An open source information system for online counseling for a Mexican university

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Abstract— **One of the primary goals of undergraduate studies programs is to promote the professional and personal growth and success of their students. First year students, however, often suffer higher desertion rates and have lower academic performance levels than their more mature counterparts. Effective counseling and tutoring of students can help lower desertion rates that are often caused by academic demands, adjustment problems, maturation, personal or economic problems, alienation, or a lack of contact and effective guidance by faculty and staff. This paper describes an open source system for online counseling and tutoring that is designed to access and provide timely and accurate information, increase and optimize contact time, provide communication tools to facilitate interaction between professors and their tutees and assist in the administration and tracking of students.**

Index Terms— **online counseling, online tutoring, retention, online learning support, online learning needs**

I. INTRODUCTION

Traditionally, academic counseling has played an important role in lowering student desertion and improving academic performance. Ineffective counseling, however, can lead to students making uninformed or incorrect academic choices, thus contributing to lower academic performance or even desertion (Soulsby, 1999; Simpson, 2005; Kuittinen, et. al., 2001). First-year students, in particular, often require more personalized attention because of factors related to the academic environment (i.e. increased academic demands, administrative procedures, course selection, etc.) or maturation (i.e. socialization, personal identity, etc.). Personal and family problems, as well as the sometimes tenuous economic situation of some students also contribute to making the first year of undergraduate studies more difficult.

Efficient access to student personal information and academic records, as well as making administrative procedures more efficient and producing required reports is of vital importance to the counselor-tutor (CT). Unfortunately, sometimes large teacher-student ratios make quick access to accurate and updated student records, administrative information and educational resources difficult. Because human error tends to be more prevalent when the level of automation in repetitive processes is small or nonexistent, the creation of online systems to assist CTs becomes very relevant.

The additional time required to access information manually increases the frequency of errors and decreases the time spent actively interacting with students. Consequently, information management becomes key as it can minimize errors related incomplete or faulty information (Coles, 1999). The online system we discuss in this paper includes a component to more efficiently provide timely information when solicited by the CT, as well as communication tools to facilitate information transfer and promote more constant contact and greater personalization of services. Also, because the system includes an extensive database, it can assist CTs record and print out required reports, which can save a significant amount of administrative time. The additional online communication tools the system provides may also allow CTs to provide more contact time and affective support for students.

Contact time between professors and their students is extremely important as it helps create both professional and affective bonds. Unfortunately, due to often excessive student-teacher ratios and conflicting schedules, students often do not receive the contact time they require. In a survey conducted at several local Puerto Rican universities, Navarro et al (2002) discovered that these two factors accounted for 75% of students who chose not to employ academic counseling services. By not taking advantage of counseling services, students sometimes do not access reliable sources of information related to administrative procedures, academic counseling and study skills. Affectively, by providing easier and more efficient access to information and providing increased contact time with students, CTs can better establish the bonds students sometimes require, particularly in their freshman year. Thus, the academic, administrative and affective "grounding" a trained and experienced CT may help lower student desertion rates.

Affect is an important component in any learning environment. The connection between positive emotions, positive self-concept, motivation, persistence and positive learner outcomes has long been established (Navarro et. al., 2000). Consequently, research related to intelligent tutoring systems is beginning to consider human-provided emotional scaffolding. A study by Aist et al (2002) provides evidence that emotional scaffolding in intelligent or expert systems has a positive effect on persistence. However, although these findings are very positive, it is still debatable whether or not these systems can effectively promote human affective bonding and the potential benefits derived from it.

Although the primary focus of the counseling-tutorial program at the College of Telematics of the University of Colima is to provide personalized intensive counseling and tutoring services for first-year students, it is longitudinal in the sense that less-intensive contact is maintained throughout the 4-year undergraduate program. Therefore, tracking sophomore, junior and senior students and providing timely intervention also represent important objectives. The system we have developed includes a "clinical" component where observations, recommendations, referrals and actions taken by the CT can be recorded and stored, thus providing additional information should it be required at a later date.

