A Contextualized System for Supporting Active Learning

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Abstract—The dynamics of the world today demands a change in traditional education paradigms to enable the creation of more efficient learning environments, where students will learn more effectively and will play a more active role in their education. They should interact with the knowledge at anytime-anywhere. In order to tackle this problem we should take advantage of mobile communication devices (e.g., smartphones and tablets) which are widely used by students and which have excellent processing storage and connectivity capabilities. In this research work, a context-aware system stimulating active learning by students was developed. This system places the student in an intelligent learning environment and is capable of delivering appropriate context-related learning contents, based on location, time, date, interaction of the student, profile of the student, and so on. Within its architecture, the system includes reasoning capability that using context-based ontology is able to deliver efficient learning resources. The experimental results obtained from various learning experiences in nursery, medicine, and systems engineering support the validity of our approach.

Index Terms—Context awareness, internet of things, active learning, intelligent educational systems

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1 INTRODUCTION

THE vast improvement in the processing capacity of mobile devices and their faster Internet access through anywhere/anytime technology enable people to explore, communicate, collaborate, socialize, etc. Since students are familiar with this technology it is not only possible but also inevitable that we should use to use it to create engaging, relevant and personalized learning experiences. In these environments, students must change their role and become active users who interact and take control of their own learning experiences instead of passive receivers [1].

The strategies for promoting active learning should teach students not only how to do things but also why they are doing them, increasing their motivation. Some of its additional advantages are that it makes learning fun and allows students to learn at their own pace according to their capabilities and are not limited by a one-size-fits-all program [2], [3]. Active learning is by no means new but thanks to the facilities offered by technology, it is now possible to create better interactive environments or even having the possibility of total mobility [4]. The concept of Internet of Things (IoT) is an alternative for empowering this last purpose: learners might perform learning activities interacting with real physical environment enriched with devices connected to internet.

This would represent an advantage with respect to those learning strategies that considers virtual words, as for example immersive learning [5]. It is possible to think of a network of learning objects (physical devices with the possibility of interconnection) which is able to interact with the students by proposing personalized tasks and monitoring their learning achievements. Such a

system should collect and analyze data from the sensors in order to be aware of the context (in the broadest sense) in which the learning activity is performed. By integrating context awareness into learning strategies we can detect changes in the student and/or their learning environment, which can then be applied for more intelligent interaction and communication. This is the framework within this work is set.

Although researchers have recognized the great potential of context-aware learning, few practical applications have been implemented. Moreover, in these cases, the studies have been conducted focusing on only one discipline. Our goal is to develop an usable and useful application to support active learning by integrating context (broadly speaking it should be based on location, time, date, student interaction, knowledge level, etc.) and reasoning about this into the system architecture with the objective of provide adapted learning resources. In our approach, the architecture has been designed with the aim of being generalizable, so it can be easily adapted to different disciplines and to use several types of sensors. Besides the technical and usability functionalities, we perform different user's studies to validate the pedagogical effectivenes. These studies show that the proposed system can unobtrusively deliver timely and adapted learning content, which is identified as a challenging aspect of context-aware research [6].

The remainder of this paper is organized as follows: Section 2 presents related work; Section 3 describes the context-based model; Section 4 explores the system architecture; Section 6 discusses the evaluation framework; and finally Section 7 outlines our general conclusions.

2 RELATED WORK

The combination of wireless technologies and sensors has been recognized as a potential way to develop context-aware systems [7]. In [8] a bibliographical review about the use of the NFC technology is presented. There exists a vast of possible applications, such as working sites, museums, guide visits, hiking, life registration, intelligent home, simulations, exercising, logistics, etc. For example, in [9] training advice can be obtained by using an intelligent chart with the different muscles groups.

In the sphere of education, various experiments have shown how learning and teaching tasks can be improved through the use of mobile devices, wireless communication technologies, sensors and localizing/tracking mechanisms. In such applications the objective is to integrate one's learning process into the environment, allowing the students' interaction with resources in the real world [10], [11], [12], [13], [14]. For instance, in the case of the health service [15], [16], [17], students can perform practical activities with the instruments to hand that might or might not be familiar to the students. The use of IoT helps students match newly learned theoretical concepts with those particular instruments in their environment.

