in which both the design of the environment and of the introduced technological aspects have been combined. Moreover, the cultural context has been highlighted as a characterizing aspect to decide which technologies should be introduced, and in Italy no other school adapted the whole Ministerial Education Program to the learning technologies.

The educational project presented in this paper has been actually realized in a kindergarten and primary school called UP SCHOOL, located in Via Trento 50, in the city of Cagliari (Italy). In September 2015, UP SCHOOL started its first year in which this educational model started working.

In this paper, we are going to focus on the learning technologies employed, adapted, and installed in UP SCHOOL to favor the development of enhanced educational programs, but still based on standard Ministerial Education

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[1] http://www.upschool.it/
UP SCHOOL designed in Italy, Inspired by the World

Programs. Indeed, the new technologies are a central component in the project, since they are employed as learning tools and they are integrated in the school activities. Tools like 3D printers are employed to develop the first "baby fab-lab" where children can learn to make and build in team. Instead, a 3D projector located in a specific school's room is dedicated to the teaching of science, while interactive tables and interactive projectors are employed during frontal lectures and group activities.

It is important to underline that the traditional tools employed during the learning are not replaced but integrated with new devices and technologies, with a controlled but spontaneous employment by the children. Indeed, thanks to the interaction with the technology, the same subjects can be taught with different tools and educative objectives, like the introduction of logic (e.g., "If you do this, this will happen").

In order to allow the students to share the information and knowledge they gathered, it is necessary to give them tools that stimulate the research and discussion among them, also letting them employ tools that the modern society requires them to adopt. Moreover, lots of subjects might use the augmented reality to collect and exchange information, or to simulate actions that would be impossible in a traditional school environment. To make this sharing of information and discussion possible, the project integrates all the forms of technologies that have been indicated by Weiser et al. as the essential elements for pervasive computing, i.e., tabs, pads, and boards [13]. Indeed, pervasive technologies are designed to support humans during their daily activities. This is one of the main purposes of UP SCHOOL that, thanks to intelligent use of technologies, effectively integrates the learning process.

The scientific contributions of this paper are the following:

- we present the first Italian educational model in which the whole learning process is adapted to the new technologies;
- the technologies have been specifically chosen and adapted to be employed by young children;
- UP SCHOOL is the first school that uses an educational model in which the learning technologies are integrated in a whole environment designed around the children, which involves both physical (e.g., the furniture) and experiential (e.g., water- and nature-based activities, yoga, etc.) elements that enhance the educational process.

The rest of the paper is structured as follows: Section II illustrates the learning technologies installed in UP SCHOOL; in Section III we present a brief analysis of the impact that the presented technologies have had on parents and children during a first presentation of the school; Section IV presents conclusions and future work.

II. Learning Technologies

This section presents the learning technologies employed by UP SCHOOL in its educational project.

A. Tablets

Tablets represent the primary type of technology with which children interact. They are introduced to substitute classic books, since they weight less and they are very easy to consult.

Moreover, thanks to their easy touch interface, it is possible to tailor the education to the needs of each child. Indeed, with monitoring algorithms that work in background while a tablet is being used, we are able to evaluate how each child learns by analyzing different aspects. For example, we can understand how focused a child is while learning a new concept by analyzing the number of seconds used to read a page.

B. Interactive Table

An interactive table is a system that, thanks to a monitor and a multi-touch system, allows the students to see presentations, and interact with the device by searching and sharing the information they want.

As mentioned in the Introduction, each technology is introduced with a specific educational purpose in mind. Teaching disciplines like geography becomes more effective with this type of device with respect to traditional methods, since children can interact in real time with a virtual globe, to locate the countries they are learning about.

The interactive table installed in UP SCHOOL as been specifically adapted to be used by young children. Indeed, the legs of the table have been shortened, so that children with an age of 4+ can sit and lie down the table to interact with it.

An example of room in which the interactive table is installed is shown in Fig. 1. As it can be noticed, the whole room is designed to integrate different type of activities, and the interactive table is placed close to a classic one, so that it can be employed only for educational purposes and enhance them.

Fig. 1. Room with an interactive table.

C. Interactive Projector

The interactive projector (shown in Fig. 2) serves as a sort of blackboard, in which the teachers and students can interact during the lessons.

With respect to a classic blackboard, this projector allows teachers to base their lessons on existing slides, enriched during the lectures with pen-based interactions, allowing them to keep strong the concept of the writing by hand. Moreover, if allowed by older, students can interact with the board thanks to their tablets.

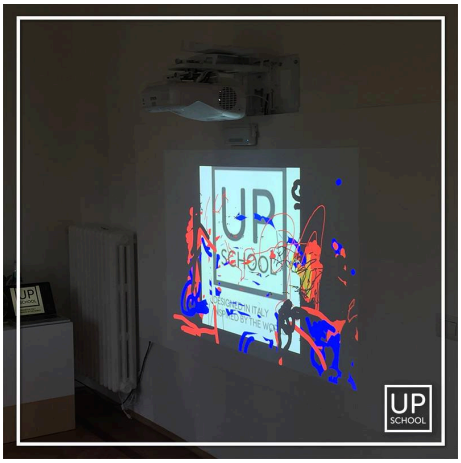

Fig. 2. Interactive Projector.

