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Artificial Intelligence and Bluetooth Techniques in a Multiuser M-learning Domain

Bonifacio Castaño
Alcalá University
Dept. de Matematicas
Alcalá de Henares
Madrid, Spain
bonifacio.castano@uah.es

Ángel Moreno
Alcalá University
Dept. de Automática
Alcalá de Henares
Madrid, Spain
angel@aut.uah.es

Melquíades Carbajo
Alcalá University
Dept. de Automática
Alcalá de Henares
Madrid, Spain
mcm@aut.uah.es

Javier de Pedro
Alcalá University
Dept. de Automática
Alcalá de Henares
Madrid, Spain
jdp@aut.uah.es

Abstract

In this paper we present a practical implementation of a multiuser technical laboratory that combines Artificial Intelligence (AI) and Bluetooth (BT) techniques. The objective is to build an m-learning environment where students can work in a customized way. Applying BT capabilities this domain can be isolated into a classroom and used by several learners simultaneously. The student activities can be supervised by means of AI strategies (planning, scheduling and expert systems) in order to adapt the modus operandi to the characteristics of each one. Integrating these technologies, the whole system will be able to recognize each user, organize his/her work and evaluate his/her results without or little educator intervention. Nevertheless, the teacher will be reported about the student actions and will be adviced when the situation requires it[1].

Keywords: M-learning, AI Planning and Scheduling, Expert systems, Bluetooth.

1 Introduction.

Traditional education, where a teacher transmits to their students some knowledge in the classroom, is a very well known communicative process. In the same way that others human situations of communication, teaching and learning are being highly affected by the development of the new technologies of information and communication (TIC). This influence has given rise to the creation of the e-learning concept. Two of the most relevant advantages of this new educational framework are the flexibility and the context adaptation capacity.

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It is evident that these features are greatly improved if the potential offered by the wireless communication systems is added (and then the term m-learning is used). Moreover, it is possible to go one step further, integrating also artificial intelligence techniques in order to automate and personalize the learning experience offered to the students, which opens a world of educational possibilities [17].

Among them, this article focuses on the problem of management within a group of students arriving into a laboratory, making practices, getting real time results, asking questions, interacting with the educator -if needed- and leaving at any time. The m-learning environment presented here offers a real solution to this challenge. It uses a Bluetooth scheme and takes advantage of this huge potential. The obtained wireless system is agile, trustworthy and dynamic.

Another fundamental question supporting the versatility and effectiveness of this m-learning answer is the characterization and monitoring of its users. A recognition strategy -based on Artificial Intelligence- allows the system to determine the capacities, preferences and availabilities of the students and to adapt its interaction with them in order to optimize its results.

The paper is structured as follows. First, we provide an overview of the current e-learning and m-learning technologies, in order to settle the context of the work presented. Then, we provide some basic information about AI techniques and Bluetooth that are the methodologies supporting the m-learning architecture proposed. In order to show the architecture's behaviour, first we describe the educational environment where we are going to implement it: a technical laboratory. Then, the main modules of the architecture itself are described. Finally, we summarize the main concepts and propose some challenges for future works.

2 E-learning and M-learning.

Current e-learning and Virtual Educations technologies have experienced an increasing research interest thanks to the use of information technologies and Internet [13][20]. The use of these technologies has generated a new kind of tools and frameworks that can be used by educators to design, deploy and control courses. In this article we present a possibility of incorporating the benefits of the wireless communication technologies to e-learning. This idea is not totally new. For a long time, its implantation has been giving rise to a new concept: m-learning (mobile-learning).

The earliest application of mobile computers for teachers and learners started at the beginning of the 1970's at the Xerox Palo Alto Research Center. Nevertheless, the authentic m-learning concept and its technical developing began at the end of the 1990's. From that moment on the number of mobile devices and its applications are growing faster and faster and today they are more than three times the number of personal computers. Some experts even think that mobile phones are going to be an alternative to PC's. In this context, m-learning appears like a very valuable investigation and application field.