Following [18], where a bibliographical review on ubiquitous learning is presented, location context dominates learning applications, understood as learner location and the locations of the target objects. Such systems may have the capability of adapt their behavior based on the context, which has been recognized as one of the key features for adaptive ubiquitous learning applications [19]. Thus, in [20] a framework to support mobile learning is presented which takes as input an electronic-based diary to inform the location and available time a student has and recommends learning objects based on a set of rules which take into account the students' location and particular circumstances such as learning styles, interruption frequency, etc.

To tackle with context we must first consider how modeling it. For this purpose there are many alternatives, either statically or dynamically, e.g., those based on key-value, marking schemes with tags (coding tags), graphs, objects, logics and ontologies [21], [22],

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TABLE 1
Comparative Analysis of Context Dimensions: Student (S), Learning Object (O), Time (T), Activity (A), and Location (L)

Author	S	O	T	A	C	Type
Londsdale et al.[14]	x	x	x		x	Th+A
Zimmermann et al.[34]	x		x		x	Th+A
Ogata et al.[10]	x				x	A+U
Wang et al.[3]	x					Th+A
Yin et al.[11]	x				x	Th+A+U
Yau[20]	x	x	x		x	Th+A+U
Ours	x	x	x	x	x	Th+A+U

Fig. 1. Context model ontology developed in PROTEGE 5.0.

[23], [24], [25]. The use of ontologies has been shown to improve the reasoning support over other approaches. This is because not only do they provide a formal semantic, based on the use of the OWL language, for representing complex data, helping to share and/or integrate context among different sources, but they also provide reasoning tools to understand context and check context consistency. They do not, however, fulfill all the necessary requirements for a generic context-modeling and reasoning [26], [27].

In this research work, we also worked with ontologies, one of the main differences with respect to the proposal of [20]. One of the more important proposals is SOUPA [28], an ontology designed for context modeling in ubiquitous environments, and the CONON [29] ontology in which logic reasoning is used to deduce implicit context and explicit context in domestic intelligent environments. In [30] an extension of the OWL language (C-OWL) is proposed which allows the integration of shared ontologies, providing logic reasoning based on C-OWL semantics. In various contextual conscious architectures OWL-DL ontology models have been adopted such as COBRA (Context Broker Architecture) [31] and middleware SOCAM [32], which support reasoning, allowing known contexts to be inferred, context conflicts to be solved and the consistency of the concept in intelligent environments to be maintained. In [33] the middleware GAIA for active spaces (environments) is presented. In GAIA, the reasoning to derive new context data is carried out by inference based on rules and statistical learning.

Focusing on the definition of context, we have observed that few dimensions other than location or time have been used in many learning applications [3], [10], [12], [15], [20]. Nevertheless, other possible definitions of context appears as an alternative criterion in some theoretical papers [14], [23], [34]. In our approach, we define context considering five different dimensions: students, time, activity, location and learning objects (see Section 3). For illustrative purpose, in Table 1 it can be found the dimensions considered by some related papers in the literature. We also include a column (Type) indicating the focus of the paper, i.e., theoretical (Th), applied (A) and user study (U).

To conclude this section, we want to remark that our contribution uses a methodology able to adapt the suggested learning resources to the context. In order to do that, we use an intelligent reasoner that after automatically capture the student context, described by these dimensions, uses an ontology to reasoning about them, using criteria as quality or consistency, in order to recommend the appropriate activities to the students.

3 PROPOSAL FOR CONTEXT-BASED MODELING

In a broad sense, context is [35] "any information which can be used to characterize the situation of an entity, an entity is a person, a place or an object which is relevant for the interaction between a user and an application including the user and the appropriate applications". Focusing on our framework, therefore, context could be anything that influences a given learning task.

