Editorial

Charalampos Karagiannidis and Sabine Graf, Co-Editors

Welcome to the Bulletin of the IEEE Technical Committee on Learning Technology, Volume 15, Number 3, July 2013 issue. This issue focuses on topics related to the **school of the future and future classrooms** and consists of six articles discussing cutting-edge research on this topic.

In the first article, Lai, Chen and Chen investigate the use of dynamic quick response (QR) codes. An evaluation with four school classes and four teachers reveal clear benefits of using dynamic QR codes in the classroom in terms of making learning and teaching easier and saving time.

The second article, written by Gigliotti, Carrington and Agostinho, introduces a study on the potential of 1:1 laptop programs to support higher order thinking in primary schools. The results include two important findings, namely that laptops can facilitate higher order thinking when learners are encouraged to take an active part in learning, and that the role of teachers is key to such successful learning.

In the next article, Mosharraf, Taghiyareh, and Pezhman Nasirifard present a new learning management system that is designed for students in elementary schools. As such, the system includes some features that are especially important for younger students, including features to increase students' motivation and reduce competitive pressure in assessments.

In the fourth article, Lembo, Mecella, and Vacca look into the drastic chnages that schools currently go through related to the use of new technologies and introduce a project that aims at creating a design methodology for 21st century schools. Furthermore, they investigate and define tools that would be in such new classrooms, including currently existing tools and new ones.

Subsequently, Bautista and Borges address the topic of smart classrooms. The authors discuss the concept of smart classrooms and propose nine principles that are essential for smart classrooms.

The last article in this special issue is written by Cárdenas-Robledo and Peña-Ayala and deals with intelligent and adaptive learning systems and proposed an ubiquitous student model which includes a variety of student characteristics to be considered for personalization of learning experiences.

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: *E-Learning in the Workplace*
Deadline for submission of articles: *Sept. 25, 2013*

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.

Scan & Learn: Exploring Application of Dynamic Quick Response Codes in Digital Classrooms

C. H. Lai, S. A. Chen, F. S. Hsiao, S. Chen

***Abstract*—This study sought for new applications of quick response (QR) codes to improve digital instruction. Dynamic, rather than static, QR codes were applied. Four teachers and four classes of 5th and 6th grade pupils participated in the pilot study, which lasted for four weeks, to understand the effectiveness and the problem of using dynamic QR codes in real instruction. The preliminary results revealed that applications of dynamic QR codes saved much instruction time and make instruction smoother. Solutions to the problems were provided.**

***Index Terms*—Dynamic quick response code, Digital instruction, Elementary school**

I. Introduction

One-to-one digital classrooms [1], where every group or student operates a computer equipped with wireless to conduct learning tasks, have received much attention from researchers and have shown positive learning effects [2-4]. In those class, students have various personal computing devices to conduct learning, such as tablet PC [5, 6], Personal Digital Assistant (PDA) [7, 8], and mobile phone [9, 10]. Nevertheless, teachers teaching in digital classrooms often encounter problems. First, for young children and students whose native language is not English or whose computer competency is low, a certain amount of time is needed to key in correct websites. When multiple uses of the Internet or information searching are involved, the accumulated time for keying in could occupy a substantial portion of a class period. Second, when students exhibit large differences in operating computers, many of them waste time waiting for others to keep up with the teaching steps. Furthermore, the students who cannot keep up are likely to get lost. Finally, teachers lose eye contact with students who are continuously operating their devices. As a result, they have difficulties mastering students' concentration and learning progress. This could possibly foster student behaviors irrelevant to the instruction.

In this study, dynamic quick response (QR) code is proposed to overcome the above problems. QR code, composed of black and white blocks of different sizes in a square (Fig. 1), is a rapid encoding and decoding method. With a scanning device and the decoding software, retrieval of information could be accelerated. As QR code presents the capabilities of rapid response and reading with fault tolerance, its application in education is promising. It has been used with mobile phones or Tablet PCs to learn biology [11] and chemistry [12], to access supplementary materials [13], and to evaluate students' collaborative learning with procedural scaffolding [14], among others. Moreover, Walsh [15] integrated GPS, QR code, and RFID to create a customized learning environment in a university library. Typically, the applications are static, i.e. connecting to teaching contents on prescribed websites. However, static QR code cannot give feedback on students' responses or be adjusted to meet the immediate teaching needs arising in a class. On the other hand, dynamic QR code, which is generated prior to or in real time during instruction, may eliminate the abovementioned problems. Consequently, this study proposes a teaching model for using dynamic QR codes in digital classrooms. A pilot study was conducted to understand the effectiveness of dynamic QR codes in real instruction.

Fig. 1. Example of QR code

II. Digital classrooms with dynamic QR code

A. Classroom setting

Our digital classroom is equipped with access points, 30 students' Tablet PCs with cameras, a charger cart for power supply, a teacher's computer, a projector, and a teaching system

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stored in the teaching server to support the digital teaching (Fig. 2).

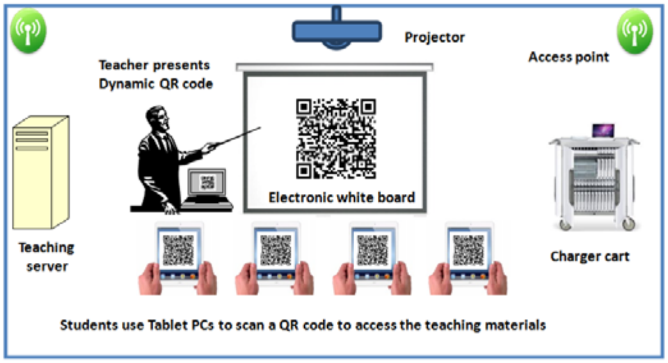

Fig.2. Digital classroom setting with dynamic QR code

B. Applications of dynamic QR codes in instruction in digital classrooms

The applications of dynamic QR codes in the instruction (Fig. 3) cover the log-in function at the beginning of class, main teaching activities, and evaluation after the instruction:

1) Log-in function: The teacher projects the QR code corresponding to the log-in website on the whiteboard (Fig. 4). After scanning and decoding, students connect to the name list page. Then, each student clicks on her/his name and presses "OK" to complete the log-in procedure. It could solve the problems of students memorizing and keying in long websites and passwords, which they often forget or type incorrectly. The teacher's computer immediately displays the log-in conditions of students.

2) Teaching activities: Dynamic QR codes are created for a wide variety of teaching activities. For example, a code may guide students to carry out experiments in a simulation system followed by another code linking to an online discussion board. Or students may scan a code to access extensive reading articles, Wikipedia, or a video on YouTube. During Internet searching, if a student finds information that is meaningful to the whole class, the teacher can instantly generate a code to share it. Dynamic QR codes grant teachers great flexibility to adjust teaching activities and deliver extra materials in real time.

3) Evaluation: Dynamic QR code allows the teacher to transmit a quiz or test to the students and carry out remedial teaching according to the evaluation and analyses to achieve individualized instruction.

Fig. 3. Students scan the Dynamic QR code via tablet PC

III. Method

Four classes taught by four different teachers in one elementary school were recruited for the pilot study in order to understand the function of dynamic QR codes in digital classrooms. The teachers are two males and two females. The school located on the outskirts of Taipei city with the normally distributed students in every class. The participated students' distribution was shown in Table 1. Mandarin and Social Studies were respectively taught to 30 and 29 5th grade pupils (aged 11), while Mathematics and Social Studies were taught to 29 and 27 6th grade pupils (aged 12). The teachers conducted instructions in the abovementioned digital classrooms and teaching systems lasted for four weeks. There were 4, 3 and 6 different class periods of 40 minutes a week in classes of Mathematics, Social Studies, and Mandarin respectively.

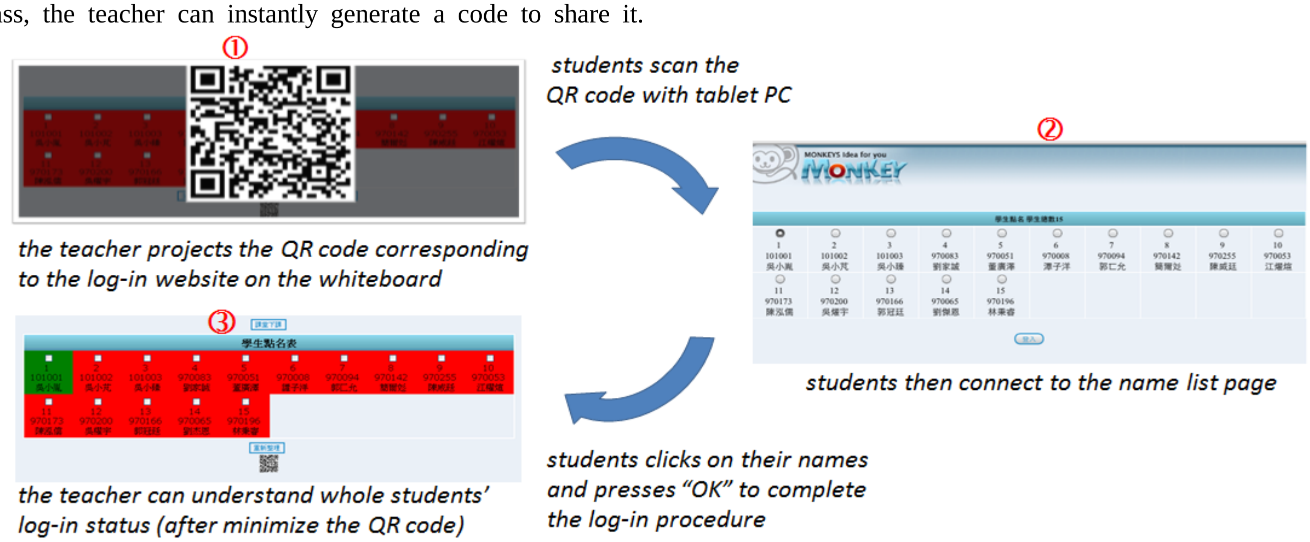

Fig. 4. Procedure of Log-in function

After the experiment, the four teachers and students took questionnaire and were interviewed respectively. The questionnaires are four-point Likert scales. They asked both the teachers and students about the attitude toward the digital learning system with dynamic QR codes (eg., the learning system with QR codes are helpful for the instruction / learning; the learning system with QR codes motivate students / me to learn).