D. Interactive Floor

A special instrument to keep the attention of children is the interactive floor. This system is based on a horizontal projection of animated images in a floor. The interesting aspect of this technology is the capability to interactively respond to the gestures, by changing the projection as soon as a child "moves" a projected object. In this way, this instrument allows us to develop a number of educational applications useful to keep the child's attention.

This is another type of technology that facilitates the introduction of the logic during the teaching, for example by showing them in real-time what happens when they rotate a geometric object.

Fig. 3. 3D projector.

E. 3D Projector

This system allows to project images in three dimensions. Fig. 3 shows its installation in UP SCHOOL. As the figure shows, it is formed by two normal projectors, specifically adapted for the purpose of having a three dimensional effect, by connecting them with a serial cable.

Thanks to this special type of projector, the teaching of science-related subjects is strongly enhanced. Indeed, children are allowed to inspect on the human body by seeing it from different perspectives, or analyze natural phenomena (e.g., the erupting of a volcano) by having the perception of what really happens.

F. 3D Printer

This type of printer allows children to learn by making something. Supervised by an expert teacher, they can create real models of what they are studying with her/him.

Thanks to the 3D printer, the capability of children to work in groups is highly stimulated, since the created model is the result of shared decisions and discussion among the children.

Not less important is the introduction of the concept of three dimensions, by participating actively from the modeling to the real creation.

III. Feedback on UP SCHOOL

UP SCHOOL's educational model was presented, along with the structure of the school and the previously described learning technologies on July 23, 2015. Fig. 4 shows a picture taken during the presentation.

Parents have shown much interest in this new educational model, especially for the technological aspects that characterize it. Children have naturally interacted with the technologies previously presented; this highlighted the capability of this novel type of school to stimulate the interest toward these technologies and to be built around them.

IV. Conclusions and Future Work

In this paper we presented UP SCHOOL that, on base of educational studies realized by its internal research team based

Fig. 4. UP SCHOOL's presentation to parents and kids.

on its previous experience, starts to introduce a new educational model, in which the structure, the technologies, and the environment, are designed to enhance the experience of children and improve the classic concept of school.

In particular, we focused on the technologies employed in the project, by presenting them, along with the motivation that led to their installation in the school.

The first outcome of the project has been great, with both parents and children appreciating the project and its technological aspects, and with a first interesting response in terms of subscription to the first year of school.

In future, the research team of UP SCHOOL will study the impact of the presented technologies in the educational model. Indeed, we will analyze the Human-Computer Interaction of the children with the previously presented technologies, and we will also run data mining and statistical algorithms to extract information from the use of these technologies and enhance furthermore the educational model.

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A Cybernetic Method to Deal with Cognitive Load in U-Learning Environments: Conceptual Proposal

Leonor Adriana Cárdenas-Robledo and Alejandro Peña-Ayala

Abstract— **This research focuses on u-learning environments settings where learners are immersed and inherently face a variety of simultaneous stimuli coming from diverse sources such as: professor, classmates, equipment, digital and physical learning objects, as well as ubiquitous devices and physical environment. When the learners are situated in such environments, they could be overwhelmed by the diversity of stimuli resulting in an increment of their cognitive load. It is thought that if the mental activity of the individuals is saturated, their cognitive performance could be reduced and their learning achievements might be compromised. The present research aims at counteracting the negative influence of cognitive load in the individual's learning. Hence, a cybernetic method to deal with cognitive load in u-learning environments (CMCLU-LE) is proposed. Such a method fosters learners to self-regulate their learning process by means of metacognitive strategies which help them to regulate the effect of cognitive load and stimulate the acquisition of knowledge.**

Index Terms—**ubiquitous learning environment, cognitive load, metacognition, self-regulated learning, cybernetic method,** CMCLU-LE.

I. INTRODUCTION

In recent years, u-learning paradigm has become very important for delivering educational contents at indoor and outdoor learning scenarios. Due to the main characteristics of u-learning [1]: permanency, accessibility, immediacy, interactivity, and situating of instructional activities Learners have the opportunity to take advantage of this kind of enhanced learning experiences in order to accomplish their academic goals.

The learning environment plays an essential role in the learners' knowledge acquisition. However, when learners are situated in u-learning environments, there are diverse stimuli that need to be faced by learners to achieve successful and meaningful learning. Thus, they might be overwhelmed by the stimuli, resulting in an increment of their cognitive load [2] (e.g. split attention, distraction, noise, multitasking, etc.).

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In this paper, we introduce the conceptual design of our proposed cybernetic method oriented to stimulate the mental activity of learners, by means of following self-regulating learning strategies [3] and using metacognitive skills [4], which both regulate the cognitive load and facilitate the learning of educational contents delivered in u-learning environments.