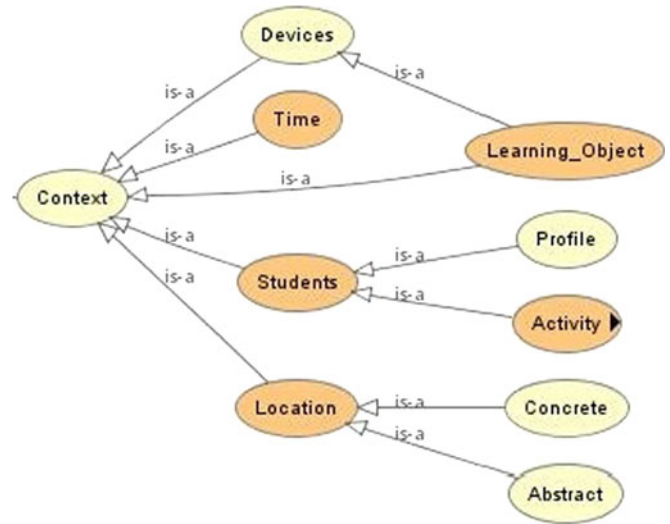Before the student begins a session, the system should recognize the context in which it will be conducted, providing those activities that best suit this context. The system must also be able to adjust content and interfaces to changes in the environment.

In particular, in this paper we consider five dimensions that are necessary when modeling context: location, student profile, time, activities and learning objects. These dimensions falls into four of the five categories for context information proposed by Zimmermann et al. [34] (presented in brackets below). Fig. 1 shows the proposed ontology.

Student. (Individually context: Human entity) This contains information relating to the student profile, such as for example academic level, knowledge that the student has about the topic, skills, abilities, class timetables, etc. This is modeled by means of a weighted representation over a set of selected concepts. Since user knowledge can evolve over time, the context of the students is updated as they interact with the system. Also related to user context is the type of device being used at this time whether a smartphone, tablet or PC.

Learning objects. (Individually context: Artificial entity) This refers to all learning objects the students interact in the environment by means of their mobile devices. The learning content is based not only on physical objects currently in the laboratory (e.g., internal computer components) but also virtual objects (any digital representation of a physical object that should also include its particular state, for instance that there is a circuit fault). By means of both objects, different situations can be modeled for students to tackle, representing the learning context in which the activity must be performed. The objects can be tagged with NFC (Near Field Communication) and QRCODE (Quick Response CODE) enabling association with the learning activities. When the student uses her smartphone or tablet to read the NFC or QRCODE of any object, the system automatically searches the database for those pending activities which best suit the student.

Time. (Time context) this relates to the temporal context, represented by the time in which the student interacts with the system. By means of this facet it is possible to detect if students are performing a scheduled activity (practice or exam) with a certain time limit or learning on their own, for instance doing exercises, with no time limit. Also, time dimension is important in such situation in which the learning activity depends on whether the learning activity is executed during morning, afternoon or even during the night, as is the case of clinical practices. In this case, time might be a particular time, date or specific period.

Activity. (Activity context) The context also depends on the activities designed by the teacher. In this case, the context of the activity must consider whether an activity is obligatory or optional,
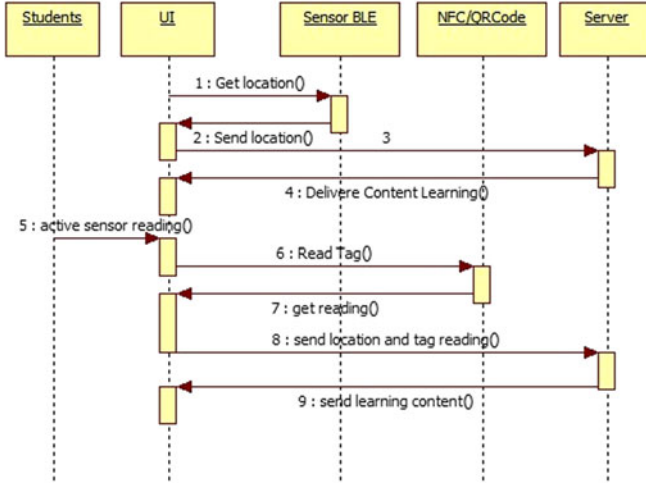
Fig. 2. Interaction example.

its difficulty, logical sequence, estimated duration, if it must be done in a group or individually, etc. Each activity might be associated to a set of learning concepts that can be used to automatically determine when the students achieve the required objectives.

Location. (Location context) This refers to the student's location (on or off campus) as well as whether they are alone or if there are other students nearby. For this purpose it is necessary to know both the GPS coordinates of the student's mobile device and the intensity of signals transmitted by BLE (Bluetooth Low Energy) sensors placed in the tagged areas (classrooms, laboratories, coffee shop, departments, etc.) which means that GPS and BLE are used for outdoor or indoor localizing, respectively. This interaction is implicit and obtained by means of machine-machine communication.