Table 1. Demographic statistics of the sample

Sample	**Girls**		**Boys**		**Total**
	N	Percentage	N	percentage	
5th grade class 1	15	50%	15	50%	30
5th grade class 2	13	44.8%	16	55.2%	29
6th grade class 1	17	58.6%	12	41.4%	29
6th grade class 2	14	51.9%	13	48.1%	27

IV. Preliminary results

From the preliminary experiments, the following findings are concluded:

1) Dynamic QR codes significantly reduced the operation time. To enter a website address as simple as http://www.google.com.tw., it took the 5th grade classes three minutes and the 6th grade classes two minutes and twenty seconds on average. In contrast, each instruction transmitted through a dynamic QR code took on average one minute for the four classes to complete the decoding and start the learning activity. A considerable amount of time was saved when students needed to input websites several times during a lesson. As much as a quarter of a class period could be saved if five keying events were replaced by QR codes.

2) No child left behind. Even the students who were originally diagnosed as having learning difficulties or who presented low computer competency could operate the dynamic QR codes to access the learning activities.

3) Both teachers and students considered the instruction procedure as smoother and tighter with the use of dynamic QR codes.

4) The action of scanning with dynamic QR codes was easily observed by the teachers, and the teaching system allowed rapid feedback. Thus, students' attention in digital learning was better monitored.

5) A technical problem was found during the study. The students seated in different locations in the classroom might have difficulty taking photos of the QR codes from the same whiteboard. The teaching system was therefore improved: (1) Two sizes of QR code were displayed at the same time (Fig. 5), so students in different positions could choose an appropriate size for scanning; (2) The teacher could enlarge or reduce QR code sizes according to the actual size of the classroom; (3) As students sitting at certain angles could not scan, a relay mode was provided by the system (Fig. 6) whereby the QR code could be enlarged on the tablets of students who had successfully decoded the code. They could then share the codes with those who encountered problems.

Fig. 5. Two sizes of QR code on the electronic whiteboard

Fig. 6. Students can scan other students' QR code

V. Discussions & Conclusions

This study aimed at applying dynamic QR codes into digital classrooms to improve instruction in digital classroom and to make it smoother. Key-in for some young pupils are big problems, especially on mobile devices without physical keyboards. QR codes, which can efficiently save key-in time, have been gradually applied in outdoor mobile leaning (eg., [16]). With the characteristic of their real-time responses, QR-code tags which are glued on the learning objects can also achieve context-aware or location-aware learning [15].

However, most research focused on static QR code (eg., [14-16]) and applied them in mobile learning. That is, few dynamic QR codes were applied in classes. The static QR codes cannot be easily and quickly adjusted following a real-time changed instructive environment. Therefore, this study put on dynamic QR codes with great convenience and flexibility into digital learning. According to the pilot study on four classes, dynamic QR codes were applied to save instruction time. Students can easily as well as quickly scan the QR code to link the learning material instead of wasting time on typing the URL. The results are similar to Huang, Wu and Chen 's study [14] which used static QR codes with smart phone. The teacher-student interaction in the digital classrooms was enhanced. Moreover, the instruction was smoother, tighter, and easier to prepare. A relay mode accompanying the dynamic QR code is also recommended. However, the more actual effects require further study and complete experimental design and analysis.

Acknowledgment

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A case study of how using laptops in a primary classroom facilitated Higher Order Thinking

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***Abstract*— Research about 1:1 laptop school initiatives highlight benefits for learning, however, there is little research about the impact of such initiatives in the primary school context. This case study reports how a 1:1 laptop program facilitated Higher Order Thinking (HOT) in an upper primary classroom in Australia. The class was observed during one unit of work and Bloom's taxonomy of HOT was used as the analysis framework. Results showed that Higher Order Thinking was evident when laptop tasks encouraged students to take an active role in their learning. HOT was facilitated by students being able to make decisions on applications to use to complete tasks and class discussion facilitated by the teacher. Technical problems experienced using laptops also promoted HOT from students. This study suggests that a 1:1 computer initiative can promote HOT but is dependent on the pedagogical practices of the teacher. This small-scale study highlights that the teacher is key when implementing laptops in the classroom and further research is warranted to inform future 1:1 computer initiatives in primary schools.**

***Index Terms*—1:1 laptop programs, primary school education,**

I. Introduction

Internationally, 1:1 laptop programs are becoming widespread in schools but are yet to be mainstream. Particularly in the United States, there are large-scale initiatives in many states such as South Dakota, Pennsylvania, Texas, Georgia, Louisiana, California, Kansas, Maine, Massachusetts, and Michigan [1, 2]. One of the largest 1:1 laptop initiatives in America, targeting five western Massachusetts Middle Schools, was the Berkshire Wireless Initiative, a longitudinal pilot study conducted over a three-year period. Findings from this study highlighted that 1:1 laptop programs allowed the uptake of current teaching approaches, increased student motivation and engagement, improved student collaboration and research skills and positive impacts on student achievement [3]. The positive effects of laptop programs on students‟ academic achievements have also been shown in other studies, e.g., [4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17]. For example, a large study conducted on a 1:1 laptop program in Maine, which involved over 16 000 students, found that 1:1 laptop programs had a significant impact on student achievement [14]. The study explored writing proficiency compared a laptop and non-laptop classroom and found that once the 1:1 laptop program had been implemented for five years, 41.4% of these students reached the Maine Educational Assessment Writing Proficiency Standard [14]. Although research exists on the positive effects of 1:1 laptop programs on student learning outcomes, these studies have only addressed one aspect of learning, such as literacy and therefore are not representative of laptop learning in all curriculum areas. For example, the study by Bebell and Kay [3] highlighted that laptops had minimal impact on learning in mathematics and science classrooms, and hence did not assist students in achieving learning outcomes.

Within Australia, the largest laptop initiative is the Digital Education Revolution, introduced by the Australian Government in 2008 to provide high school students (Years 9-12) in one state, New South Wales, with their own laptops by December 2011. This initiative has invited reform to school teaching and learning in Australia, and has encouraged teachers to engage in professional development to ensure they can competently address 1:1 laptop programs in the classroom [18, 19, 20, 21]. A recent study by the Australian Government surveying principals of schools where the Digital Education Revolution initiative had been implemented found that these principals perceived the laptop program has having positive effects on learning, as students had access to computers that could engaged them in the learning process [18, 19, 21]. There is, however, minimal evidence to support these perceptions, as research about this initiative has also highlighted students leaving their laptops at home and/or not using them in the classroom [22]. There are calls for governments to work in collaboration with teachers to help teacher develop strategies to successfully integrate computers in the classroom [23]. Therefore, further research is needed to determine the effects of the Australian Digital Education Revolution on students' learning outcomes.

A current worldwide initiative is the One Laptop per Child, designed to provide laptops to students in disadvantaged areas, so they can participate in educational experiences allowing access to the internet and software applications available on laptops [24, 25, 26, 27, 28]. In Australia, this initiative has targeted Indigenous children in remote areas. Findings from a study investigating the impact of this program in an independent Aboriginal school, found that students were more engaged in the learning process and felt a sense of worth after completing laptop tasks and receiving recognition from their peers and the teacher [25]. This shows that laptops can be effective tools for learning, allowing students to develop positive attitudes towards their education. On the other hand, international research conducted on the One Laptop per Child

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initiative in Colombia found that the distribution of these low cost laptops did not appear to assist students in gaining access to social improvements, such as jobs [29]. Further research is needed to unpack these contradictory findings in order to identify effective strategies for future classrooms.

In regards to primary school classrooms, there has been little research conducted about the influence of 1:1 laptop programs [30]. Thus, the research reported in this paper examined how laptops were used in an upper primary classroom in an established 1:1 laptop program and whether the laptop-based tasks supported Higher Order Thinking (HOT). The focus on HOT was taken because of the little research that has taken this particular focus and yet HOT skills are what teachers strive for their students to demonstrate.