This paper, in Section 2, discusses the definition and conceptualization of the terms counseling and tutoring, in general terms. Section 3 provides the specific context of a counseling and tutoring contexts of both Mexico and the College of Telematics of the University of Colima, Mexico. Section 4 describes our methodology, how Virtual Software Companies (VSC) were developed, and how the Capability Maturity Model (CMM) and Capability Maturity Model Integration (CMMI) provided the methodological foundations for developing the software. Section 5 offers information about the structure and function of the system itself and Section 6 discusses system requirements. Finally, Sections 7 and 8 provide our conclusions and future work, respectively.

II. TERMINOLOGY

The terms "counseling" and "tutoring" sometimes overlap. In general terms, however, the term counseling refers to "academic counseling," which consists of a series of actions to help students determine career objectives, understand administrative procedures, evaluate and track academic progress, select appropriate courses and/or majors and other similar aspects related to academic choices. In other words, counseling can be defined as "a system of relationships and processes designed to help people make choices and solve problems," (George & Cristiani, 1995) and its goals are "to facilitate behavior change, improve the client's ability to establish and maintain relationships, enhance the client's effectiveness and ability to cope, promote the decision-making process and facilitate client potential and development (Fujino, 2003)."

The term tutoring more often refers to a "specialized kind of instruction that structures itself according to individual needs and understanding of students (Legaspi & Sison, 2002)." In intelligent tutoring systems, Rosic et al (2000), comment that tutoring basically supports and improves the process of learning and teaching arbitrary domain knowledge. Consequently, the goal of tutoring is to provide personal, additional, often remedial out-of-class exposure to course content, as well as assist students develop or improve study skills.

An example of the different functions of the counselor and tutor can be found in the University of Texas Tutorial Assistance Program. This program distinguishes between two types of support personnel: counselors or advisors and study assistants. The primary role of counselors-advisors is to help guide students during the school year and study assistants help students with course content. The Program provides for two types of training. For instance, counselors-advisors receive training in interview techniques, consulting and diagnostics, training in educational psychology and administrative functions (because their tutees are not familiar with formal administrative policies). On the other hand, study assistants receive instruction in the areas of teaching strategies, communication skills and how to deal with affective considerations, including problems with self-confidence, motivation, anxiety and failure (Baudrit, 1999).

In the specific case of Mexico, full-time college and university professors are required to provide 10 hours per week of personalized, one-on-one interaction with students, consisting of academic and personal counseling and tutoring related to specific course content and study skills, including how to prepare to learn, how to employ different learning skills, time management, critical thinking, decision making, test preparation, reading and speaking skills, etc. Consequently, professors must meet the dual demands of an academic counselor-advisor and a study assistant, which according to McPherson and Baptista (2005), citing many different authors, includes coach, leader, tutor, moderator, facilitator, motivator, mentor and mediator, among others. CT programs in the Mexican context can be defined as the creative relationship between a teacher and a student (or small group of students) that evolves in order to deal with relevant academic, administrative and personal topics in a private manner, in order to contribute to the teaching-learning process. The relationship is personal in that the intent of the program is to establish the much deeper and affective personal and academic relationship necessary to accompany students throughout their studies (González et. al., 2002).

III. SPECIFIC CONTEXT

Mexico is a country that does not have a "deep-rooted" educational culture. Before the 20th century, education was accessible only to the elite. Consecuently, there were only a few, mostly private colleges and universities which dealt with a very small minority of the Mexican population. A free-public education did not really come into existence until after the Mexican Revolution, which ended in 1921. Consequently, most of Mexico's public universities were not established until well into the 1930s and 1940s, when the first generations of "common" Mexicans had finished their high school educations. Still, because Mexico was comprised of a largely impoverished, rural, agricultural population, the number

of persons who had access to the newly founded public universities was still small.

The last quarter of the 20th century, however, saw a great increase in the number of students wishing to study, in general. This significant increase was also true for students wishing to study professional careers. The demand has grown to the degree that a significant percentage of students have had to be refused admission because of a lack of physical space, personnel and funding. Unfortunately, an unacceptably large percentage of students who are accepted to Mexican public universities either abandon their studies or show poor academic performance.

In order to mitigate these two problems, the Mexican National Association of Universities and Institutes for Higher Learning (ANUIES, in Spanish), as part of its strategic planning for the years 2000-2006, has recognized the need to establish tutorial programs to promote the integral formation of students (Ceballos & Romero, 2005). One of the main objectives of the program is to provide assistance to undergraduate students who often lack any type of outside support should they encounter any academic or personal problems.