Different well known e-learning standards, such as IMS [11], SCORM [21] or LOM [14], are currently being used to define and develop new adaptive virtual based education tools [22]. These tools support the creation of personalized learning designs (LD) [12]. They also can be used by educators (and/or course designers) not only to define the contents of a course (i.e. by using the IMS LD specification), but also to create adaptive and personalized learning flows, so that, the educational system can monitor and control the whole learning process. This way of designing make possible to reuse and to exchange useful information between different platforms. When these systems incorporate wireless elements, as cellular telephones, PDAs, Laptops, and other mobile devices, the term m-learning should be used. In this context, many of the fixed systems advantages can be taken. Among them it is possible to be emphasized: the possibility of giving service to many users simultaneously, the capacity to put the contents to disposition of the students at the opportune time and place and the flexibility in the access to any electronic document.

According with some authors [26][23], the wireless communication with movable devices presents several details that gives it a special character. Some of the most important features are:

1. The possibility to use very small time intervals. For example, in a bank queue or in the waiting room of a doctor.
2. The need to simplify the contents presentation due to the limited display and input capabilities of the mobile devices.
3. The capacity to adjust the information provided to the user, based on its temporal and local context. So, it is possible to interact with a user according to its time availability, without being conditioned by the opening time of a certain building or service. Otherwise, the space location of a student will be determinant to select the type of information provided to him. For instance, it has much more sense to send a bibliographical reference when a student is in a library. Another chance is to guide him through a museum (with information about the nearest pictures) without imposing him an established route.

It is evident that these features condition m-learning applications but, simultaneously, they open a world of possibilities. For instance, in order to take advantage of the adaptation capacity to the context, the need for a real time management should be mentioned. The Bluetooth solution presented in this article offers an authentic possibility of satisfying all of these technical requirements. This wireless system is agile, trustworthy and dynamic. In addition, it even works when the user concurrence is high.

Another fundamental question to assure the versatility and educational effectiveness of an m-learning environment is the characterization and monitoring of its users. A recognition strategy would allow determining the capacities, preferences and availabilities of the students. So, it will be possible to adapt the system performance with the learner aptitudes in order to optimize the global results.

In order to adjust the m-learning course contents to the students, most of the Virtual Learning Environments contain pre-fixed courses where the user navigates and learns the available concepts. Some m-learning tools include Situation Learning (SL) courses where the user is presented with different pre-defined situations and where (s)he has to choose among different options. The drawback of this type of courses is that nothing is dynamically generated and a lot of effort is required to create challenging situations that keep the student attention. Although instructors can get statistics as well as other information about the student progress, there is still a lack of feedback among the previous users, the tool itself, the instructors, what the user is interested in and the future users. Among the tools developed on this direction we can mention the Course VisSystem [15] and the Dynamic Assembly Engine [7].

An interesting approach for automatic course generation (in some ways similar to the one presented in this paper) is the work of Ulrich [25] who uses an AI Hierarchical Task Network (HTN) planner called JSHOP [10]. This system assembles learning objects, retrieved from one or several repositories, to create a whole course. It can also schedule them along a period of time and consider previous student results to generate different Learning Designs (LD).

Besides the contents adjust, other alternatives of adaptation to the special features of the students have appeared. Some of them are based on the classification of the users into different groups, in agreement with their learning style. In this context, several styles have been defined: active, reflexive, theoretical, experimental, etc. and different ways of communication with each one have been settled down. This method supposes an advance but it still presents a lot of rigidity [18].

In this article a method based on the application of the IA techniques of planning and scheduling is offered. By means of these techniques the characteristics of the different users are detected (recording how they use the system). Then, in every case, the way to interact with each one of them is determined. In this process of mutual interaction two things must be considered: the objective of learning or formation wanted for the users and the resources susceptible to support the students. This way to work allows a complete adaptation to each student (maximizing the effectiveness of all the process) and it offers the possibility of managing user groups [5].