II. Laptop-based tasks in an upper Primary Classroom

A. *Methodology*

The case study comprised one classroom of 27 students (11 boys, 16 girls) and 2 teachers (one was a pre-service teacher conducting professional experience) in an Australian primary school within an established 1:1 laptop program. The research question was: How can laptops be used in the classroom to promote HOT? A cross-curriculum unit of work (9 lessons averaging 90 minutes in duration) about Australia's Identity was observed. Students used their laptops in each lesson and created a number of work samples on their laptops that were assessed by the teachers. Each lesson built on knowledge from the previous lesson and the teachers created laptop-based learning tasks (both individual and group tasks) that involved students creating artifacts such as an advertisement, digital portrait, Venn diagrams, responses to questions, and graphs.

Data collected included: 9 classroom observations, student work samples from each lesson, interviews with teachers (before and after each lesson) and student focus groups (after each lesson).

Data was analysed based on Bloom's taxonomy [31] to identify evidence of Higher Order Thinking. Bloom's Taxonomy divides educational objectives into three domains: Cognitive, Affective, and Psychomotor (often described as knowing, feeling and doing respectively). A goal of Bloom's Taxonomy is to motivate educators to focus on all three domains, creating a more holistic form of education. However, for the purpose of this study, only the cognitive domain was drawn upon as the focus was to examine whether laptop based tasks created by teachers enabled students to engage in Higher Order Thinking [31]. Within the cognitive domain, learning at the higher levels, and thus demonstrating HOT (create/synthesis, evaluation, and analysis) is dependent on having attained prerequisite knowledge and skills at lower levels (apply, understand and remember) [31]. A coding system was devised whereby each level was numbered starting from the highest cognitive level, eg., 1. Create/Synthesis, to the lowest thinking level, eg., 6. Remember. Descriptors for each level in terms of what a teacher would do to facilitate that level of thinking and what students would exhibit as evidence for that level of thinking were developed inductively from the data. Example teacher descriptors for 1. Create/Synthesis include: Facilitates learning by asking students questions, observing what students are doing and offering guiding advice; involved in analysing and evaluating students' work; and promotes learning through providing additional comments to students' responses or questions. Example student descriptors for 1. Create/Synthesis include: creates plans to solve problems, actively participate in classroom activities; puts forward ideas; and participates in making, designing and creating. Each of these descriptors was allocated a letter from the alphabet. For example, observational data of the teacher when providing students with support was coded as 'Promotes learning through providing additional comments to students' responses or questions' (1C).

B. *Results*

Both Higher Order Thinking and Lower Order Thinking was demonstrated by students in the lessons and HOT was evident in most lessons. Three themes surfaced as to how HOT was evident: student autonomy to complete laptop-based tasks facilitated HOT, classroom discussions facilitated HOT, and using the laptops in themselves facilitated HOT. Each of these themes is elaborated as follows.

Student autonomy to complete laptop-based tasks facilitated HOT

All but one of the laptop-based activities, were designed such that students could decide on how they would complete them. For example, whilst the teacher did provide some support and guidance, students had to select the program available on their laptop best suited to the task they had to complete. By giving students the freedom of choice in selecting programs, the teacher promoted student engagement in thinking deeply about the task. The teacher reported that the laptops facilitated HOT because they provided students with access to the Internet and through Internet-based research tasks invited students to decide what information was accurate and important to use and include in their work:

For the poster they definitely did [use laptops effectively] because they were learning how to research… and pick points that stood out to them …and put it into …a different… format…they wanted to display …so they were able to explore technology a bit in that way and how they wanted to… spruce up the poster and make it a bit more fancy...(interview, pre-service teacher).

The decisions made by students when completing their work samples, and the discussions they had with one another, showed evidence of HOT. The laptops facilitated HOT as the students had to think about how they could modify their work samples, e.g., the design of an advertisement to better position their product: "There was heaps of pictures but some of them were not that clear … so we wanted something big enough so it wouldn't be blurry and those looked good." (student focus group)

Classroom discussions facilitated HOT

The class discussions facilitated by the teacher, which involved probing for deeper understandings through the use of questioning when completing the laptop-based tasks, engaged the students in HOT. For example, the teacher would often respond to student answers with a question: "What do you say to describe someone who lives in the outback?" (observation, student); "What work would a typical Aussie do?" (observation, teacher response). If students gave limited responses to questions, the teacher rephrased the question or asked another question.

The use of technology facilitated HOT

The use of the laptops themselves promoted HOT because although the pre-service teacher's limited knowledge about certain software applications limited the assistance she could provide her students, this enabled HOT as the students worked together to solve technical issues as illustrated in these comments from the interviews:

"I'm still not quite familiar with how everything works on the whiteboard and just finding things on the Mac and that sort of thing, so I might need my technology assistant to help me, one of the students…"

"Some students…might not be proficient with the use of …Photobooth…we have the technology helpers in the class."

"Was good because they were exploring the different types of programs and how to use them and some of them that didn't know how to use them other students nearby helping them and telling them how to transfer a photo onto the program and that sort of thing."

C. Discussion

Both Higher Order and Lower Order Thinking (LOT) was evident during the laptop-based activities in this case study. Laptops are tools for learning, however unless they are combined with effective pedagogical practices (such as thinking about how students will use laptops in classroom activities, and how students will achieve curriculum expectations) it is argued that they will only promote the development of LOT skills [32]. Two pedagogical strategies evident in this study as effective laptop-based tasks, were 'student autonomy' and 'active learning'. When students were encouraged to make their own decisions and thus given some autonomy that consequently enabled them to be more active in their learning. The findings of this study suggest that students should be given 'ownership' of their work to allow engagement in HOT [33]. Through allowing students to take ownership of their work they are able to engage in HOT, as they must understand the task they have been allocated, think about the applications on their laptops and devise plans to complete the laptop-based tasks set by the teacher.

Teachers' skills, understandings and knowledge of technology can influence their abilities to assist students with technical issues when they arise during learning experiences. The pre-service teacher had limited experience with Macintosh computers and thus experienced difficulties in using this technology during classroom learning experiences. Although this could have been considered as hindering the learning experience for students, instead it had a positive impact on the students' abilities to engage in HOT when using the laptops. This was because the students were actively involved in solving problems. They had to investigate or identify the issues and then work individually or collaboratively with their peers to put forward ideas that would assist the teacher in using her laptop. Furthermore, when the students were using their laptops, if they encountered any difficulties and the teacher was unable to assist them, their peers would help them solve the problems they encountered.

To encourage effective implementation of 1:1 laptop programs in future classrooms, 'technology partnerships' between teachers and students should be fostered. By working together through technical problems, teachers can improve their technical skills and students are empowered to be more active in their learning. By inviting students to take a more active role in the learning process, where they take responsibility for their education, the development of HOT skills can be fostered [33]. This is because students are engaged in problem solving and critical thinking, to solve technical issues that arise with laptops in the classroom. This can contribute to their sense of worth and value in the classroom environment, as well as enable them to develop the computer skills necessary to participate in our current and future digital society. The ability to engage in HOT is deemed an imperative quality for a "successful learner" as students "are able to think deeply" [34].

It is important to note several limitations of this study, which include timeframe, the bias of the researcher and number of participants involved in the study. The main limitation was that the study had to be completed within a tight timeframe (several months) and the researcher was only able to collect data on a single case. If more time was allocated to this study, data could have been collected on multiple cases to ensure the validity and reliability of the findings. Another limitation of this research was the fact that the researcher was the main instrument for data collection. As a result, the observations may reflect the researcher's beliefs and bias [35]. Overall, this research was conducted in a single upper Australian primary school classroom, involving twenty-eight participants: two teachers and twenty-six students. The scope of this study was limited, as a small number of participants were investigated. Additional research needs to be conducted to support the findings of this study and to inform the implementation of future 1:1 computer classroom practices.

III. Conclusion

This study has provided some insight into how higher order thinking was facilitated in a primary classroom through the completion of laptop-based tasks. Given that 1:1 computer initiatives are yet to become mainstream in primary schools, research of this kind is important to inform future 1:1 computer implementation in primary classrooms. Overall the research found that HOT was evident in laptop tasks that allowed students to take an active role in the learning process and make decisions about how they would present their work. The three main findings of this study were that student autonomy facilitated HOT, class discussions facilitated by the teacher promoted HOT, and the use of technology itself through some technical difficulties experienced enabled HOT This study, was limited in terms of scope, as the case comprised one primary school classroom and data was collected based on nine classroom lessons. This study to our knowledge, however, is one of the first of its kind to closely examine teacher and student interactions to determine if higher order thinking was evident from students. A suggestion for future research is to replicate this study on a larger scale to further investigate whether 1:1 computer initiatives allow students to engage in HOT.