This paper is organized as follows: Section 2 provides a brief overview of related works with a focus on cybernetics [5] and activity theory [6]. Section 3 presents the context of the research. Furthermore, the underlying concepts that support the proposal are introduced in Section 4, whilst, a profile of the cybernetic method proposed is described in Section 5. Finally in section 6 a conclusion is outlined.

II. RELATED WORKS

In the following paragraphs a short sample of related works is introduced. Regarding cognitive load, Liu et al. study split attention and redundancy effects [7], where cognitive load theory is used as a framework to compare three different mobile learning conditions. Similarly, the present research addresses the split attention as a type of disturbance that affect cognitive load. Moreover, due to the nature of u-learning environments additional issues (e.g. mental demands, distractions, stimuli, multitasking, etc.) are also considered.

Chang et al. study the effects of English proficiency and material presentation mode (single channel vs. dual channel) on English listening comprehension [8]. They take into account cognitive load and learning attitude in a u-learning environment, and implement an activity using a personal digital assistant. Likewise in this proposal mobile devices are considered as a learning tool to facilitate learning and a mean to deliver contents using different presentation modes.

Concerning cybernetics, Abdulawahed and Balid propose a cybernetic model of self-regulated learning from a perspective of control systems in terms of closed cycle [9]. Whereas this research proposes a cybernetic method in order to provide self-regulated learning guidance for learners by means of metacognitive strategies.

Westera provides a theoretical description of the arrangement of adaptive, a machine generated learner feedback which relies on cybernetic principles [10]. The author explores how cybernetic principles could be

implemented in complex learning environments. Also this research takes into account the cybernetic elements to develop the proposed method to be applied in u-learning environments.

In the light of activity theory, Brevern and Synytsya propose a systemic-structural theory of activity from a holistic point of view supported by learning technology [11]. In the same way, such a theory offers to the ongoing research a paradigm to develop the architecture of the proposed cybernetic method.

III. RESEARCH SETTING

The present research encompasses the *domain* of u-learning, where the *object* of study is the cognitive load produced on the learners' brain as result of diverse and simultaneous stimuli that surround the u-learning environments. Therefore, the *problem* is that cognitive load could affect the learning of educational contents. A proposed *solution* is to train learners to become aware of and exercise their metacognitive abilities under the guidance of self-regulation learning.

In this case, the *hypothesis* is defined as follows: The cognitive load in u-learning environments can be triggered by distractors coming from different sources (e.g. digital and physical learning objects, teaching and learning styles, devices, environment settings, etc.), as well as the learners themselves (e.g. motivation, level of knowledge, attention, etc.). In consequence, while learners are performing complex learning tasks in this kind of scenarios, they might feel overwhelmed by the amount of information that have to be processed simultaneously to acquire meaningful learning.

Furthermore, the aforementioned cognitive load can be manifested in diverse ways, for instance, the inherent complexity of the educational topic, the presentation of the learning materials and the mental effort demanded for the assimilation of educational content.

IV. UNDERLYING ELEMENTS FOR THE PROPOSAL

The basic elements, which are presented in this section, shape the solution proposal and provide a theoretical context for this research. Therefore, an essential construct is Metacognition which is employed to regulate learning and cognitive load. According to Efklides and Misailidi, metacognition is "cognition of cognition [12, 13]", and it has two main functions named monitoring and control of cognition [14].

On the other hand, Vanderswalmen, Vrijders, and Desoete point out that: Metacognition is composed of three phases: 1) metacognitive knowledge, which constitutes knowledge and deep understanding of cognitive processes and products [4, 15]; 2) metacognitive experiences that refer to conscious experiences of the use of metacognition; 3) metacognitive skills are manifested as the deliberate use of strategies (procedural knowledge) to control cognition [16]. The purpose is that learners become aware of their mental activities in order to improve their academic performance.

According to Tsai, Shen and Fan self-regulated learning is one of the most important abilities required for online learning, and because of the social, electronic, and self-directed nature is essential to investigate the learners' self-regulation in this kind of environments [17]. This learning paradigm encourages learners to take control of their own knowledge acquisition process. Thus, self-regulation is the individual's ability to plan, monitor, and regulate the behavior in changing situations [18].

Moreover, Zimmerman express that: "...Learners can be described as self-regulated to the degree that they are metacognitively, motivationally, and behaviorally active participants in their own learning process [19]. Besides, Zimmerman highlights three important elements: students' self-regulated learning strategies, self-efficacy perceptions of performance skill, and commitment to academic goals.

In addition, cybernetics and activity theory are constructs equally important employed in the ongoing research, which are interwoven in the conception of the proposed method. Regarding cybernetics, Wiener defines it as: "the science of control and communication, in the animal and the machine" [20]. In this context, Heylighen and Joslyn state that: "Cybernetics focuses on how systems use information, models, and control actions to steer towards and maintain their goals, while counteracting various disturbances". The previous authors claim that due to the inherent transdisciplinary nature of cybernetics, it can be applied to understand, model, and design systems of any kind, such as: psychological, technological, biological, ecological, physical, social, or any combination [21].