Additionally it is interesting to mention that in mobile learning several problems exist that are not present in e-learning. For instance, one of the most important is the hardness to obtain or send printed material [24].

3 Artificial Intelligence Techniques.

The main aim of Artificial Intelligence (AI) [16] is to study how to build artificial systems that perform tasks normally performed by human beings. This concept was born in 1956 in the Darthmounth conference. From that moment on a lot of effort has been made and many goals have been achieved but unfortunately many failures as well. Today the AI is a very important discipline and it includes a number of well-recognized and mature areas: Expert Systems, Fuzzy Logic, Genetic Algorithms, Language Processing, Logic Programming, Planning and Scheduling, Neural Networks and Robotics. Within these fields, our work focuses on *AI planning and scheduling (AI P& S)* and *expert systems* techniques.

Next subsections describe the techniques used in our m-learning architecture.

3.1 AI Planning Techniques.

These techniques have been applied to solve complex problems in domains such as robotics, logistics or satellites.

The new Virtual Learning Environments also provide an interesting field for AI researchers. In this domain they can experiment with their automatic problem solving algorithms, or develop and design new techniques in this discipline. Then, the educational investigators can use this new kind of tools and methods that could aid them to detect, reason, and solve (automatically) deficiencies observed in their initial learning designs. Again, one of the areas of AI most suitable to be applied within this context is the Automated Planning and Scheduling. The combination of both tools can perfectly handle temporal reasoning and resource consumption, together with some quality criteria (usually centred on time or resource application).

In this context, a *planner* solves a concrete problem by finding a sequence of actions that transform an initial state into a final state. In a learning environment, an initial state can be described by the student's previous knowledge, the resources that a course (set of learning activities that are performed by the students) uses and the time period when they are available. A final state, or a goal, would be that the students are able to apply critical thinking to a specific subject.

In order for a planner to solve a problem, it is needed (1) to specify the domain that is composed of a set of operators that allow the planner to go from a defined initial state to a state in which a set of goals is fulfilled, and (2) to describe the initial and goal states. The standard language to specify the domain and the problem is PDDL, now in its 3.0 version [8].

There are several planning techniques, among them we have chosen a total order planner. This generates solutions that are sequences of total ordered actions. The basic structure is a tree where nodes are plans or states, and edges can be actions or state transactions.

3.2 AI Scheduling Techniques.

A *scheduler* organises activities along the time line by taking into account the resources available. Many procedures used in this area of scheduling systems come from the Operational Research (OP) and the Constraint Programming. (CP). This last discipline has been applied to the different scheduling problems with very good results, i.e. the Job Shop Scheduling Problem (JSSP) [9]. These JSSP methods can be easily generalized and applied into a learning environment. In this case, instead of machines and jobs, there are students, teachers and learning units in courses.

In the application displayed in this article this adaptation is made in a natural way taking into account that each learning unit can be considered as an operation that needs to be processed during a period of time, for a given student (machine) and under the supervision of an educator. The course also must have a limited duration (deadline) and an instructor can only manage a limited number of students (each teacher is a resource with a total resource capacity given by the number of students he is able to advise).

In addition, it is necessary to know the initial and end time of each learning unit task considering precedence constraints among them. Also, it is mandatory to impose a course deadline (its total duration) and the resources (number of teachers) that are available. Furthermore, it is needed to establish other variables imposed by the problem conditions: number of learners, learning activities duration, course length, etc.

Once all these data have been recorded, it is up to the educator or the pedagogical responsible to establish the best way to distribute the number of hours and their contents among the different units in order to assure the quality of the educative process. This business can be done automatically by applying planning and scheduling techniques. The results will be a plan, or a set of plans, if a solution exists for a given deadline. A plan can be seen as a sequence of learning activities (operator applications) with a specific duration that must be accomplished from the initial state to a state where the goals are reached, under the teacher supervision, with the resources available.