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Developing a Child-Centred LMS to Enhance Learning and Creativity of Students in Elementary School

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***Abstract*— What is preferred by adults and what works for them will not necessarily be appropriate for children. Nowadays, most things designed and created in the world still have not been designed for children as a user group. eLearning systems, as an important human achievement in the age of technology, exhibit a similar situation to other experiences. Much research and many innovations in these systems are accomplished for young people in higher educational environments. In this paper, we design and implement a learning management system (LMS) for students in elementary school, which leads to their meaningful learning enhancement. Decreasing competitive pressures and fear of failure through changing assessment process and improving motivation of learning through sending some informative and positive feedback are the other features of our LMS. Pedagogical constraints and children's preferences are the foundations of our system that is implemented based on MVC pattern. This LMS has successfully passed primary tests and started to be used in a real elementary school; however, its development is still on-going.**

***Keywords*— Child-centred LMS, elementary school, modelling, personalization**

I. Introduction

Rapid development of information and communication technology has provided new learning environments, bringing online education as a necessity in many sectors of society. Research in this area has led to many advanced tools and methodologies to satisfy learners' needs and improve their performance. Personalized learning environments, as an important achievement of this research, have been identified as the base of other developments [1]. Identifying the concept of life-long learning with the advantage of social relations in online environments causes educational environments move to constitute networks of learning [2]. Standard user profile is the common element of all these networks.

Despite accomplishments of much research in on-line higher education, and even for adults, there are limited studies focused on children [3]. Special psychological and pedagogical approaches, educational circumstances and constraints, as well as inappropriate experiences of computer applications and online interactions in children reduce domain of research that familiarize children with eLearning systems. Nevertheless, life-long learning approach proposes an integrated educational profile of students, comprising primary education situations as well. Therefore, existence of eLearning environments for children equipped with a standard profiling process is an essential element.

The purpose of this paper is to introduce a personalized child-centred LMS which leads to learning and creativity enhancement. Considering children's circumstances and pedagogical polices, the implemented LMS guides students in navigation and learning process. In this respect, children's knowledge level, learning preferences, and interests are determiners of delivering appropriate learning contents. Through positive informative feedback, the system guides and encourages students in learning trend as well as increasing their motivation. Moreover, in order to eliminate assessment stresses and competitive pressures; the LMS uses a self-assessment process. Applying all these features is utilized through a child-friendly user interface, considering children's curiosity and fantasy-driven nature.

The paper is organized as follows. Section 2 gives a brief overview of pedagogical policies necessary in learning management systems with a focus on elementary school students as their users. Section 3 presents child-centred LMS architecture and its components. The processes of the system are introduced in section 4, and implementation details are discussed in section 5. Finally, section 6 concludes the paper and outlines areas for future research.

II. Pedagogical Policies

Primary education is a critical stage in children's development. In addition to learning about many domains, primary education has profound effects on shaping children's lives [4]. Ordinary children experience many learning activities, such as writing, reading, discovering, solving problems, etc., for the first time in elementary school. Many individuals' skills are more flexible in childhood, and educational environments have a key role in shaping them appropriately. In terms of developing intellectual skills, such as creativity, [5] proposed that the capacity of original thinking is 90% at the age of five, but this is only 2% for adults. Therefore, eLearning endeavours for improving intellectual skills in children are too vast to be compared with those in adults.

Although eLearning facilities can encourage children's creativity, they impose some constraints that can inhibit it. Fear of failure and existence of competitive pressures in evaluation process are some barriers of creativity. Educational systems can sever these constraints by taking assessment as a mean to promote learning, not to score students [6]. In this respect, children should be assessed during all learning phases in order to deliver personalized content based on their profile. Continuous assessment with the aspect of learner-centred can reduce children's concerns and improve their learning.

Because of children's curiosity and fantasy-driven nature, computer games often motivate them [7]. These characteristics can encourage children to participate in other activities, such as learning. Curiosity is the result of a knowledge gap, and fantasy is defined as an object that "evokes mental images of physical or social situations not actually present" [8]. Fantasy-learning environments may increase intrinsic motivation of individuals—especially children—through satisfying their needs not available in face-to-face interactions.

According to self-determination theory, individuals' motivation for engaging in activities can be distinguished between intrinsic and extrinsic. Intrinsic motivation originates from internal enjoyment or satisfaction of individual in an activity, but extrinsic motivation is directed at attaining or avoiding something outside the self [9]. Children do some activities when they are intrinsically motivated, but social demands and role responsibilities curtail the freedom of being intrinsically motivated, which lead to highlight extrinsic regulation in adults [10]. Several studies have shown that feedback messages, punishments, and rewards can affect students' motivation, whether intrinsic or extrinsic. Regarding [11], positive performance feedback enhances motivation, whereas negative feedback reduces it. These effects are more common in children. Therefore, it could be beneficial if eLearning systems were equipped with feedback mechanism that would encourage children to learn, as well as enhance their motivation.

In face-to-face educational environments, students and teachers have active interactions, but the brisk nature of children makes these interactions more dynamic. Effectiveness of eLearning systems is facilitated through joyful environments that encourage children's desire to engage with them. Operative feedback should not only encourage positive motivation of children, but it should also enhance their self-esteem [12]. One of the relevant key feedback aspects is a model that posits seven principles of sustainable feedback [13]. Five principles of this model are necessary in child-centred eLearning system, which include:

- Clarifying what the desired performance is;
- Facilitating the development of self-assessment;
- Delivering high quality information to students about their learning;
- Encouraging positive motivational beliefs;
- Providing opportunities to close the gap between current and desired performance.

One possible problem of designing an applicable LMS for elementary schools is the ability of students to work with computers. Regarding [14], children's working memory is more limited compared with adults, so text-based or graphical user interface with complete descriptions is the best way for their easy interaction with computers. Selecting appropriate sentences, colours, sizes, and font types is more effective in attending to and understanding of children. eLearning systems can be more successful in improving children's learning, if they can engage more children's senses in the learning process. Utilizing intriguing and meaningful pictures, animations, and other media seems necessary in these systems. Designing simple navigation, removing complex processes, using different colours, and observing symmetry are the other important features [15].

III. System Architecture

The goals of our child-centred LMS are delivering personalized learning contents to elementary school students and enhancing their meaningful learning. This system comprises four main elements. Admin Core is the management component of the system that is composed of databases and is being controlled by administrators and instructors. Student Core consists of all parts relating to students, such as personalization engine. Domain Model and Student Model are delegation of owners in this system. Fig. 1 presents architecture of child-centred LMS.

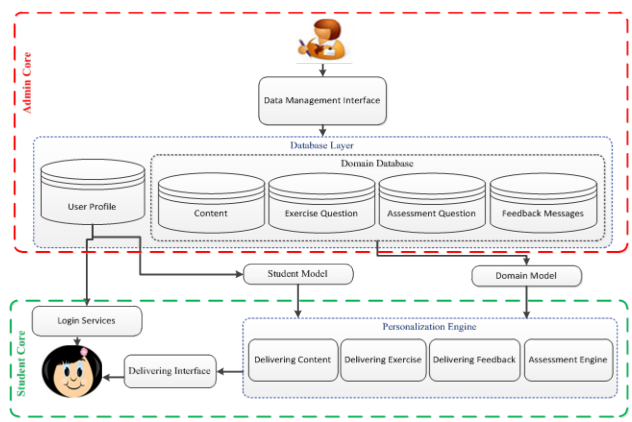


Fig. 1: Architecture of child-centred LMS

A. *Admin Core*

LMS administrators and instructors should be able to access the system databases and add, edit, remove, and control their contents. The accessibility is authorized based on their role in the system. Obviously, a teacher can control only his/her course files.

B. *Student Core*

Providing personalized services with observing all the pedagogical policies is the main goal of the system. Delivering learning contents which are appropriate to students' knowledge level, interests, goals, and learning style is the first obligation of the system. Obtaining exercises and encouraging children to accomplish them is another goal of child-centred LMS. Selecting appropriate questions for sending to learners in the form of self-assessment and delivering positive and informative feedback in the suitable time are other special features of this system. As noted in section 2, the students' assessment should be accomplished without stress and with the aim of students' learning improvement. In this respect, our system evaluates students' responses automatically utilizing expert-provided correct responses that are stored in system database.

C. Student Model

User model is a virtual delegate of a user in the system. Student characteristics and impressive features in learning process are represented via the model of students composed of their profile, demographic characteristics, interests, learning style, and information of knowledge level in each domain. During the registration phase, the student profile, demographic characteristics, and interests are determined. Learning style is defined based on an electronic questionnaire merged with LMS. A modified MMTIC (Murphy-Meisgeier Type Indicator for Children) as a child version of MBTI (Myers-Brigs Type Indicator) is being used in this respect [16]. Knowledge level of students is measured using a pre-test at the beginning of a course.

D. Domain Model

One of the highlighted objectives in designing the child-centred LMS is the possibility of working with several learning domains. Consequently, we decided to have a general domain repository to store several domains with different definition levels. In each domain, different topics form a conceptual network in which all the concepts are defined as nodes. Concept relations are logical links represent prerequisite, subset, and parallel dependency. Regarding the conceptual network, the sequence of delivering learning material is determined and the level of user knowledge defines the start-up point. Fig. 2 presents a diagram of conceptual network.