As for activity theory, Peña et al. express that: "...it is a useful framework to design e-learning systems and provide student-centered education" [22]. The authors indicate that: "activity theory defines principles oriented to shape a conceptual and general activity used as foundations for specific theories". Moreover, Pachler et al. point out that: "...activity theory is a construct highly sophisticated which has a philosophical and scientific multifaceted base..." [23]. In this context, activity theory serves as a support for the development of the cybernetic method which is an object of interest for this research.

V. A PROFILE OF THE CMCLU-LE

The proposed solution consists of a *cybernetic method* that enables in a personalized manner learners to follow a holistic model of self-regulated learning as well as become aware of and use their metacognitive abilities in order to deal with their cognitive load in u-learning environments.

The method takes into account the user characteristics in order to exploit metacognitive strategies. As a general schema of the elements considered in the proposed solution, Fig. 1 shows that learners' characteristics, level of knowledge and behavior are inputs considered in order provide a suitable self-regulated learning guidance supported by metacognitive strategies. These strategies are meant to help learners to deal with cognitive load while they are performing activities in u-learning environments. In this figure the context (i.e., represents the u-learning environment and distractions) and the feedback (i.e., information derived from the interaction) are depicted with bidirectional lines.

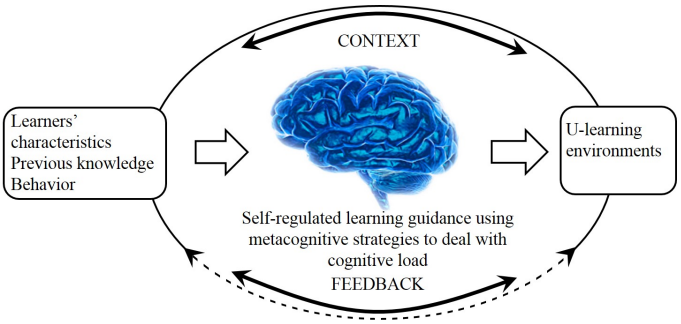

Fig. 1 General schema of the proposed solution

A. *Proactive and reactive regulatory mechanism*

In this research a cybernetic method is conceptualized with the aim at fostering learners to self-regulate their cognitive load and their learning process in u-learning environments. With this in mind a general description of the method is provided, as well as its conceptual architecture.

Since the perspective of cybernetics, the proposed method has to do with the way in which learners apply the method and control their actions towards the awareness of their metacognitive skills in order to acquire new knowledge. Meanwhile the learners themselves counteract the effect of cognitive load and the distractions in u-learning environments. The basic unit of the proposed method is called: the Proactive and Reactive Regulatory Mechanism (PRRM). This mechanism considers as a part of its regulation function the following components depicted in Fig.2.

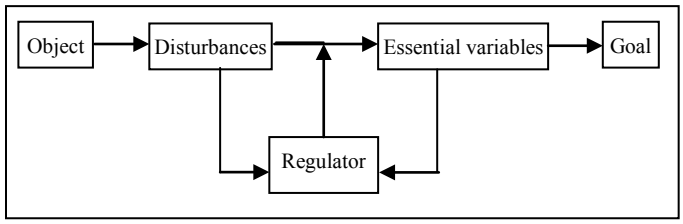

Fig. 2 Regulatory mechanism of the cybernetic method

Where: *disturbances* are inputs such as stimuli and the alterations that might change the state of the system. These come from the u-learning environment (e.g. digital content, motivation, physical objects, learning environment). *Essential variables* are variables of interest which are important to maintain the balance of the system (e.g., state variables, cognitive load, and acquired educational content). *Regulator* represents the essence of the cybernetic method because takes over the proactive and reactive information flows. *Goal* identifies the products, the results, or the observable behavior of the learner such as knowledge acquisition and skill use. *Object* refers to the ultimate purpose of the system: the learning acquisition in a particular domain of knowledge.

The PRRM employed in the cybernetic method allows to monitor the general state of the system. Hence, it takes into account the activity in progress to oversee the accomplishment of the object and the goals, the estimation of essential and state variables; with the aim at successfully fulfilling the activity, it is possible to make suitable adjustments when it is needed.

B. *Architecture of the cybernetic method*

The cybernetic method proposed in this research to activate metacognitive activity, counteract cognitive load, and stimulate learning is organized as a hierarchical structure architecture based on the activity theory.

The architecture consists of four levels, sketched in Fig. 3, where each level contains one or more elements, and each element includes the regulatory mechanism presented earlier in this section. The levels are described as follows:

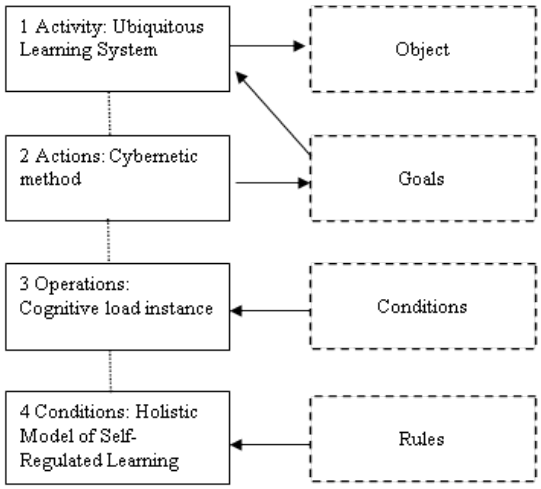

Fig. 3 Architecture of the cybernetic method

Level 1, Activity: Ubiquitous Learning System (ULS) is the first level of the architecture and depicts the whole system. The main object of this system is learning and it considers the diversity of stimuli surrounding the u-learning environment while the learning experience happens.