The primary reason students receive little or no outside support is because their parents and the general community possess relatively little academic experience. Statistics compiled by the Mexico's National Institute of Geography, Statistics and Informatics (INEGI, in Spanish) reveal the following alarming statistics:

- The average Mexican goes to school for 7.7 years
- 10% of the population has no formal education
- 18% of children do not complete elementary school
- 43% of 16-year olds do not go to school
- Only 47% of persons between the ages of 16 and 19 go to school
- Only 17% of persons between the ages of 20 and 24 are enrolled in school (INEGI, 2000)

The above statistics show that a great number of students leave school the first two years of undergraduate studies. As a result, Mexican public universities established tutorial programs beginning in 2000. Results of these programs, however, have been somewhat mixed.

An interesting study concerning their tutorial program was carried out by the College of Engineering of the Universidad Nacional Autónoma de México (UNAM), Mexico's largest and most prestigious university. The study parallels that of Navarro et al (2002) in that the majority of students choose not to attend sessions. In the case of the UNAM College of Engineering (UNAM, 2001), almost 60% chose not to participate in the program. The primary reasons and respective percents for their lack of participation are presented in Table 1.

Reason for non- participation	Percent of students surveyed
Lack of time	35%
Lack of interest	30%
Could not find their tutor	25%
Scheduling problems	10%

Table 1. Reasons for student non-participation

The results of the survey indicate that over one-third of students chose not to participate in the tutorial program because of reasons related to personal contact with their tutor. The sometimes limited student interest in tutorial programs is alarming, especially when the dropout rate, traditionally, in the areas of technology and engineering is relatively high. According to (INEGI, 2000), out of approximately 1,865,000 undergraduate students in Mexico, only about 1,600 study Telematics. According to College of Telematics statistics (Damián, 2000), the student desertion and failure rate in 1996 was 38% in the first year of the undergraduate program, and the final graduation rate of that generation was only 55%, meaning that from 3rd to 8th semesters, another 7% dropped out. Because relatively few students choose to study telematics nationally, and because the rate of desertion is considered too high, the tutorial program of the College of Telematics gains even greater relevance.

The tutorial program in both Mexico and the College of Telematics began in 2000. In 2000, the desertion and failure rate dropped to only 6% the first year and was 11% for students who were enrolled in semesters 3 to 8, meaning that the graduation rate had improved to 84% for students enrolled in the College the entire 4-year degree program. However, it is impossible to attribute the decreased desertion rate and increased graduation rate entirely on the tutorial program as, coincidentally, the College also made substantial curricular changes in 2000 (Contreras, 2004).

IV. METHODOLOGY

Under the supervision of a professor, students elaborated and applied a survey of the tutorial program of College of Telematics of the Universidad de Colima as part of a needs analysis. The survey reveals negative aspects concerning the tutorial program, including: missed sessions (with or without previous notification), privacy concerns (professors work in shared spaces), difficulties related to orally expression, a lack of confidence or affectivity in their relation with their tutor, faulty organization and insufficient counselling and tutorial resources, cost (both in time and money) and a lack of contact time with their tutors, in general.

Because all students of the College of Telematics must know how to employ computer resources, the students were asked if they would favorably view incorporating online resources to complement the tutorial process and what advantages they perceived in incorporating them. The students overwhelmingly replied that they wished to incorporate online tools and information systems into the tutorial process. Furthermore, they felt that additional online tools might offer the following advantages: privacy, anonymity, greater access to CTs, group sessions, displacement (transportation costs and commuting time), learning communities, resource distribution, organization of information, and personal comfort, among others.

As a result of the survey and needs analysis, the students established a fictitious software company called "Softpark" and developed an online information system, called "Sistema Manejador de Información de Tutorías en Línea" (SiMiTuL, or Information Management System for Online Tutorials, in English). The project proposal for SiMiTuL was presented to the client who required an online system that managed information and provided communication tools to support counselling and tutorial activities. The client, in this case, was the head of the tutorial program of the College of Telematics. This client represented a genuine client in the sense that he had manifested the need for such a system, yet had no formal computer training or any conceptualization of how to develop the system.