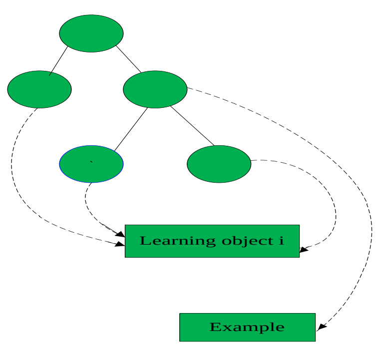


Fig. 2: Conceptual network of a course domain

IV. System Process

Delivering personalized learning services to children involves five operations: logging in, delivering learning contents, exercising, assessing, and sending feedback. The process of system operation is summarized as follows:

- Students log in to the system via a login interface. When a student logs in, the login service checks his/her account via the user profile database. If the student is a beginner, the system guides him/her to complete the registration process, and then it administers a questionnaire to assess his/her learning style. In the following steps, the system evaluates the student knowledge level via a pre-test in the course domain in which user wants to participate.
- If the student is registered, the system guides him/her to the course page where student's courses are listed. Selection of any course navigates the student to the corresponding course page and provides the overview and continuation possibilities to him/her.
- Review process provides all the previous phases which the student has passed. Selecting an on-going process is feasible if the student can pass learning topics prerequisite of other topics in the network domain concepts.
- Instructor specifies the specific times when assessment or exercise questions should be delivered to the student. Assessment questions are in the form of self-assessment. Although the student can ignore them, both receiving more appropriate personalized services as well as gaining of better learning performance depend on them.
- For every student action in this LMS, the system sends positive informative feedback to him/her. This feedback can notify the student about his/her knowledge level, motivate him/her for continuing learning, and guide him/her to better learning performance.

Fig. 3 shows some schemes of this system.

V. Implementation and Evaluation

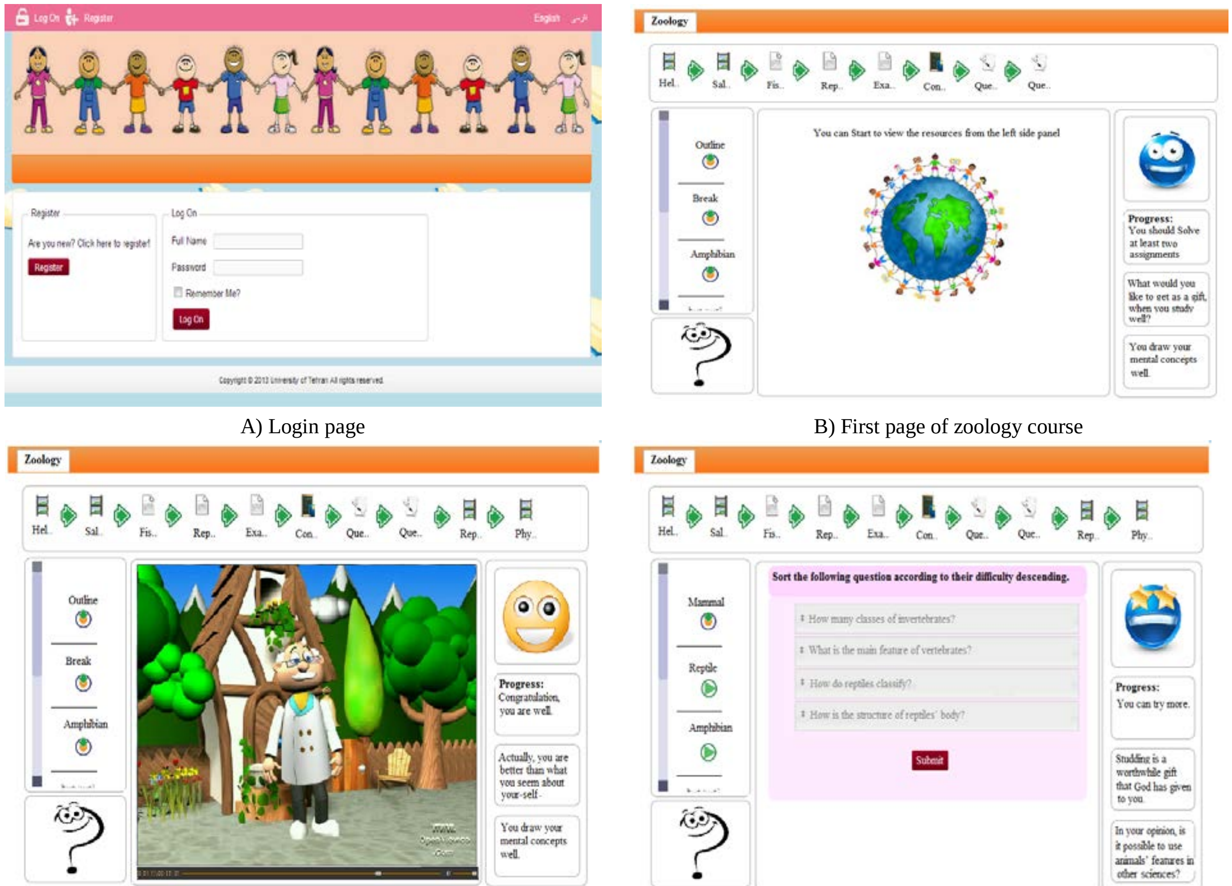
For implementing the first version of child-centred LMS, Microsoft ASP.NET MVC 3 framework and Microsoft Visual Studio 2012 as IDE was chosen. In addition to default libraries and packages of ASP.NET MVC 3, many other free and open source JavaScript libraries such as jQuery, jQuery UI, jScrollPane, VideoJs and Kendo UI are were used. The main reason for choosing ASP.NET MVC 3 framework was its MVC based (Model-View-Controller) pattern and object-oriented aspect of C# programming language which makes it reasonably easy to build standard and scalable web applications.

Child-centred LMS produced by eLearning laboratory at the University of Tehran passes the primary tests and is already in use in some elementary schools. Moreover, this system is being used as a pilot for other research focused on children in online educational environments.

The first result of system application shows the satisfaction of both teachers and students in regard to the system facilities and its effect on learning stimulation, as well as child-friendly UI. However, illustrating effects of the LMS on students learning needs a long-term use of it, at least entire course duration. In future publications, we will describe results of applying this LMS in some elementary schools.

VI. Conclusions

In pervious sections, we introduced a child-centred LMS designed, implemented, and applied to elementary school students. Using this LMS, children's intrinsic motivation to engage in learning activities can be increased. In addition, there are some important features of this LMS which make us to believe that it can decrease competitive pressures and fear of failure, such as impalpable assessment, self-assessment, and positive and informative feedback. The proposed system personalizes delivering services through modelling users and instructional domains. With applying some personalization rules, learning contents are delivered to students based on their knowledge level, interests, and preferences. All the provided facilities can improve children meaningful learning, which



A) Login page

B) First page of zoology course

C) Delivering learning contents

D) Delivering self-assessment

Fig. 3: Some schemes of child-centred LMS

leads to enhancement of their creativity. Design and implementation of this system is accomplished by ASP.NET MVC 3 framework which implements the standard MVC (Model-View-Controller) pattern.

Improving this LMS may continue with more detailed studies about the possibilities of synchronous and asynchronous group discussions and collaborative learning. In this respect, applicable grouping algorithms for children should be verified. Monitoring students' interactions and analysing their behaviours need to become the focus of other future research that can be applied to optimize personalized services. In addition, it seems beneficial and in some extent necessary to improve our LMS to enhance other intellectual skills of learners.

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BPM4ED: A Research Project for Designing 21st-Century Schools

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***Abstract*— Schools and teaching are quickly changing due to the continuous evolution of the world and society, and thus new forms of education are required: on the one side, the emergence of smart cities and smart communities demands for active citizens interacting with institutions, and on the other side ICT is modifying both the learning environments and the training models. The so-called "21st century schools" differ from the current ones in almost all the aspects: building architecture, furniture, teaching and learning methods. This new kind of school is spreading all over the world, and governments recognizing the importance of an efficient, modern and up-to-date education system are committed in the design and implementation of these new schools. But some problems make this scenario confusing, preventing an ordered development of this new kind of schools: first, the lack of theoretical models able to represent the "21st century school" features; second, tools to manage and design these schools and their services and activities are, when they exist, based on the old paradigms (i.e., the traditional school with classrooms, etc.) and are not still integrated in an unique toolbox able to support the whole school operations and management.**

In this paper, the ongoing BPM4ED (Business Process Management for EDucation) research project is described: schools are seen as organizations and business process management techniques are used to analyze and classify them; the final and ambitious goals of the project are the development of a design methodology for "21st century schools" and the definition, design and implementation of a new class of integrated tools, possibly including the existing ones, to manage all the school activities and services.

***Index Terms*—business process management; design methodology; theory of organizations; 21st century school.**

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I. Introduction

The current schools (or the most of the existing ones), which we will refer as "traditional", are characterized by fixed and invariable elements. These involve architectural infrastructures (classrooms, gyms, laboratories, etc.), as well as functions, roles, rights, and responsibilities of teachers, students, and parents, which are clear, distinguished and determined (for instance, the teacher teaches classes of pupils, parents and students participate in class councils, including the choice of textbooks, teachers plan their own activities, etc.).

In recent years, the integration of ICT in the educational process is fostering the development of new learning environments [10,15] and teaching models [9,10], up to, in the most successful cases, the design of completely new schools, in which the concepts of classroom and class do not exist anymore; these schools are referred to as "21st century schools".