Note that Zimmermann et al. [34] proposes "Relation context" as the fifth category to describe context. This category is used to capture the dependencies an entity established to other entities. In our case, the particular instances of these relations will be obtained by the reasoner. Thus, for example, when an engineering student enters a lab (location context), the system might know that they have two hours to perform an activity (time context). Given their knowledge of the domain, activities performed, etc. (student context) and that there are other similar classmates, a group learning activity (activity context) is selected by the system. In order to perform the activity, the group must choose from the different types of equipment or objects available (object context), e.g., printed circuit boards, and use their mobile devices to read the NFC code. The system then automatically understands that the students are using a particular model with test connection pads and displays an activity configured for that particular model which might include animations, a website with information resources, formatted text or audio. In this way, active learning is stimulated and the students themselves are responsible for their own learning; technology is a way to reach a goal.

In order to allow our learning system to be aware of the context and also to interact with the students, two types of communication mechanisms must be modeled: machine-machine communication, such as a sensor-device (smartphone or tablet) or device-system, and user-machine communication. Fig. 2 shows a sequence diagram of an explicit interaction. On the other side, the teacher constantly monitors the activities, obtaining comprehensive information about how learners performs the required activities. So, in case of being necessary she can promote a different learning strategy for the activities at hand.

4 SYSTEM ARCHITECTURE

In order to facilitate these interactions, a client-server based architecture (Fig. 3) is developed:
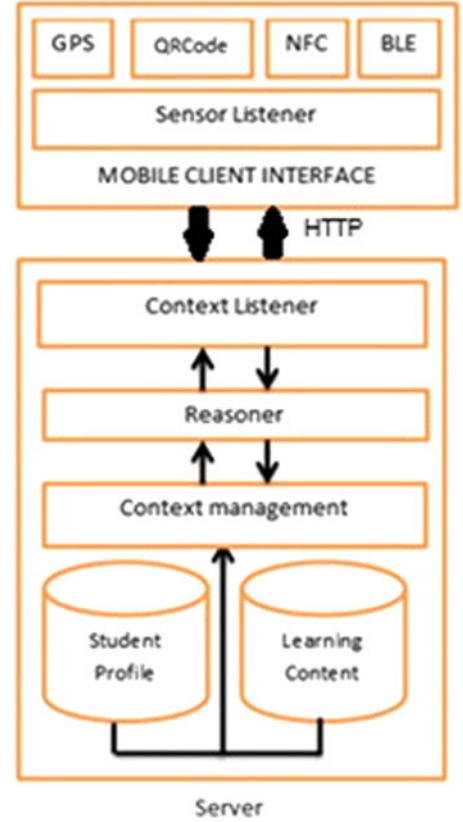

Fig. 3. System architecture.

4.1 Client Components

The client is an application developed for the Android 4.3 operating system which allows BLE tags to be read.

Sensor listener. The purpose of this component is to read the different sensors, those relating to location (GPS and BLE) and also those associated with the objects (NFC or QRCODE). These sensors allow user movements through the classroom to be detected. After a change in location, the system immediately sends an HTTP request to the context listener. This in turn sends it to the reasoner which is then responsible for returning the learning content associated with the new location.

Mobile client interface. This interface is responsible for capturing the user's explicit request, receiving the learning content to be displayed in a format according to the features of the user's device and gathering the user's answers to the activities and sending them to the server.

4.2 Server Components

Context listener. This component is responsible for obtaining context information and constantly listens to client requests. This interaction is carried out either implicitly, for example, to obtain the student's location or explicitly, as the student reads the NFC sensors or QRC tags.

Reasoner. This component receives the information from the context listener. Using all the information, the reasoner can construct a model of the context (as a whole) enabling the provision of suitable learning content. The reasoner uses Pellet 2.3.1 (An Open Source OWL DL reasoner for Java) which is responsible for executing the inference rules contained in the ontology "Ontology Web Language (OWL)". The rules supply the context knowledge base so that students can suggest the knowledge content based on the implicit interaction [36], [37]. The inference engine delivers the appropriate learning content based on the rules established in the ontology. For example, two inferences rule in SWRL (Semantic

Fig. 4. Learning experience in medicine.