Level 2, Actions: Cybernetic method is the second level of the structure, which is represented as a set of actions based on established goals, where each action includes its own PRRM oriented to regulate a particular cognitive load effect.

Level 3, Operations: Cognitive load instance is the third level of the architecture, whose operations are constrained by conditions oriented to regulate a cognitive load effect.

Level 4, Conditions: Holistic Model of Self-Regulated Learning (HMSRL) is a set of rules that are specified in the fourth level of the hierarchical structure with the purpose to perform a particular operation.

The actions of the cybernetic method are linked to the cognitive load instances considered in this research. This instances come from the inner and outer world of the learner immersed in a u-learning environment, e.g.: emotional state, mental demands, distractions, stimuli heterogeneity and parallel processing. The treatment for each cognitive load instance is characterized by the HMSRL which provides the guidelines to deal with the cognitive load effect through

regulatory actions to be performed by the learner. The cybernetic method is intended to be embedded in the digital content pertaining to a theoretical and practical subject addressed to undergraduate learners in a laboratory environment. The learners will perform their activities supported by the self-regulated learning guidance delivered by means of mobile devices.

VI. CONCLUSIONS

The ultimate goal of the ongoing research is to foster cognitive activity oriented to knowledge acquisition in a particular educational domain, and trigger learners' mental activity in a ubiquitous-learning environment.

Furthermore, the research is mainly focused on learning in ubiquitous environments and the ways used for dealing with cognitive load. In this context, the cognitive load is understood as an extra mental effort that learners face while perform their learning activities.

The current research aspire to contribute to the solution of the cognitive load problem through the application of self-regulated learning strategies and the exercise of metacognitive skills by means of the proposed cybernetic method.

As a future work, this research considers to implement the cybernetic method in a u-learning system. Such a system will take into account the user model in order to deliver suitable and personalized training to learners, with the aim at fostering the use of the strategies to face cognitive load.

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DoosMooc: An Online Learning Environment Equipped with Innovative Social Interactions

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***Abstract*—Recent rapid developments in information and communication technology have particularly facilitated social pervasive interactions with the potential ability to bring about great outcomes for collaborative learning activities. Classic web-based learning environments utilized in online or blended learning centers inadequately support learners to play active roles in learning processes. In response to this demand, this paper introduces DoosMooc, an integrated social learning environment equipped by a series of modified or redesigned actions, interfaces, representations and workflows which enable learners' communications and collaborative activities. Using the environment in an academic blended learning center has revealed the significant roles played by DoosMooc main features such as formal and semantic course contents, peer reviewed posting, portfolio, and leader box in facilitating students' social interactions leading to more qualified engagements in course learning activities.**

***Index Terms*— E-Learning, portfolio, gamification, social learning**

I. Introduction

During the recent years, our study on personalized web-based learning environment shifted from offering new aspects in learner modeling [1], to enhancing collaborative learning activities through more efficient grouping algorithms [2], and further to providing context-aware learning services [3], and finally to evaluating collaborative learning activities [4] [5] [6]. In order to respond to the recently highlighted need for interactive learning environments which allows for communication, collaboration, and authoring, we designed, implemented, and evaluated a new social learning environment, namely DoosMooc[1]. It also provides solutions for analyzing and representing considerable amount of data produced during students' social and learning actions, represented as user portfolios and content peer reviewed models. The present paper describes the main features of DoosMooc as well as how it supports social learning activities.

A. Web-Based Learning Environment

Traditional learning management system (LMS) often provides facilities for teachers to share course contents, define learning activities such as assignments and discussions, and assess learners' participations. These kind of environments offer much less possibilities for learners to play active roles in learning processes [7] [8]. Actually, due to the recent rapid growth in social networks such as Facebook and Google+, learners expect LMSs to supply facilities for sharing, commenting and even voting. In response to these demands, some newly designed learning environment have provided their courses with embedded social interactions for all participants [9] [10]. Although so far there is almost no document describing the relevant methodologies or results achieved by the mentioned commercial systems, the remarkable potential of online social networks to enhance learning experience was explained in some academic studies. Providing a traditional LMS with several social networks-related modules, Rodrigues et al. suggested that social networks can create communities to let the learners play active roles, shape their learning processes and easily interact and cooperate with each other [11]. Identifying the main principles on which an LMS can support personal learning activities, Jeremic et al. integrated social and semantic web technology along with the linked data paradigm to improve the interactivity of an ordinary LMS and let learners span their learning process across different tools and services [12]. It has also been revealed that allowing students to construct their learning environments through adding tools, resources, and people to their learning atmosphere enhances their feeling of ownership over their learning environments [13].