Finally, it is appropriate to emphasize the possibility of compiling the information of the student interactions with the system throughout the time. This information can be used as a feedback in order to reschedule the whole course or to change the time assigned for a specific task. This way allows a better course adaptation to both: the student characteristics and the available time.

3.3 Expert Systems.

An expert system is a computer program that employs human knowledge to solve problems that usually would require human intelligence. This kind of programs represents the expertise knowledge, about a specific class of problems, as data or rules that can be called upon when needed. They can also provide some analysis of the problems and they can even recommend user actions in order to perform improvements and rectifications. Expert systems seem to arrive at conclusions using reasoning capabilities.

Expert systems consist of two main parts: the knowledge base and the inference engine. The knowledge base contains the expert system knowledge. This can be catalogued as: factual and heuristic. The factual one is that knowledge that is widely shared and it can be typically found in books, articles, journals, etc. The heuristic knowledge is more experiential and it is rarely discussed. This is the knowledge derived of good training, good judgment and plausible deduction in the field. These two kinds of knowledge are organized and represented as rules IF-THEN. The inference engine manipulates the information stored in the knowledge base in order to form a line of reasoning. This engine is built into program modules according to the problem-solving designed method.

One of the most attractive features of expert systems is their capacity to review its consultations and provide the user with an explanation for how its conclusions were derived. The exposition function is basically a record of the reasoning process used by the expert to solve the problem. It provides for a better understanding of how the conclusion was reached and yields in the user greater confidence in the conclusion and the expert system.

Expert systems can afford many tasks: monitoring, design, control, simulation, learning support and information retrieval, among others. In this article one expert system is used as instruction system to monitoring the learning process of a group of students. The system detects mistakes and identifies the suitable solutions. In this way, the system facilitates the student's education and the correction of errors.

4 Bluetooth.

Bluetooth wireless technology is a short-range communications system intended to replace the cables connecting portable or fixed electronic devices. Bluetooth is now the largest radio-based technology after GSM. Currently, consumers specifically recognize the significant technological advancements of Bluetooth in three markets [2]:

1. **Mobile phones / Handsets.** Bluetooth-equipped cell phones are rising quickly, with an estimate of 303.7 million units sold worldwide by 2007.
2. **Headsets.** The headset trend is becoming the new wearable technology. Industry experts say Bluetooth headsets will also be able to use with iPods switching from music and calls.
3. **Automotive industry.** The Bluetooth applications for cars are being included in newer car models coming out and also being sold as after market kits. The hands free solution as a safety benefit is one of the most demanded options.

Due to the wide adoption of Bluetooth and its quite interesting properties, a lot of effort has been made trying to evolve it beyond the initially envisioned wire replacement function to a large-scale networking technology. Now it is possible to use Bluetooth communications in a multi-user environment like the one found in a classroom or a library while maintaining short connection times and good performance behavior. Also, using artificial intelligence planning techniques, it is possible to handle the communication needs of an m-learning environment in a very efficient manner.

One of the most interesting features of Bluetooth technology in an m-learning environment is its short range of operation: most portable devices have a coverage area of 10 m, rapidly decreasing when obstacles are present (i.e. walls). It means, for instance, that devices inside a classroom are discoverable and can join the network whereas those outside the classroom are not. It makes this technology suitable for context-dependent applications, where two adjacent rooms can be considered two different m-learning cells, perfectly isolated from each other, and users are clearly identified as forming part of one cell or the other. That's the reason why we prefer Bluetooth to Wifi, because the scope of the cell for a server is similar to the scope of the teacher's voice into a classroom.

Alternative wireless protocols, like Wifi, have extensive support for privacy. Bluetooth supports both one-way and two-way authentication by using a challenge-response scheme based on shared secret keys, though not all Bluetooth devices are required to support this feature. In addition, to protect the privacy of the communication medium, the Bluetooth base-band protocol implements a stream cipher using an encryption algorithm.