Fig. 5. Learning experience in the nursery.

Web Rule Language), a language used to express rules and the associated logic are:

R1   `Students(?s) ∧ hasActivity(?s,?a)∧`
`hasExecute(?a, ?e) ∧`
`temporal:hasStartTime(?e, ?start) ∧`
`temporal:hasFinishTime(?t, ?end) ∧`
`temporal:duration(?dur, ?start, ?end,`
`temporal:h)`
`⟶ sqwrl:select(?s, ?e, ?dur)`

In this case, the system selects a planned activity that have to be executed during a period of time, but the location is not important (it can be done in classroom, laboratory or elsewhere in the campus).

R2   `Students(?s) ∧ hasLocation(?loc,?s) ∧`
`hasActivity(?s,?a)∧hasExecute(?a,?e)∧`
`DateTime:hasStartTime(?e, ?start) ∧`
`DateTime:hasFinishTime(?t, ?end)`
`⟶ Deliver_Learning_Object(?s, ?e )`

In this second example, the rule is launch when the student has planned a learning activity which have to be done in a specific location, i.e., anatomy labs, and in a certain date/time. In this case, the student must be in this location (the position is obtained either implicitly, through GPS/BLE, or explicitly, reading a NFC tag) during the required period of time.

Content management. The knowledge content manager provides access to the learning content and student profile; the content resources might include video, audio, html pages, animation, etc. This component is responsible for delivering the learning content required either by the reasoner or explicitly by the student.

4.3 Contribution Overview

Once the framework has been present, in this section we will focus on how it extends previous work. Our approach considers five different dimensions to describe the context, highlighting time context which has been identified as a critical element to identify the activities for being delivered. Therefore, a more detail definition of time is used, i.e., we do not only consider the actual time (as is usual in the literature), but also relate time with context associated to the activities (deadline, expected duration, etc.).

In order to tackle with this high-dimension of context, we use an ontology-based reasoner that allows us to do inference task (including conjunctive queries). By means of this reasoner, we can easily change from one domain to another, since the reasoning details were hidden. The teacher only has to populate the ontology using a set of predefined datatypes (using a XML schema). This is a difference from other approaches [14], [20] where the selected activities were obtained using a set of specific rules.
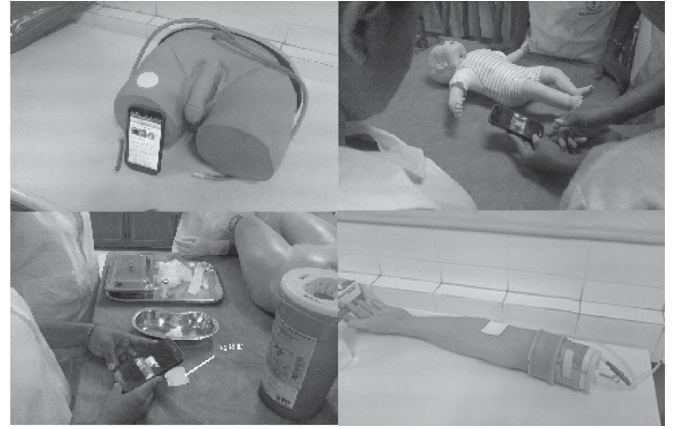
Also, the teacher receives reports from the completed activities, either individual or collaboratives. Our approach also perform inferences taking into account the profiles of individuals in a collaborative team. So the delivered activities are adapted to the team composition (considering the roles, experience and skills of its members). The fact that we consider collaborative activities is also an important feature that differs our approach with respect to the ones presented in the literature where collaborative activities has been considered as a possibility in some theoretical models. We do not know any real application implementing this capability in a context-aware learning system.

Last, but not less, in this paper we do not only present the theoretical architecture, but also it has been evaluated with real users under three different disciplines, as it will be shown in Section 6, which strength the contributions.