Fifth semester students at the College of Telematics are required to develop software and information systems as part of the curriculum. Traditionally, this type of course is largely characterized by methodologies that include extensive bibliographical and theoretical components, accompanied by individual or group (2 to 4 students) projects. These courses usually produce applications that are limited in scope as they are meant only to meet course requirements (Licea et. al., 1996). In order to provide more "real-life" experience and expand the scope of projects, we chose to establish "Virtual Software Companies"(VSCs), employing processes and procedures that parallel "real-world" software production. The objective of establishing the VSCs was to permit students to develop real projects for real, non-expert clients, using Object Modelling Techniques, which includes the theory and practice of system specification using Object Oriented (OO) methodologies to visualize classes and the relationships between them and Unified Modeling Language (UML), which permits its users to develop graphic representations that permit developers and architects to model a software system before it is actually developed.

The objectives, methods and practice offered students by establishing their VSCs is similar to what James E. Tomayko of the Carnegie Mellon University Software Engineering Institute proposes in the original Capability Maturity Model (CMM), whose goal is to improve information technology services, such as management of hardware and software, operations, and software maintenance (Tomayko, 1987), and the newer Capability Maturity Model Integration (CMMI) (Carnegie Mellon Sofware Engineering Institute, 2005), which is a process improvement approach that provides organizations with the essential elements of effective processes. Since their introduction in 1987 and 2000, respectively, CMM and CMMI have gained widespread acceptance by industry because they enable persons or organizations to evaluate the software process maturity of their software and permits them to improve their software development process. By employing these strategies, we hope to provide students with experience related to both the project development and software production process.

In order to evaluate the performance of the VSCs, we employed the 5 levels proposed by Collofello et al (1994), which include:

Level 1: The course does not consider Software Engineering as a discipline.
Level 2. The course uses a software development model.
Level 3. Students and teacher work to document the processes (which is not required in Levels 1 and 2).
Level 4: The instructor initiates extensive measurements and analysis of the processes.
Level 5. The instructor uses the measurements and analysis in Level 4 to improve and optimize the software engineering process with regards the development of future course projects.

The students were required to at least reach Level 3, and with the help of the instructor, reach Level 4. The individual instructor carried out Level 5 in order to study and refine the processes used in the same course the following school term.

To make the VSCs more authentic, students were assigned different roles according to their individual interests and antecedents, including writing, research and programming skills. The students were then assigned the following roles:

Project Manager: determines the technical requirements of the project, using object oriented methodologies for detailed analysis. The project manager is also responsible for defining the product specifications.
Analyst: insures that the final design is in accordance to the specifications determined by the project manager his team.
Quality Control Engineer: makes sure that persons participating in the project employ the same procedures, tools and techniques in order to insure the required degree of confidence and quality. The quality control engineer also realizes periodic review of intermediate products as well as insures that requirements, specifications and design parameters are met.

Test Engineer: plans and executes system tests and evaluations. The test engineer also tests different modules and the code generated during the project and participates in the technical review of the project.
Programmer*:* actually does the programming for the project and is also responsible for the installation and configuration of the tools necessary for the construction and execution of the software system.
Documentation Specialist*:* produces and administers all documentation related to the project, including the user manual. During the technical review, the documentation specialist functions as the secretary and is in charge of recording minutes, agreements and printing acts of the meetings.
Maintenance Engineer: writes the maintenance guide of the product and elaborates both traditional and online forms requesting feedback or corrective maintenance of the product.
Validation and Verification Engineer: acts as an independent member of the development team and is responsible for creating and executing tests, as well as validating and verifying plans for every product generated during the development of the project. He is also responsible for planning technical review and follow up.
Software Configuration Manager*:* identifies the intermediate products of the software development process in order to control versions and define the strategy and numeration of the different versions of the released product. He is also responsible for the committee that is in charge of changes made to the product and makes sure committee resolutions are actually implemented.

The role, purpose, relevance and objective of each member of the VSCs was discussed and bibliography was provided. The VSCs then had search for possible clients. When they identified their clients, the VSCs had to identify client needs using interview techniques and surveys. They then had to develop and present their projects to the client. Contracts were drawn up and signed in order to increase student commitment and offer the clients a guarantee that the product would be delivered according to agreed specifications and in the time frame agreed upon. By the end of the course, the students had to have successfully developed the project and delivered the evaluated and tested software to their client. Client satisfaction was the number one prerequisite, as students could not receive course grades if the client had not signed a letter of acceptance and satisfaction.