B. Social Learning

Social learning theory defines learning as a cognitive process which takes place in a social context where observing the consequences of a behavior (reward and punishment) let a learner make decisions about the performance of the activities [14]. The theory also emphasized that cognition, environment, and behavior are interrelated and play role in learning process. Empirical studies revealed that observing and imitating others can facilitate learners' knowledge sharing skills [15]. Given the importance of interactivity and engagement of student for successful learning processes, the role of discussion forums in knowledge construction and participants' communications was investigated [16]. To avoid inefficient learning discussions, participants' interactions and contributions were suggested to be managed from a holistic point of view [6], or be guided by a range of social and epistemic scripts [17].

II. Main Features

This paper introduces DoosMooc E-Learning platform, developed by the University of Tehran[2]. As shown in Figure 1, DoosMooc is similar to Google+. Some tabs are provided at the top of the page, and below them some boxes are sorted in two columns, each representing a course resource, forum or

[1] DoosMooc is a combination of Doost which means friend in Persian language and MOOC. This term emphasizes on the importance of social relationships between learners.

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

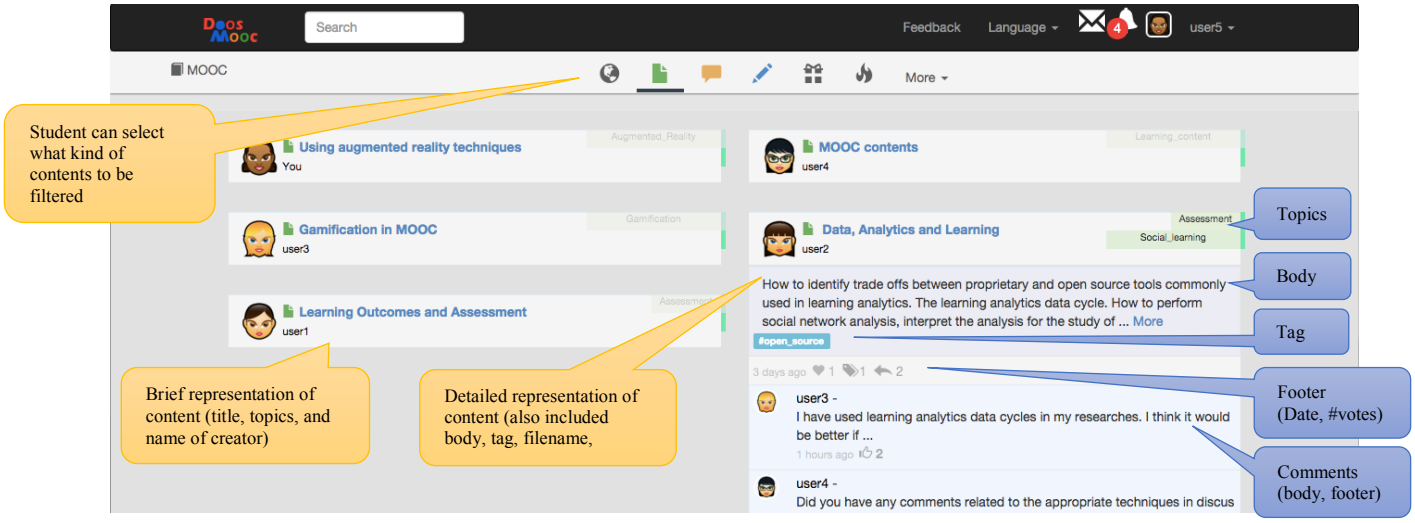

Figure 1- A sample course View in DoosMooc consisting 5 brief and 1 detailed represensentations of learning content

assignment. All course contents are shown by default, because the *All* tab (globe icon) is the default tab. But a user can filter a certain type of course contents by selecting another tab, for example *Resources* (green icon), *Forums* (yellow icon), and *Assignment* (blue icon). In the case of brief view of a resource in Figure 1, the small box displays the title and the topics covered by the content, while the detailed schema of a resource depicted in the figure indicates that the resource covers two topics, has one tag, and has so far received one vote and two comments. The following subsections will describe formal and semantic course structure and the concepts of *topic, tag*, *vote* and *comment*. Actually, DoosMooc was designed based on the hypothesis that Google plus-like appearance of a learning environment would make the environment more familiar and attractive to learners. Therefore, it will be supposed to subsequently increase the learners' social interactions and lead to more qualified learning activities and contents.