Moreover, the "21st century schools" have to be a part of modern societies, playing a central role in them, as required by emerging concept of smart cities.

In Europe, and all over the world, there are different "types" of "21st century schools" [9,10,11,12,13,14], which differ significantly from traditional schools in both the teaching methods that they use and in the services provided to students, as well as in the architecture they adopt.

Also in Italy, a process of modernization of the education system is undergoing. It comprehends the creation of models of new schools called "schools 2.0", which, supported by ICT, have to significantly change not only the learning environments but also the entire organization and structure of schools.

However, if traditional school scheme and structural characteristics are consolidated and recognizable, new schools lack a characterization and prototypes, to which to refer to.

Two problems arise: the realization and the diffusion of these new schools within a country. A typical policy to cope with this problem is the so-called *dissemination* (see, for example, [9,10,11]), according to which *new schools* are first designed and realized and then they are taken as *models* and "*replicated*". The replication usually requires the teachers to visit these new schools, appreciating their learning paradigm, environment, organization and management; therefore, they decide to import the new model in their own school. A net of private and public institutions that fund its realization assists this process.

We argue that, although this policy may represent an effective way to avoid impositions in changing the model, it implies difficulties when importing it. In fact, schools are complex organizations, and designing them involves many variables, so that enormous difficulties have to be faced in designing a "21st century school". *Importing* not always means *copying*, but it means adapting the model to the characteristics and needs of the community and the place where the school is located.

A design methodology is therefore needed to help schools in being involved in the modernization process. This is also strongly motivated by the more and more complex management of the activities to be accomplished in the schools, especially when they offer services to all citizens, not only to students, and when they make use of a lot of technological tools, as it happens in new schools. Thus, the instructional design methods have to take in account both individual learning processes and collaborative ones, as well as problem solving activities, and activities related to the specialization of the smart communities to which the school provides services.

In this scenario, the BPM4ED (Business Process Management for EDucation) [25] research project was conceived and is currently ongoing. In BPM4ED, schools are seen as organizations and Business Processes Management techniques (BPM for short) are used to analyze and classify them. The final and ambitious goals of the project are the development of a design methodology for "21st century schools" and the definition, design, and implementation of a new class of integrated tools, possibly including the existing ones, to manage all the school activities and services. The stages of the project and the related activities are described in the rest of this paper (each section is devoted to a stage, from the idea underlying the project to the final goals) and summarized by the UML activity diagram in Fig. 1.

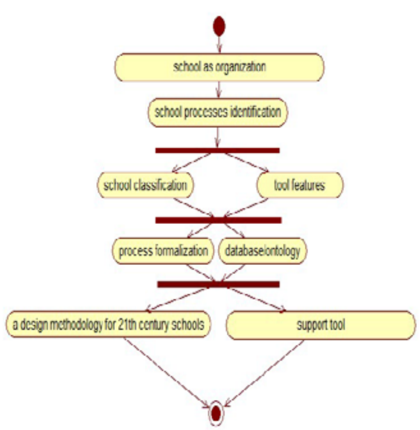

Fig. 1. The activity diagram of the research activities in BPM4ED

II. The Idea: Framing the School Organization within Theory of Organization and its Working within Business Process Management (BPM)

A. *Schools as organizations*

The basic idea underlying the project consists in framing the school structure within the organization theory [1], and in modeling the school way of working through the Business Process Management approach [2].

According to this view, the school structure has the following components: ***mission*** (the main goal of the school); ***processes*** (describing the services provided by the school and the activities performed); ***resources*** (needed by processes to work).

The resources can be classified according to the ***organizational and*** the ***technical environments***. The ***organizational environment*** consists of:

- roles and their social structure: used to define the role(s) of people working in the school and the relations among each others;
- physical environment: both the internal environment (classrooms, laboratories, etc.) and external environment (in which the school is located).

The ***technical environment*** consists of:

- tools: software, hardware and other ones to accomplish the activities of the organization (e.g., broadband lines for the Internet connection, cloud computing, IWB, etc.);
- an information system: "An integrated man/machine system for providing information to support the operations, management and decision making functions in an organization. The system uses computer hardware, software, manual procedures, management and decision models and a database" [5].

B. *Classification of schools*

The first partial outcomes allowing a broad assessment of the validity of the idea are described in [3,4]. In [4], a new instructional design methodology based on eXtreme Programming [16,17,18] is proposed to guarantee transparency and community participation to the school life. In [3], using the classification of Venkatraman [7] and the results from Sims et al. [6], it is discussed how it is possible to classify schools in six levels:

Level 1 – *Localized exploitation of ICT to improve school services efficiency and transparency*

Example 1 (technologized traditional school): a school with a wireless infrastructure, where classes are given by presentations using IWBs; the school has a Web site with all the information about its activities and organization, the taught subjects, the timetables of classes and parents' meeting, enrollment forms, etc.

Level 2 – *ICT for the internal process integration*

Example 2 (school provided with an Internet connection,

intranet and an e-learning platform): the e-learning platform serves to integrate some teaching processes.

Level 3 – *School process redesign (ICT for new process realization)*

Example 3 (school provided with an Internet connection, intranet, an e-learning platform, communication and cooperation tools as e-mail, chat, videoconference): this kind of schools allows for new teaching activities, new relations among students, between students and teachers, parents and the school, etc. From the point of view of processes, schools belonging to this level have automated some processes and have redesigned processes concerning the relations among stakeholders and actors.

Level 4 – *Redesign of processes concerning the relations between the school and the other participants*

Example 4 (school provided with an Internet connection, intranet, an e-learning platform, communication and cooperation tools): the school provides a set of online interactive services for all the stakeholders; moreover new relations with external stakeholders can be undertaken (the network management is entrusted to an external provider). It is worth to notice that the schools of this level need specialized (e-learning) platforms to allow the previous relations.

Level 5 – *Redefinition of the school goals*

Example 5 (school provided with an Internet connection, intranet, an e-learning platform, communication and cooperation tools): the school tries to personalize as much as possible the teaching/learning processes; moreover, the school can realize processes that are usually performed by external stakeholders (e.g., e-book publishing activities).

Level 6 –*No school/ Network of schools*

Example 6 (distance and mobile devices, a cloud computing platform, software to share services): in this case, decentralization is the main feature and the goal is to realize the Web 2.0 idea of "multiple sources, more services".

III. Stage 2: Feasibility Analysis

The goal of this stage is to identify in detail the school processes in order to improve the previous classification. We sketch below our approach. A more detailed analysis, and the complete classification of school processes we have carried out, can be found in [8].

First of all, a notion of school process is needed; this is possible by modifying the classical definition of business process [1] to make it suitable for schools.

Definition (*School process*). *A school process consists of a set of activities that are performed in coordination in the organizational and technical environment of the school. These activities jointly realize a school goal. Each school process is enacted by a single school, but it may interact with processes performed by other schools or organizations.*

In an analogous way, it is possible to redefine the classification of processes on the ground of their functions [2]:

- **school strategy processes:** they describe the strategy of the school, to develop a long-term sustainable formative plan;
- **organizational school processes:** the school strategy is decomposed by goals; each organizational process serves to reach one of these goals;
- **operational school processes:** these processes are a further specification of the ones in the previous category and they include the activities and their relationships;
- **implemented school processes:** these are the school processes that are implemented; they contain information on the execution of processes and activities other than the technical and organizational environment in which they have to be executed.

For instance, the main process in a school (e.g., an Italian school) is the *training plan process* which originates the school goals on the ground of analysis of the external environment of the school (the smart community features and needs) and the constraints (school building features, laws, teachers' visions and skills, etc.). The school goals are fulfilled by the *organizational school processes* (e.g., PROCESS NAME: student enrollment; input: student data; output: class and section), which, in turn, are more precisely described by the *operational school processes* (e.g., PROCESS NAME: student enrollment; activities: registration, access, find school by school-code, choose the curriculum, compile the form with personal data, choose other schools, send data, obtain receipt) which, finally, are realized by the *implemented school processes* (e.g., an online enrollment software).

IV. Stage 3: Applying Processes to School Analysis

This stage is devoted to the application of BPM to school analysis; this means both to classify schools (i.e., to provide a precise and detailed classification) and to study the features of tools and devices used in schools.

A. School classification

Classifying schools in a precise way, according to their way of operating, is an important task as it contributes to devising the new design methodology for schools; in addition, school classification can make clearer and precise the concept of "modern school" or "21st century school".

B. Tools features

Tools have to support the application of the methodology and this task serves to define the main feature of the tools.

V. Stage 4: Process formalization

Different process modeling tool and notation have been proposed in the literature over the years: *(i)* those ones adopting an activity/control-flow view, as BPMN – Business Process Model & Notation [19] or YAWL [20], *(ii)* those ones adopting a more declarative view, i.e., focused on expressing constraints on what is allowed/not allowed in the process more than prescribing a rigid sequence of activities, as Declare [21], and finally *(iii)* the more recent ones following the so-called adaptive case management view, aiming at adding flexibility in the management of the processes as well as more attention to precise data modeling [22][23]. In the project, also on the basis of previous research focused on artifact-centric modeling of processes [24], we envision the development of a process modeling notation, routed on the above notations, but specifically tailored to school process modeling, which require a certain amount of flexibility in the process models themselves.