V. SYSTEM DESCRIPTION

The online counseling platform integrates the databases and online communication tools needed to administer, access and disseminate information, in order to promote more quality contact time between the CT and student. Figure 1 presents a basic schematic of the database and its contents.

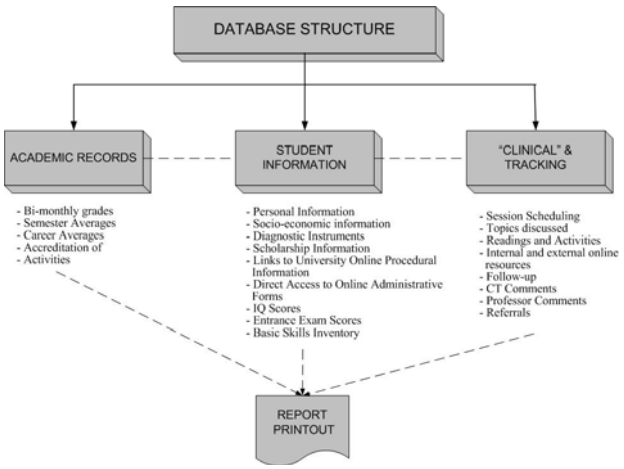

Figure 1. Database Contents

First of all, the online system is designed to tie into the student academic records database to provide tutors with accurate and up-to-date "read only" information related to a student academic history. The system also creates an additional online database to register any additional information, including additional personal information (socio-economic, family, work), test battery results (IQ, entrance examination results, professional interest inventory, personal characteristics inventory, and basic skills inventory, as well as session topics, teacher observations, tutor observations and referrals (i.e. psychologist, doctors, social workers etc.). Administering information efficiently is important because it saves a lot of time that is currently lost either due to the difficulty of obtaining information, or problems related with printed materials. Because the system is comprised of databases, this system also saves administrative time as it can print out different required reports, resulting in decreased time allocated on administrative concerns.

The SiMiTul main page has a simple and straightforward design that permits its users to quickly use the system, which is illustrated in Figure 2.

Figure 2. SiMiTuL Home Page

The home page of SiMiTul (fig. 2) contains five different sections:

1. *Title***:** users provide their name and can access a "Help" option should they require assistance.
2. *Menu:* gives the various options provided by SiMiTuL and permits registered users to access the system and employ its tools, according to the privileges granted by either the administrator or individual CTs.
3. *Work area:* offers the physical space where the different activities are visualized and the interaction with the system actually occurs.
4. *Places of Interest:* proposes a variety of links that are related to University-related administrative information, academic counseling (resources and materials), personal counseling (professional assistance) or tutoring (study skills)
5. *Registration:* asks individual CTs or students to provide their login and password to either register as first time users or to be recognized by the system.

The SiMiTuL system functions to serve four different groups of users:

1. **Administrator:** This person is the head of the tutorial program who is responsible for registering CTs and students. Figure 3 shows the administrator interface, which features a calendar that provides the actual date, dates that specific month in which tutorial services were provided and highlighted dates in which sessions have been schedules. This calendar additionally provides a history of the dates in which sessions were held as the Administrator or individual CT can forward the calendar to program future sessions or roll back the calendar to review past sessions. Access to the databases is provided from the calendar interface provided in Figure 3. The administrator can also provide topics for chats, forums, employ Bulletin Board Service (BBS), modify or eliminate files employed in the File Transfer Protocol (FTP). Because the administrator has a mailing list of all of the CTs and tutees in the system, he can invite any specific individual or group of CTs or students by e-mail to meetings or reunions, as the case requires.