DoosMooc is a social network based learning environment made based on MVC framework and Bootstrap, and hosted on www.doosmooc.com. It has been recently used in a formal course in order to be refined and preliminarily evaluated. Similar to any other LMS, DoosMooc allows teachers to share learning content, define course assignments, and set up learning forums. However, it supports realizing social learning theories through providing students with affordances similar to those for teachers. Students can share educational resources, design assignments, and grade answers uploaded by their peers. The environment also provides students with means for social interaction through which they can express their feelings about all course content shared by instructors and peers. The environment collects all social actions and calculates contents and users' credits. Indeed, commenting and voting mechanisms made it possible to recognize more popular and informative contents. The environment also reports most active and most popular users. Participants can view a summary of their correspondent tracked and gathered data as their open model. The mentioned features are described in details in the following subsections.

A. *Formal and Semantic Course Structure*

In this environment, all students and teachers could share almost any sort of learning contents such as texts, files, and images. However, they are asked to assign structured and unstructured metadata for their shared contents to make them more accessible and informative. Indeed, participants could choose structured metadata from a pool of topics already determined by the course teacher, create new tags, or use the tags assigned for other contents. Topics represent a course organization and consist of all subjects expected to be covered during the course. The structure helps students see their progress in all course topics and evaluate their progress in comparison to peers. These detailed reports are available in the tab of Portfolio to be further described.

B. *Peer Reviewed Posting*

The environment offered many social interactions facilities within the scope of the course similar to modern web-based social networks. Course participants are allowed to leave comments describing their ideas about learning contents or to express their feelings and understandings through some predefined vote labels such as "Interesting", "Like it", "Bored", "Lost Interest" or many others. Different types of votes are available for different types of contents. All social interactions are considered as signs of content popularity and effectiveness, enabling the environment to highlight and recommend the most appropriate contents for each learner.

C. *Social Open Model for Course Contents*

The main significant problem in social learning environments is the huge number of actions taken by the environment participants. As illustrated in Figure 2, any of the DoosMooc contents can accept creation, management, social, special, and metadata actions. Instead of representing actions taken by all participants which lead to long and hard to read learning contents with hard to trace recent status, some strategies are designed and implemented in DoosMooc, which consider the role of the actions in peers' social learning processes. Strategies shown in the figure imply that some actions may be represented in two styles of brief and detailed schemas, while the others may be shown just in detailed schema and be hidden in other situations. In this way, participants are notified of all social and

learning actions taken by all peers in manners useful for their learning processes. These strategies make DoosMooc distinguishable from other social networks which try to attract viewers by as interesting representations as possible.

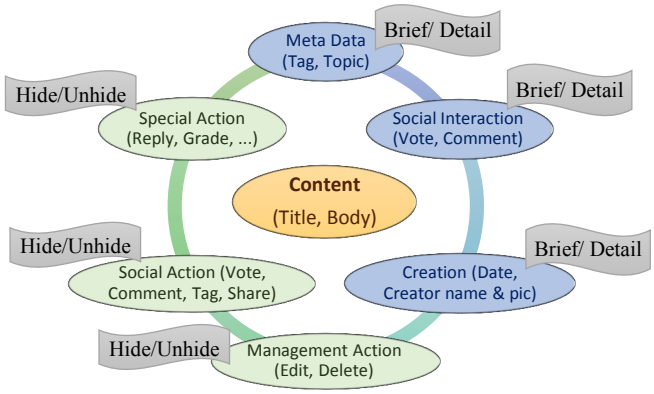

Figure 2- Action impacts on content representation

D. *Portfolio: Visualized Socially Based Learner Model*

As shown in Figure 3, portfolio is a graphical representation of students' progresses provided based on all learning and social actions taken by them during a course. Each student's portfolio of any course consists of a time curve of all educational activities by date, and two bar charts of knowledge and social credits achieved by him/her in the course topics. Since the charts report the minimum and the maximum values of all grades next to a student's own grades, they help the student understand his/her position among the peers and manage his/her learning activities to make expected improvements. Since all portfolio items are separately reported for course topics, it needs that firstly the course topics have been precisely defined by the teacher, and secondly all participants have tried to assign corresponding topics when they shared new contents such as resource, forum, discussion, and assignment.

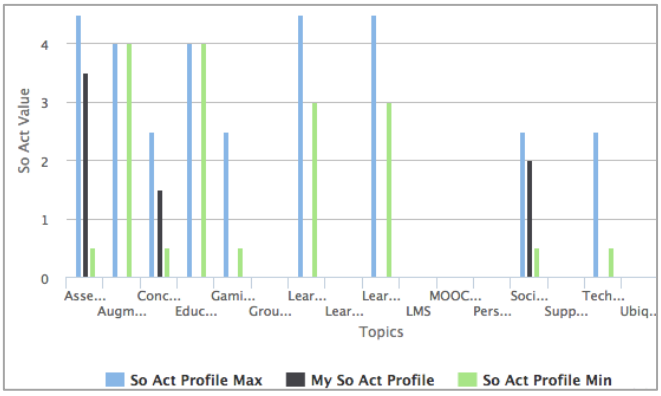

Figure 3- Part of a student's portfolio which shows social actions taken for all topics of a course besides the minimum and the maximum values

E. *Leader Box: First level of gamification*

DoosMooc recognizes the most active and popular students as Leaders. A box similar to Figure 4 appears at the top of each course page and shows the picture and a summary of the activities of the students who are distinguished as the most popular ones. The box also represent the most active students who have participated in course activities seriously. The selections are based on all learning and social activities taken by all students during a limited time period to be chosen from a drop-down list consisting of the last week, the last month, and the whole duration of a course.