VI. Final Stages: Designing The Tool and The School Design Methodology

This will be the final stage of the project, in which the design methodology (or methodologies, depending on the kinds of schools) will be devised, and the management tool(s) will be designed and realized.

To these aims, advanced software engineering methodologies, as those in [4], will considered.

VII. Conclusions

The BPM4ED (Business Process Management for EDucation) project is currently ongoing and is supposed to still run for a few years. We aim at experimenting and validating the project results, as soon as they are conceived, on real schools, stage by stage.

To this aim, we are currently selecting a number of Italian schools to be truly representative of various aspects, so that they can be considered as testbeds and living labs.

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Smart Classrooms: Innovation in formal learning spaces to transform learning experiences

Guillermo Bautista, Federico Borges

Abstract— **Despite entering a new century where agents and elements in education have changed, students, teachers, curriculum, resources and so on, the classroom, as the learning space in the school, has experienced no change as regards configuration and structure. Traditional classrooms with rows of desks facing the teacher and the board do not fulfill present-day educational needs and expectations; therefore the learning space at school requires adaptation to the new contexts and roles in education. In this paper the authors outline general principles on the design and methodology of *Smart Classrooms*, new learning spaces which may better fit present and future learning needs and roles.**

Index Terms— **Smart classroom, future classroom, learning space, school innovation.**

I. Introduction

During the XX century the classroom and its formal learning space have experienced but few changes regarding configuration, traditional structure, methodologies and semantic arrangement, but in the meantime, everything else has changed: students, teachers, curriculum, resources available to both students and teachers, and the social context where schools exist. While there is an ample array of new tools, resources and methodological options and possibilities to be applied to education, as regards classroom arrangement we still find a traditional setup, mostly when seeing a space full of desks and chairs in rows facing a board and a teacher's desk. This traditional arrangement corresponds to an "industrialized" model of education, where the teacher is in possession of knowledge and is the main mechanism of transmission of that knowledge. This 'transmissive arrangement' is radically opposed to present-day theories of learning and pedagogical paradigms, which are fundamental to the educational curriculum in many countries. A radical change is needed in the way teachers and the ecology of school understand learning space, that is, the classroom and its nearest spaces, if the focus is on key pedagogical ideas from present-day theories of learning, such as social construction of knowledge, autonomy of students in their learning, catering for diversity, collaborative and significant learning, curricular globalization, problem-based learning, and so on.

In terms of what the classroom space should be like, how it should be conceived, which elements should harbour, and so on [1], there exists the need for educational authorities and teaching staff to deeply reflect about methodologies in relation to technology integration and to other types of resources for a more efficient learning.

Recently there have been remarkable social and economic efforts in the deployment of educational policies for the integration of ICT, such as 1x1 projects, which have involved a considerable investment by governments in a good deal of countries, e.g. Educat 2.0, One laptop per child, Plan Ceibal, Enlaces, etc. Nonetheless, the discourse on how the learning space at school is arranged when ICT are intensively integrated is virtually non-existent. Even in the so-called computer classrooms, the traditional structure is kept unchanged, computers and screens are simply fitted over desks, and everything goes on as ever.

II. The Concept of Smart Classrooms

More often than not the concept of smart classrooms is wrongly associated with a traditional classroom which is heavily equipped with technology. In the discourse about these learning spaces the need for pedagogical changes such as innovation in the teaching role, or the new role students take, the role of the contents, who decides on the learning process, resources, etc., is usually overlooked. There may be a heavy integration of technology, but within a traditional classroom arrangement, usually under a traditional methodological paradigm. In fact, some authors argue that the concept of smart classrooms should precisely involve an invisible integration of technology with the learning space [2]-[3]-[4].

Whenever we speak about learning spaces we cannot dismiss what present-day classrooms are like, nor the way their architectural design may eventually end up exerting an influence on actual teaching; that is, *built pedagogy*, the ability of space to influence how one teaches [5].

The constructive design of a classroom and its functional and ergonomical design are crucial to have efficient and useful smart classrooms, as work teams and researchers in architecture have shown when dealing with these issues in

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depth [6]. The ideal scenario, when talking about innovation in the school's learning space, is to link both the architectural and functional design with the pedagogical approaches to be applied [7]. Thus, in reviewing graphical material and literature about learning spaces, we can find that every time authors mention spaces for creative or innovative work, or niches for collaborative work, or entrepreneurship, they refer to places which are clear, calm, and offer varied possibilities for people to meet and talk in a flexible arrangement [5], for instance, they explain that a given structure and space arrangement can promote exploration, experimentation, collaboration and discussion. Thus, the concept of smart classrooms rests on the intersection of three axes, interacting in the design and use of the learning space:

1. The classroom's architectural design and its ergonomy.
2. The functional, invisible, justified and intensive integration of technology, ICT particularly.
3. An innovative pedagogical methodology, appropriate to that space, which makes learning more efficient and satisfactory, and based on teaching principles such as collaborative learning, project-based learning, curricular globalization, students' autonomy, educational co-responsibility, etc.

Therefore, smart classrooms should be associated with organizing and setting learning space in schools in a way that the best conditions for learning, physical and methodological, are generated in the most efficient and satisfactory way possible for all agents involved in the process. Pedagogical design should consider, and maximize, learning space so as to make the most of it; teachers should also contribute to make space to be perceived in the same way as methodology, resources and learning activities are, all integrated and articulated for a learning proposal to end up being successful.

In traditional classrooms the board and the teacher stand out at one end of the room, and this is what makes classroom dynamics to be those of transmissive, unidirectional lessons. Precisely, an important justification as to why analyze modifications in space in order to improve learning is that the structure of a traditional classroom tells us the way learning will take place there, and that students' preferred styles and learning activities, considered to be chair-students, will not be taken into account. If we are providing new tools to teachers and students, and assigning a new role to them, we cannot keep using a classroom structure which strongly conditions the dynamics of the educational process.

III. Principles of Smart Classrooms

There is no single model of a smart classroom. Around the world there are a number of innovative learning spaces in various educational institutions which, given their singularity and structure, can be considered to be smart classrooms or labs of didactic innovation, e.g. Stockholm University's Future Classroom in Sweden or Universidad Camilo José Cela's smart classroom in Madrid.

In order to establish universal principles as guidelines for the design, arrangement and pedagogical practice in formal learning spaces, our research group EMA (http://www.ub.edu/grupema/web_2013/cat/inici.html) carried out a thorough literature review about learning spaces and their features regarding architectural, design and pedagogical issues. In addition we did some research as well on various learning spaces considered innovative and facilitators of learning in schools in Stockholm (Sweden), focusing on the analysis of ICT integration, which resulted in important findings to guide the design and arrangement of classrooms in a non-traditional alternative way [8]. At the present time we are extending our research, in the Catalonia region in Spain, by means of research on various schools with classrooms organized differently in terms of space and of pedagogical aims. This research is reinforcing and widening our knowledge on the principles that we established.

The following are the principles for smart classrooms in terms of arrangement and pedagogical configuration which we have established as widely generalizable and which should be considered in order to transform any formal learning space into a smart classroom [9].

1. Flexibility of physical arrangement

The arrangement of a smart classroom and its elements should be such that it allows agile and easy variations in activities, that is, make it possible to change student grouping, the type of resources being used, use of various types of resources at the same time, ICT and non-ICT, for different students to carry out different tasks, e.g. searching information, discussing, watching a video, etc. Therefore classrooms will be supplied with varied furniture elements to achieve flexibility of space arrangement, for instance using movable, rolling desks and chairs, or stackable, folding chairs, ergonomical spaces, areas for different uses, etc.

2. Adaptability

From the idea that every teacher and every class is different, and that space can be adapted to their needs, the concept of smart classrooms includes the principle of adaptability to the type and needs of teacher and of each student. Adaptability has to do also with a space which enables the inclusion of students and teachers with special education needs. Therefore classrooms will have furniture and objects that help in catering for learning difficulties, such as the ones impaired students have.

3. Comfort

A smart classroom should be a place arranged to comfortably do various activities –reading, watching videos, playing, listening to music and audios, writing, talking, debating, experimentation, and so on. Under this principle, elements which enable this well-being should be included in the learning space for the various tasks to be done for learning, such as couches, pillows, rugs and carpets, comfortable chairs, lecterns, desks and tables of various types, headsets, right lighting, etc.

4. Multiplicity

This principle refers to smart classrooms having features which enable the use of various types of resources and stimuli. While teaching and learning, the arrangement should enable possibilities for creativity, reasoning, logical thinking, etc., and it should be adapted as close as possible to learners' various needs and learning styles. Thus, it should be an open space where we can have access to any source of information, either physical or in digital format particularly.

5. Connectivity

The concept of connectivity has a twofold character. On one hand it is required that the learning space has a good network connectivity, both local and global, to use to the most the potential of mobile devices. Connectivity should be wireless, and this is fundamental to maximize physical mobility around the space and comfort in using technology. On the other hand, beyond digital connectivity there exists social and informational connectivity. Through networks, students live connected to teachers, friends, family, professionals and to a large number of information sources, both in their immediate surrounding and from distant places. This connectivity should not be underestimated by teachers, who should explore their possibilities and evaluate to what extent they can contribute to improving learning space and learning processes. To some extent this principle can be linked to the theoretical framework of Connectivism [10].