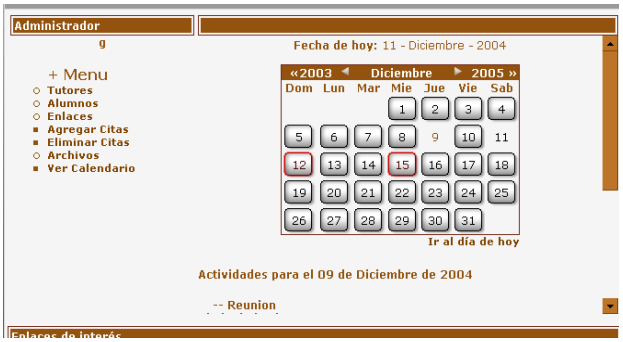

Figure 3. Administrator Interface

The Tutor-Tutee pairing interface in Figure 4 shows how the system automatically assigns, or pairs, CTs with students. The system mathematically totals the number of full-time professors and the number of first semester students. It then takes the average of students per professor and assigns them alphabetically. The Tutor-Tutee interface permits the Administrator to view CTs and students. Furthermore, SiMiTuL permits the administrator to automatically inform CTs and students of their assignments and provides follow-up as the CTs register their first and any subsequent sessions. The system also permits the Administrator to change any CT-Tutee pairing if necessary.

Figure 4 Tutor - Tutee Pairing Interface

2. **Tutors**: are the individual CTs who can create different discussion topics in the different forums provided by SiMiTuL and are directly responsible for providing counseling and tutorial services to the students. Figure 5 shows the follow-up or tracking feature of the CT, who can download or upload data into the clinical or personal sections of the information module, as well view "read only" information provided by the academic records database of the University.

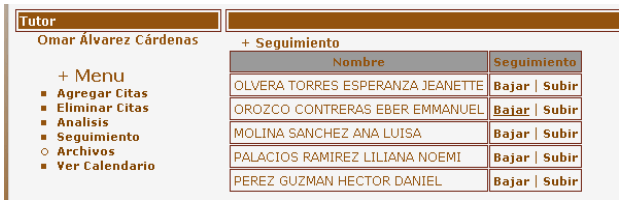

Figure 5. Follow up and Tracking Console

3. **Students or Tutees:** are students who are enrolled in the College of Telematics or, in the future, different schools and colleges of the University. Students can be provided privileges to create chat rooms or forums with prior authorization of the Administrator. Students who are registered in the system may enter the different chats or forums using their real name or an alias, depending on the degree of confidentiality required. The students, however, do not have access to any of the information contained in the different databases.

Figure 6. Student Interface

4. **Visitors:** are the unregistered users who can visit the page, but can not participate in the different activities or access any information that is provided by it. Visitors can only access the different links that provide university general and administrative information or different internal or external sources that provide academic or tutorial resources.

VI. SYSTEM REQUIREMENTS

Technologically speaking, the SiMiTuL online counseling-tutoring platform works as a client-server and is open source. We used Apache Server, PHP and MySQL to develop the platform, which requires only 50 MB of hard disk space and 128 MB of RAM. This system, which has been evaluated by a small test group is scheduled to be piloted under test conditions at the College of Telematics of the University of Colima, Mexico. The advantages of the system include:

1) ***Infrastructure:*** The system does not require extensive infrastructure as any desktop computer can be configured as a server. It presently functions on both traditional and wireless networks.

2) ***Diversity:*** The platform is compatible with both the Windows, Unix, and Linux operating systems.

3) ***Cost:*** The cost of development, installation, and implementation are low because the development tools used are available free of charge on the Internet. The installation does not require any additional or special hardware or software and the implementation process is simple in already existing LAN networks.

These three considerations can be particularly important in developing countries where both human and material resources are often more limited.

VII. CONCLUSIONS

Providing students with the opportunity to reach their personal and professional growth and contribute to their ultimate success is one of the primary goals of any college education. If good educational and counseling practices converge with the efficient and well-planned use of technological resources, universities may, in the future, expand the parameters that define traditional educational practices, concentrating on humanizing education -- not only producing capable professionals, but persons who are more able to live and contribute to an increasingly more complex society.

VIII. FUTURE WORK

The open source information system for online counseling and tutoring is to undergo a series of pilot tests during the spring, 2006 semester to determine factors such as usability, including user satisfaction (administrator, tutors and tutees). A performance evaluation and other technical tests will also be carried out. Upon concluding the pilot phase, we hope to introduce the system in the fall, 2006 semester and again evaluate it on usability, user satisfaction and performance, plus begin longitudinal studies to determine what effects (if any) the system has on variables such as contact time, session cancellations, participation rates, satisfaction with the tutorial process, student performance, first-year student desertion rates and ultimately, graduation rates.

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