5 A Simple Scenario.

The chosen scenario is a technical laboratory for engineering students where they will work on programming practices. That is, the learners will be asked to implement software developments related with the theoretical subjects studied in common classes.

This laboratory constitutes an m-learning cell where students can enter or leave at any time during a given schedule. They are supposed to carry their own laptop computer with Bluetooth capabilities. The system detects such students and manages profiles and access rights. Once a student is authenticated, the system sends to the laptop the application needed to interact in the m-learning environment, if it is not already installed. The system also sends to the student the appropriate tasks, according to the schedule and the personal situation. The student can send the solved practices back to the system for evaluation which, in turn, gives him/her feedback about the punctuation obtained, on-line advice on how to proceed if the work done is incomplete or below the minimum required level, or the next task to accomplish if he/she has passed the exam.

This way to proceed will give the learners the feeling that they enjoy a personalized service. This impression and the system ability to produce a quick response are essential for keeping students’ attention and motivation. On top of that, the student can ask the system for any kind of information about the course, like the practices' program, their content, groups to join, exam dates, and so on. He/she can also ask for on-line advice or for an appointment with the educator at a later date.

The system also interacts with the educator, who can enter his agenda, the programmed practices, support material and so on. The system sends the educator various logs, not only about the performance of the whole system, but also about the work done by every student in the laboratory: number of tries for every practice, punctuation obtained, time needed to accomplish the work, progress made, and so on.

Apart from presenting statistical data in several fashions, the system is also able to learn about the behaviour of the students, valuate the difficulties encountered for every task assigned and detect such things like two students presenting similar solutions to the same task. When the system is not able to evaluate the practice presented by the student, it will ask the educator for advice on how to proceed. If the solution proposed by the educator allows the system to go ahead with the evaluation, it will be incorporated to the knowledge database for future use.

One important factor here is error (i.e. incorrect response) treatment. The system obtains more information from wrong answers to the tasks assigned than from those correctly performed. To the error analyst, errors are significant in three respects: they inform the educator about what should be taught; they inform the researcher about the course of learning; and they are an outcome of the student testing, helping him/her to notice the target features of the task.

From the viewpoint of the organization, the students initially enrolled in the laboratory will form a unique group of basic level. As the practices advance some students will show greater skill than others, and they will be distributed among different categories.

The teacher will group the learners by level of difficulty or training. The exposed system can be a helpful tool for management or record the results of each individual student, subject to the metric imposed a priori by the professor. This strategy will result into changes in the membership of a particular group. The improvement in student performance will be assessed in the anointing of various metrics, such as: time spent in resolving the practical, skills learned, etc.

6 M-learning Architecture.

Figure 1 shows the basic architecture of the m-learning environment. It comprises a Bluetooth communications module, a Server, an integrated Planner and Scheduler (P&S) and an expert system called Evaluator.

The students interact with the m-learning platform by means of a **Bluetooth communication system**. This system is responsible for: detection of users entering or leaving the m-learning cell, establishment and release of work sessions with these users, and exchange of data between users and the learning environment. It will also manage and optimize in an intelligent manner the communications performance of the m-learning cell. With this intelligent management it is possible to extend the number of simultaneous users of a Bluetooth piconet from 7 to the amount normally found in our laboratories, i.e. up to 30 users. In fact, our device is designed to manage with Bluetooth technology up to 200 users with a data rate of 185 bytes per second. If the number of users is reduced, capacity is proportionally increased for each user into the piconet. At the same time, it also significantly improves the discovery and establishment times of Bluetooth in order to fulfil the real-time needs of the interaction with the users.

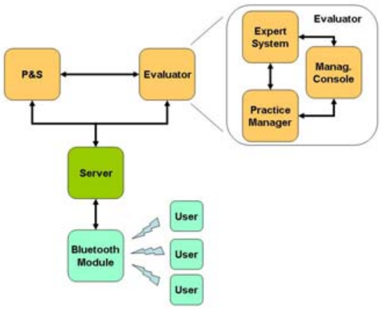

Fig. 1. M-learning environment architecture.