5   CASE EXAMPLE: "CARE FOR PATIENTS WITH HEART INSUFFICIENCY"

In order to prove how Contextualizing may support active learning, various experiments have been conducted on three different university courses: medicine, nursery and systems engineering (see Figs. 4, 5 and 6). The following activity, which has been designed for the nursery studies, will be presented with the objective of illustrate our approach. In this case the activity, which have to de done during a healthcare internships, is designed to introduce the students to several issues related to the urgency services, under the guidance of medical staff.
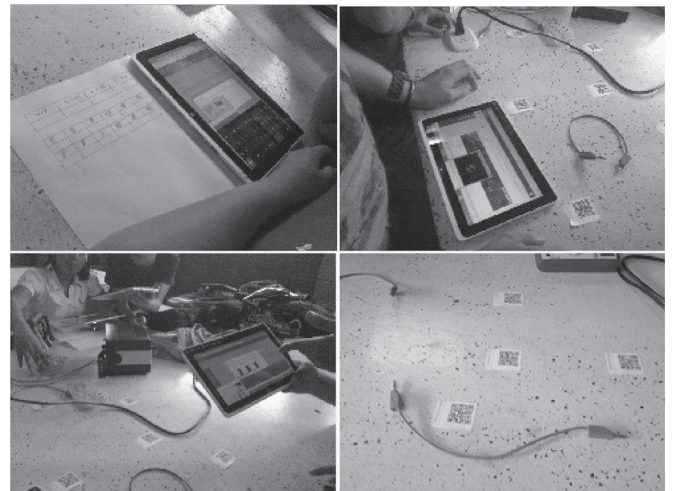

Fig. 6. Learning experience in systems engineering.

Activity: Improving the abilities and skills in anatomy, physiology and pharmacology

- Previous work: Before the activity takes place, the system provides learning objects about diabetes mellitus, hypertension, immediate postoperative care, adverse reactions, and indications on medicines used for the treatment of these diseases. The student should have studied this information before the practice.
- At the hospital: the student enters into a room labeled with a NFC tag. Using her mobile device, the student read the label, which indicates that is in urgency, and the system recognizes that the student is in place. The system starts to generate announcements associated with the scheduled activities via mobile notifications and text messages.

  While the student is moving around the service, she could read the NFC tag associated with a particular patient. Then, for example, the system informs that the patient, a 54 years old male gender with heart insufficiency, arrived at the emergency service at 6.00 a.m. The system provides the symptoms of the patient in the arrival and informs that he has a history of hypertension and deep venous thrombosis.

  The system recommends opening a nursing note which describes in detail the condition of the patient: cerebrospinal flow; oriented, disoriented or drowsy. It also recommends doing a physical exam, describing what arm is down, and taking the pulse, among other procedures. Then the system recommends checking the medical history and medical orders. It also suggests advertisement concerning about the patient, taking medications card, organize the schedule for taking vital signs of patients, etc.

- After practice: At the end of practice the system assigns a set of activities to reinforce the practice; these activities are also evaluated. This activity is finally socialized with the other students, where each one describes his experiences and opinions.

As we can see, during this practice, the context is strongly influenced by the patients (and their diseases), the time in which the practice is done, etc. but also it is influenced by the particular tools and procedures in the medical service.

6 EVALUATION FRAMEWORK

The main aim of our research is to describe how the use of Internet of Things changes outcomes for students. In order to evaluate these changes three different disciplines, i.e., Medicine, Nursing and System Engineering, were selected. The students[1] were randomly split into two independent groups of the same size: the control group, which only received traditional lectures, and the experimental group, which worked with the interactive system. Teaching resources therefore represent the independent variable and academic performance the dependent variable.

In particular, in our evaluation we perform several experiments in which the covered topics were selected in such a way that the students can do similar exercises, assuring in this way that the results were comparable. Particularly, the topics were blood pressure measuring (Physiology course, third term of Medicine studies), conducting peripheral catheterism (Clinical Practice course, third term of Nursing studies) and direct current circuits (Physics II course, third term of Systems Engineering).

Two different tests were designed and these included various questions about the cognitive objectives of the selected learning units. The first test, pre-test, evaluated the student's previous