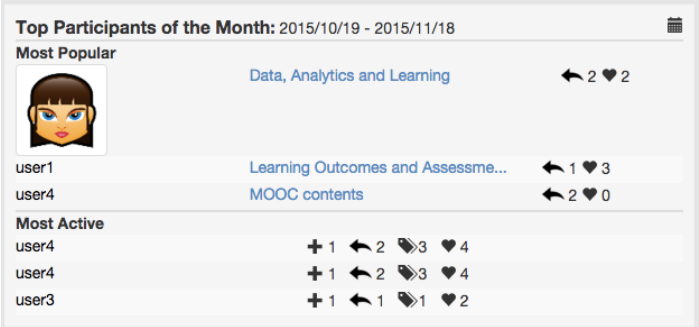

Figure 4- A Leader box

F. *Interactive easy to use interfaces*

DoosMooc lets students take learning and social actions through action icons provided below a course content. Each icon normally open a correspondent easy-to-use interface just besides the content with no need to navigate across different pages. Throwing away unneeded details in order to have enough room for effective ones, such interfaces provide optimized levels of information representation which display required data and ask as much less questions as possible. These interfaces may smartly change during time in response to the content recent status.

III. Evaluation

As a preliminary evaluation, a formal course in an Iranian public university was managed through DoosMooc. The course had 18 enrolled students, lasted 16 weeks, and comprised of two phases in order to let the researchers investigate the learners' acceptance toward the new environment in comparison to an ordinary learning management system, as well as the issues to be regarded in the future versions. Moodle version 2.6.1 [7] was used in this study as a virtual learning environment for several weeks and was then replaced by the DoosMooc platform. At the end of the course, the students participated in an interview to express their ideas about DoosMooc and Moodle and the significant features of each. Table 1 shows the functional or non-functional (F/N) features, mentioned by the students and whose numbers are reported in the right column.

As the table indicates, the features highlighted by the students for Moodle are mainly functional and can be easily provided in the next version of DoosMooc; however, those highlighted for DoosMooc such as *Portfolio* are supported by its innovative socially-based infrastructures which are not available in ordinary learning management systems such as Moodle. Almost all students enjoyed DoosMooc non-functional features such as *Social Relationships*. Furthermore, as few students mentioned, DoosMooc has facilitated observational learning and promoted learners' self-awareness, considered as outcomes of all supported social learning activities. Accordingly, it can be concluded that DoosMooc can respond to the need for social media in education and opportunities for collaboration which have been identified as two of ten top trends for the period of 2012 through 2017 [18].

TABLE 1
SUMMARY OF THE RESULTS OF THE STUDENT INTERVIEWS

	F/N	Feature	#
Moodle	F	Variety of Learning Activities	8
	F	Grade Book	8
	F	Weekly Format	7
	F	Online Users	7
	F	Plugins	5
	N	Organized View	14
	N	Detailed Management Interfaces	7
DoosMooc	F	Portfolio	12
	F	Sharing Resource	9
	F	Leader Box	6
	F	Self & Peer Assessment	5
	F	Adaptation	3
	N	Learners Social Interactions	16
	N	Social Environment	8
	N	Similar to Social Network	7
	N	Dynamic Organization by learner	7
	N	GUI	5
	N	Observational, Social Learning	5
	N	Mobile view	3
	N	Self-Awareness	2
Both	F	Notification & Email	11
	F	Messaging	4

F/N Functional / non-functional feature

IV. CONCLUSION

This paper introduced DoosMooc as a member of the next generation of classic teacher-centered learning management systems such as Moodle. Actually, classic LMS provided lots of facilities for instructors but a few functionalities for students. Teachers could create contents in their courses while students were pure consumers with no room for sharing and commenting. However, DoosMooc is learner-centered where learners could play significant roles in their learning processes. They could share learning contents, assign appropriate metadata, participate course discussions, and socially interact with their peers through comments and votes. The social interactions provided in DoosMooc brought about some new characteristics for ordinary activities like forums. Indeed, instead of just writing pure text, participants were allowed to tag and clarify the concepts stated through their new posts. Considering vote functionality it's easier for participants to understand which subject and discussions are more popular than others. DoosMooc also provides graphical representations of all students as *Portfolio* as well as representing the most popular and the most active learners as *Leaders*. A preliminary evaluation in a blended learning environment demonstrated the feasibility and the opportunities that drive from the socially based DoosMooc infrastructure. More specifically, the main provided features benefit learners in experiencing real social learning activities and achieving higher levels of awareness.

Future work will include an extension of the preliminary studies to evaluate dimensions considered in the design and the implementation of DoosMooc through some detailed investigations. Additional features and plugins will be added in the future version of the environment in order to provide learners with a wider range of learning activities.

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