The **Server** will interact with the client application in the user's laptop using the Bluetooth module. It is responsible for the dialog and transactions with the students, performing all the tasks not requiring intelligence. A user entering the m-learning cell will be authenticated and registered. The basic m-learning application, if not present, will be sent to the student's laptop, as well as the tasks assigned by the P&S module to the student. It will manage all the requests asked for by the students, sending them to the P&S module or the Evaluator when appropriate. In turn, it is responsible for delivering to the students all the information coming back from the Evaluator or the P&S module. Eventually, the Server will take care of detecting users leaving the m-learning cell and will update the active users' database accordingly.

The Server is also the bridge between the educator and the system. All the information about the courses or the practices, as well as the educator's agenda, the students list or the laboratory groups list is accessed through the Server. Only the information pertaining to the P&S or the Evaluator (domain, constraints, evaluation rules, and so on) will be introduced using the management console module of the Evaluator.

The **Evaluator** is a dedicated PC platform for automatic evaluation of the practices sent by the students [6]. It comprises three main functional blocks:

1. **Practice manager.** It implements an automatic service for delivery and collection of practices without physical intervention. Periodically checks the registered student database, maintained by the server, seeking for new users in the m-learning cell. For any new user, it looks at the student's personalized program and sends him the scheduled practices, together with a practice management agent. The agent allows the student, not only to send the solved practice for evaluation, but also to ask for on-line or physical advice about the work to be done, among several other capabilities.
2. **Expert system.** Once the student has finished the practice, it is sent for evaluation. In order to do that, the practice management agent delivers the information coming from the student to the expert system which, according to a given set of rules (implementing the evaluation criteria), analyzes the information and reports the qualification obtained. Moreover, it notifies to the student the list of errors found, as well as a series of guidelines in order to improve the student's experience. All the events are collected by a trouble-tracking system and saved in a database, together with the answers recorded by

the teacher through the management console. This database is the learning repository for the expert system, which can afterwards propose more elaborate answers and guidelines, based on the answers of the students and the difficulties found.

The expert system is similar to those found in other intelligent tutoring systems (ITS). As shown in Figure 2, an intelligent tutoring system is composed by three modules (the expert, student and tutorial modules, respectively), plus an interface. The **expert module** comprises all the cognitive information, stored in knowledge databases. Here it is possible to find all the specific and detailed knowledge obtained from human experts after several years of teaching.

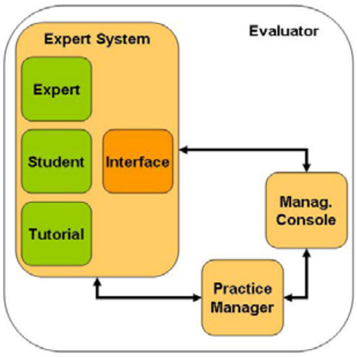

Fig. 2. The intelligent tutoring system is at the heart of the evaluator.

The **student module** stores the history and progress of the student interacting with the expert system. It comprises all the data and information about the student, helping in the diagnosis of the tutorial process. It is possible to use that information in order to choose the next lesson to be taught and the appropriate methodology and strategy.

The **tutorial module** is responsible for solving the problems encountered during the development of the content program and the way it is taught. It selects the teaching material and dictates the sequence to follow. It has the ability to control the progress made, to answer some kind of questions posed by the students, and to detect the type and level of help to be offered.

The **interface** is a set of communication channels between the student and the system, and the only physical way to capture the student's development. It needs to be dynamical, flexible, easily accessible and with multimedia capabilities.

The expert system has also the potential to detect when the answers sent by two different students are significantly similar, reporting the degree of similarity found and notifying the teacher, who can then send a message to the involved students in order to clarify the situation. The expert system does so thanks to the use of NLP (natural language processing) techniques.