TABLE 2
Academic Results for the Different Experiments

Medicine, N = 24						
Test-Group	Mean	Sd	Two sample t-test		Bartlett test	
			t	p-val	B stat	p-val
Pre-Ctrl	2.646	0.966	0.471	0.639	3.377	0.066
Pre-Exp	2.534	0.652				
Post-Ctrl	4.031	0.543	−3.404	0.0014	0.002	0.963
Post-Exp	4.562	0.538				
Nursing, N = 26						
	Mean	Sd	Two sample t-test		Bartlett test	
			t	p-val	B stat	p-val
Pre-Ctrl	1.923	0.399	1.525	0.1334	2.352	0.125
Pre-Exp	1.721	0.545				
Post-Crtl	3.223	0.733	−4.546	0.0001	0.161	0.688
Post-Exp	4.111	0.675				
System Engineering, N = 24						
	Mean	Sd	Two sample t-test		Bartlett test	
			t	p-val	B stat	p-val
Pre-Ctrl	1.587	0.708	0.018	0.985	0.565	0.452
Pre-Exp	1.583	0.830				
Post-Ctrl	2.708	1.382	−2.481	0.017	6.041	0.014
Post-Exp	3.521	0.814				

knowledge (before attending the practical class) and the second test, post-test, was used to evaluate the students after the class. In order to measure improvements in learning, we provided the same tests to both the experimental and the control groups. The score obtained, ranging from 0 (bad) to 5 (good), reflects the knowledge acquired by the students. A questionnaire was also used to evaluate students' opinions.

6.1 Pre-Test and Post-Test Analysis

Table 2 shows the results obtained for the three disciplines, focusing on the mean and standard deviation of the scores obtained by the student (second and third columns). To analyze these results, first we focus on the differences between the means obtained by the experimental and the control group in the previous evaluation (see rows labeled as Pre-Ctrl). In order to show whether these differences are significant or not we use a two sample t-test.[2] The results of the t-test, with p-values > 0.05, allows us to assume that there is no significant difference between the pretest scores for the two groups for all the disciplines.

As expected, all the students obtains better scores in the post-evaluation, but the scores for the experimental group are higher than that of the control group: 0.531, 0.888 and 0.812 points higher for medicine, nursery and engineering courses, respectively. Again, we use a two sample t-test (see rows labeled as Post-Ctrl in Table 2), but in this case the statistical analysis allows us to conclude that these are significant differences[3] (p-values < 0.05).

Finally, we have conducted an analysis which includes covariance with the purpose of determining whether the initial knowledge (pre-test) included as a covariable, affected the academic performance of the students (post-test) which is the dependent variable. For the case of systems engineering, the intercept for the control group and experimental group are 2.074 and 2.889, respectively with a slope of 0.399 (average increase for each incremental unit in the initial knowledge) for the two groups. The results shows

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1. The average number of students enrolled on each course was 50 (the limit at the University of Cordoba, Colombia).

2. The homogeneity of variance has been previously tested using Barlett's test (p-values > 0.05 for all the cases,reported in Table 2).

3. We want to note that Bartlett test does not reject the null hypotheses (at 0.05 significance level) for the post-test scores in System Engineering. Therefore, in this particular case, we had used the unequal variance t-test, Welch's test (this is the result reported in the table).

that there is no indication of any differences in the slope of the improvements between the experimental and control groups, t-value=1.891 and $Pr(> |t|)= 0.065$. Similar results have been obtained for the nursing discipline (intercepts of the control and experimental group are 3.053 and 3,960, respectively; slope=0.3992; t-value=0.419 and $Pr(> |t|)= 0.677$) and medicine (intercepts of the control and experimental group are 3.790 and 4.332, respectively; slope= 0.091; t-value = 0.940 and $Pr(> |t|)= 0.352$). All the p-values were not lower than the 5 percent, so they are not significant. This means that the initial score (pre-test or initial knowledge) is not a factor which explains the final score of the student.

The above results confirms statistically that those students using our learning system had better performance (in terms of academic improvements) than those following the traditional lectures. In other words, our approach was helpful to the students in improving their skills.

Fig. 7 shows the behavior for the different students in both, control and experimental groups in pre-test as well as in the post-test evaluation.

6.2   Student Opinion Analysis

In order to measure students opinion, we designed a Likert-type scale questionnaire [38], see Table 3. This questionnaire consists of a set of statements on six different aspects in terms of their experiences with the proposed system. Since the objective is to measure how useful context-awareness is when designing active learning strategies (our latent variable), only the students in the experimental groups were considered. In order to evaluate each statement, the student can choose from a scale of one to five, where 5 means fully agree and 1 fully disagree.