6. Personalization

Smart classrooms should allow students and teachers to personalize their environment according to their likes and needs. Therefore we are not referring to a standard, impersonal, cold environment, but a space which progressively teacher and students should make their own, personalizing it by means of activities which support and reinforce learning.

7. Order / Organization

This is an important principle, even though it is not easy to design, and attain, sustainable placing, storing, arrangement and rules of use of spaces and resources available. For this reason teachers should carefully consider the order and arrangement of spaces and resources so that these are the most adequate for the learning activities that will take place in their smart classroom. At times, a chaotic space may foster creativity, but in any case this chaos should be controlled and re-oriented whenever necessary. After each activity is over, resources should be available to another student, another group of students, or a different activity.

8. Openness

This principle relates to the false and rooted belief that learning takes place only in the formal space in the traditional classroom, where the teacher presents information and gives a lesson in a transmissive way [11]. Learning however takes place beyond the classroom space, both physically and virtually, and therefore activities put forward for smart classrooms should consider these extended learning places and learning times in order to learn beyond the classroom and the class times traditionally assigned.

9. Safety / Security

Learning spaces with heavy technological integration require that hardware and software have a high degree of security. Smart classrooms will have an arrangement which prevents users from having physical accidents and will also be safe in terms of access to information and communication on the Internet from the classroom. Therefore security systems will be taken into account when conceptualizing and designing smart classrooms.

In sum, the arrangement, structure, methodologies and principles of smart classrooms intend that learning experience be as likely as people's learning ways, preferences and styles, in a natural way and in a personal space; all this through active participation, experimentation, collaboration, solidarity, rapport, creativity, leadership, and so on.

IV. Conclusion

The structure and arrangement of traditional classroom space does not go with changes happened in educational agents, methodology and social context. Smart classrooms rethink learning space and learners' expectations about what this space, along with resources and methodologies, should be like. The concept of smart classrooms rests on the intersection of three axes: design of its space and ergonomy; integration of ICT in a functional, invisible, justified and intensive way; and an innovative pedagogical methodology, based on teaching principles such as collaborative learning, project-based learning, curricular globalization, students' autonomy, and educational co-responsibility. The design and implementation of a smart classroom should contemplate a flexible structure adapted to users' needs, comfortable, with multiple resources, socially and digitally connective, personalized, tidy, open to its immediate environment and to the world, and lastly, safe for its users and safe in its technological equipment.

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Systemic Approach-Based, Intelligent and Adaptive User Model for U-Learning

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Abstract— **In this paper we present a summary of a research proposal oriented to develop an intelligent, adaptive, and systemic user model. The purpose is to include this model as part of an ubiquitous learning system (ULS). The aim is to personalize the learning content delivered through ubiquitous devices in an intelligent way. The base line of the approach is ubiquitous computing, which allows users to have wireless access to contents through a variety of devices. It provides a kind of *everywhere* computing platform. In this way, an ULS promotes and facilitates people learning who use ubiquitous, pervasive, and mobile devices by means of presenting personalized educational contents in an interactive and attractive manner.**

Index Terms— **personalized and adapted contents, ubiquitous learning, user model, ubiquitous learning system**

I. Introduction

Ubiquitous devices have become widely used in daily life, opening a window of opportunity for education. These kinds of devices are suitable resources to provide educational content to individuals. Educational services are spreading anytime and anywhere by devices such as: laptops, smart phones, audio players, interactive TV, radio-frequency identification, GPS, smart watches, and interactive boards.

Currently, users in general spend a considerable amount of time in communication, entertainment and information search using devices such as a smart phone or tablet; during that time these devices could be exploited for educational purposes, using ubiquitous technology as a means to acquire knowledge about a particular topic or subject.

According to Ogata and Yano "…Ubiquitous learning integrates high mobility with pervasive learning environments, where the learner is moving with a mobile device and the system dynamically supports learning by communicating with embedded computers in the environment…" [1]. Whereas, Hwang, Tsai and Yang assert ubiquitous learning is: "…any learning environment that allows students to access learning content in any location at any time …" [2]. In resume, ubiquitous learning provides "anywhere and anytime learning".

Ubiquitous technology is an efficient way to supply educational content to individuals geographically disperse and those who are in constant movement. It also reaches a wide scope and provides accessibility to education, not only for users who live in the city, but also for those who reside in isolated regions, where ubiquitous devices make the difference to permit communication between people.

The research proposal considers the generation of a user model that integrates learner characteristics concerned with domain knowledge, learning styles, feedback, motivation, meta-cognitive skills, and user context. The idea is to intelligently adapt and update the educational content to the dynamic requirements of different users over time.

II. Related Work

In this section an initial sample of related works is briefly presented. The first two works address a system/holistic approach and the subsequent ones correspond to learning and ubiquitous aspects.

The first work shows a holistic approach to personalize the human computer interaction to support and improve usability in e-learning systems. The authors analyze e-learning in relation to mobile devices capacities, student knowledge level, interaction styles, and skills [3].

In this context, a Systemic-Structural Theory of Activity (SSTA) with a holistic standpoint by means of teaching-learning technology is introduced in [4]. The SSTA offers ways to holistically integrate diverse viewpoints of teaching learning activity about conceptual, strategic, semantic, heuristic, algorithmic, logic, and computational issues.

Concerning ubiquitous topics, [5] presents a system that learns patterns based on the users locations and their properties. The system can infer properties and generate a user model to represent each new individual that is incorporated to the environment. The algorithm implemented is useful in ubiquitous computing environments in order to provide a user model for specialized information services.

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As for [6], they offer an integrated approach based on an automatic, global, and dynamic student modeling. This approach uses the behavior and actions of students with the aim at identifying the students' progress, learning styles, interests, knowledge level, problem solving abilities, preferences, social connectivity, and location. They approach provides rich and accurate self-adaptation in each service and allow teachers to get a better understanding of the students' learning process in a ubiquitous learning environment.

In another vein, data mining techniques by are used [7] to support personalized learning content adaptation mechanism in mobile learning environments. The system applies data mining techniques such as clustering and decision trees, to manage historical learner's requests and deliver quickly a suitable content version adapted to the learner when there is a similar existing request stored.

What is more, [8] presents the creation of a dynamic user model based on learning styles to enrich and support the automatic generation of an adaptive IMS learning design. The goal is to reduce teachers' time and efforts by means of providing learners with personalized learning experiences [8].

III. Research proposal

We believe that it is necessary to explore more flexible and capable ways to provide a wide coverage of education at any level. Thus, it is important to use the variety of ubiquitous devices as a mean of learning transmission.

On the other hand, there are many educative institutions that offer educational programs using information technology and communication. However, most of the programs do not consider the individuality of the student, her/his learning style, or domain knowledge level. Thus, students deal with limited possibilities to develop a suitable school performance.

Chrysafiadi and Virvou [9] present a literature review where they found that the most common features described in student models are the student's cognitive features (e.g. knowledge, ability to learn and understand, memory, problem solving and making decisions abilities …). The authors state that students in addition of having cognitive abilities, they also need critically assess their knowledge in order to choose what to study. Therefore, adaptive and/or personalized systems must consider metacognitive skills.

Therefore, learner' traits about motivation, feedback, assessment, and meta-cognitive skills are worth to be considered in user modeling for an ULS. The aforementioned attributes will allow building more accurate and suitable user model in order to provide adapted and personalized contents to the learner.

This research proposal aims at developing a user model from a systemic point of view. Due to the complexity of the user modeling immerse in a ULS, it is important to consider a systemic/holistic approach to tackle the problem and achieve an effective engagement and performance for the learner.

With the intention to build a holistic user model for an ULS, this model must exhibit attributes that provide personalized content to learners in an intelligent manner. Furthermore, in order to accomplish a suitable level of personalization, the proposed user model represents the following domains: background domain knowledge, learning styles, motivation, feedback, metacognitive skills, and user context.

Motivation and metacognitive skills are essential issues to be addressed in this proposal. It is desirable to identify the effect of using ubiquitous devices in learning activities through a ULS. What is more, it is pertinent to determine how such devices motivate the students to learn. Moreover, it is important that the learner become aware of his/her own domain knowledge and her/his metacognitive strategies that he/she is able to use during the learning process in a ULS

The aim is: the ULS provides personalized learning content in an effective manner that engages the learner. Therefore, it is necessary to know how all these aspects are related each other and how they impact the school performance of the students.

IV. CONCLUSION

Ubiquitous technology has become more accessible due to the world wide spreading and cost reduction in devices production. It allows obtaining information and resources anyplace, anytime, and anywhere. In consequence, it is convenient to exploit this technology in educative sectors, and support individuals in motion or geographically disperse.

The user model proposed in this paper should exhibit features of intelligence and adaptation in order to fit the user characteristics, learning styles, domain knowledge, feedback, motivation, metacognitive skills, and user context, enabling to promote an attractive and pleasant manner to learn.

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