The subjects for this experiment are laboratory practices related to network application programming. Linguistic pattern recognition methodologies are used to detect similarities in the code presented by two students. NLP techniques go beyond traditional information recovery, allowing the expert system to understand a document in a similar way as humans do.

3. **Management console.** The teacher has at his or her disposal a complete set of tools for performing on-line administrative tasks and track the activities accomplished by all and every student in real time. Among them, it is worth mentioning: a database compiler, in order to incorporate the expert system database to the report manager; an interactive graphical interface for real-time event monitoring and dialog with the students; a query tool, for definition and incorporation of tasks and evaluation rules; an event-reporting module for interaction with the Planner; and a report generator.

Finally, the **P&S module**, by means of the IPSS system [19], detects the characteristics of the different students (observing how they use the system). IPSS extends the capabilities of a non-linear HSP [3] metric planner, integrating CSP-based scheduling abilities. In IPSS two main modules interact during problem solving: (a) IPSS-P that corresponds to the planning reasoner (it is composed of a total ordered (TO) planner and a deordering algorithm that transforms the TO plan produced by into a parallel plan the scheduling component reasons upon); (b) IPSS-S that corresponds to the scheduling reasoner (it is composed of a Temporal Constraint Network (TCN) that represents the current plan as a STP [4] and a resource reasoner that analyzes multi-capacity resource conflicts according to the algorithm proposed in [1].

The planning and the scheduling parts interleave information during the solving process. The planning module performs a bi-directional search: it begins by performing backward search from the goals, selecting respectively which goals to achieve, which operator to use to achieve the corresponding goal, and which bindings to use for its variables.

Then, the deordering algorithm starts computing the link that satisfies the preconditions of the operator that is going to be added to the TCN and must be supported by the effects of an operator that is already in the TCN. To compute the links, our algorithm starts searching from the first operator applied (origin) until the last one. The operator and the computed links are then added to the TCN.

In every case, the way to interact with each one is determined. In this process of mutual interaction two things may be considered: the objective of learning or formation that is wanted to be reached for the students and the resources susceptible to support them. This way of work allows for a complete adaptation to each student (maximizing the effectiveness of the whole process), also offering the possibility of managing user groups. The result is a personalized program for every student. The general course program is the environment and guideline, giving the boundaries (lower and upper) where the individual programs can be dynamically established. The final result obtained by student gives feedback in order to improve the overall program for the next season.

In addition to the domain defined and the constraints introduced in the P&S module, the information provided by the Evaluator is very important. The personalized program of a given student may be dynamically altered as a result of the evaluation information. Two students of the same laboratory group may follow similar or very different paths, depending on their own achievements.

Taking into account a temporal scope, the system is responsible for two different kinds of tasks. There are some activities related to the interaction with the students that need to be performed in real-time. With the speed and performance of a nowadays average computer, it is possible to perfectly fit such charge for the number of simultaneous users forming a typical laboratory group (i.e. 20 to 30 students), even for a group 3 to 4 times greater. Other no real-time, processor-consuming works need to be done prior to the scheduled class period. These are, for instance, the tasks the system needs to accomplish in order to update the various databases and to decide on the materials and learning paths to be offered to the students.

7 Conclusions and Future Work.

In this paper we have presented a basic m-learning architecture. Bluetooth permits the creation of cells with a classroom scope, allowing for a context-aware approach. The addition of intelligence greatly improves the learning possibilities and the user experience: the Evaluator contributes with an automatic evaluation and feedback methodology and the P&S module improves the system with a student by student approach. This work is just the basic architecture, but offers plenty of opportunities for further research. The management of many adjacent cells, with users roaming between them, or the support for wider access to the learning resources so that students could take part in e-learning from remote locations is one of the issues. Another one is the automatic generation of activities depending on the student's performance. Finally, the modularity of the system and integration with existing or new e-learning components is another field that offers plenty of potential.

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