From the obtained results, it is clear that the students believe that the system facilitates interaction with the context in which the activity takes place, and that such interaction helps them to improve their learning processes. The reliability of this conclusion is measured by considering the Cronbach alpha coefficient, which has the value of 0.8366, 0.8103 and 0.863 for the disciplines of Medicine, Nursing and Engineering, respectively. Note that these values are greater than the 0.7 value which is considered to be the rule of thumb for confirming the reliability of the hypothesis.

7   CONCLUSIONS AND FUTURE WORKS

Our results prove that that the use of context-awareness as a tool to select the learning activities that should be done by the students helps to improve their performance in active learning tasks. In this regard, five different dimensions have been identified that can be used to define the context: student, time, activity, learning objects and location. These dimensions are used to propose context-awareness activities to the student. Empirical evidence suggests that the system correctly displays learning content regardless of the academic program concerned.
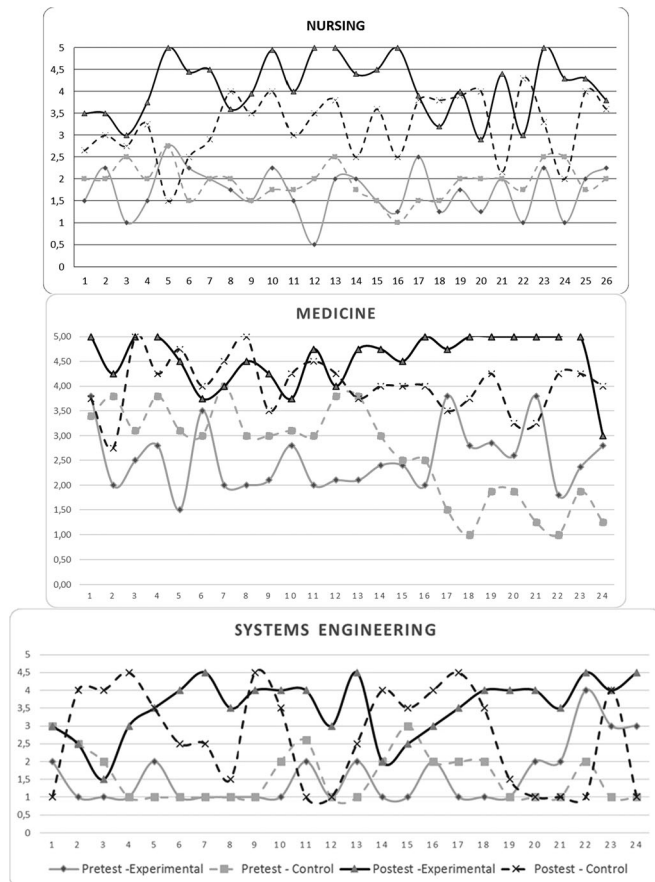

Fig. 7. Academic behavior for the control and experimental groups in the different courses.

One of The great challenges with the actual application of the developed system was the incorporation of the active learning model for the students as well as for the teachers. For the students it is a little boring at the beginning due to the new learning approach, where the students have to assume the reluctance to the change. For the teachers, the work load is bigger due the class preparation which includes the educational resources associated to the new system as well as the unforeseen coming from the dynamics of the type of learning he is dealing with and the changes in the evaluation system.

For futures works new questions and/or open interviews to complete the satisfaction survey are incorporated the system will be evaluated with groups from the foods industrial, agronomy and environmental engineering programs. This will be contrasted with academic programs from the education faculty to be analyzed according to the required practical abilities

TABLE 3
Questionnaire Presented and Results Obtained

	Questions	Medicine		Nursing		Engineering	
		score	SD	score	SD	score	SD
1	The system facilitates learning.	4,250	0,532	4,231	0,514	4,208	0,721
2	Learning content presented by the system is suitable.	4,167	0,637	4,153	0,613	4,083	0,881
3	The system interface is easy-to-use and user-friendly.	4,333	0,761	4,346	0,745	4,417	0,776
4	The system allows interaction with context.	4,125	0,612	4,192	0,634	4,375	0,770
5	The system allows the execution of activities on and off the University campus.	4,292	0,751	4,346	0,689	4,292	0,624
6	The system facilitates the development of active learning activities.	4,625	0,711	4,577	0,643	4	0,780
	Cronbach Alpha	0.8366		0.8103		0.863	

ACKNOWLEDGMENTS

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