Enhanced Affective Factors Management for HEI Students Dropout Prevention

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Abstract. Among the problems affecting Higher Education Institutions (HEI) in Latin America and the Caribbean there is the dropout, which relates to a more general issue consisting in dealing with the diversity of students. Here provided solutions are to detect and deal with student's particular capacities and needs. To cope with this situation the ACACIA project has defined a framework that develops both CADEP centers and technological infrastructure. The former consists of an organizational unit focus on Empowering, Innovating, Educating, Supporting, Monitoring and leveraging institutions in dealing with such diversity. The latter is based on building the required infrastructure to tackle those issues and covering both face-to-face and eLearning educational settings. This comprises non-intrusive affect detection methods along with ambient intelligent solutions, which provide context-aware affective feedback to each student. Preliminary experimentation results open interesting avenues to be further progressed thus taking advantage of current developments on affect computing technologies.

Keywords: Emerging technologies for collaboration and learning · Recommender systems for technology-enhanced learning

1 Introduction

UNESCO in its Post-2015 Education Agenda presents evidence of problems affecting Higher Education Institutions (HEI) in Latin America and the Caribbean. This has been useful to identify critical situations. Among those situations there is the dropout, which is caused mainly by affective and academic factors, as well as cultural, economic or social exclusion or disability.

Nicaragua, Colombia, Brazil, Peru and Chile share key priorities in their development programs for education, which to be achieved would require to open regional mobility for the students in higher education institutions based on the optimization of

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resources and international cooperation processes. These aspects can be found in European Union priorities for the region (European Commission 2014).

In order to tackle the student retention problem, the importance of evaluating students' motivation and attention to the class is of major importance. This entails dealing with class evaluation and further planning. Aiming at performing such evaluation, it is possible to obtain information by distributing surveys or by performing measurements, which may involve psycho-physiological information sources. The first case allows subjective assessment and depends on the will of participants to contribute. When the approach is to use measurements, this requires the proper consent of participants and their parents (when dealing with underage students). Here, although the approach should be as minimally invasive as possible, even non-invasive at all, there is the problem of collecting and dealing with sensitive data such as psychological and physiological information. This information is expected to provide more reliable means of getting assessments. Although the prospect of invasive measurements can be seen reluctantly by students, or any other people, who tend to resist such approach. Here there is the problem of invading each one's privacy as with such measurements it is possible to surpass a person's will by measuring their physiological information and not depending on his/her voluntary deployment of information.

This paper addresses how the ACACIA project is dealing with the student retention problem in terms of setting up an organizational unit, so-called CADEP centers, which deals with the educational and managerial issues involved, and developing the required technological infrastructure, which needs to be established in order to detect and manage the affective issues involved in such problem. To present such view, this paper is organized as follows. First the problem of the student's retention and the required infrastructure for detecting affective related issues are described in terms of related literature. Then the ACACIA approach to deal with those issues is presented covering both, the ACACIA-CADEP strategy and the technological infrastructure that has been developed to detect and manage the affect state of students, which affects their retention. The paper concludes with a summary of main conclusions and future work.

2 Student Retention and Affective Related Issues

The problem of student retention is well known and widely studied, as can be seen in (Summerskill 1962), (Astin 1977, 1993), (Bean 1980, 1983), (Bean and Metzner 1985) and (Spady 1970) among others. Studies by the Centre for the Study of College Student Retention indicate that despite the efforts of universities retention policies have not succeeded in increasing retention rates (Seidman 2015).

There is evidence for problems affecting higher education in Latin America and the Caribbean (LAC) which relates to how these countries are dealing with the concept of education for all (UNESCO 2014), were following critical situations arise:

- Dropout derived from emotional factors, academic, economic or social cultural marginalization, or disability;
- Lack of educational resources among faculty staff to meet the requirements affecting vulnerable students;

- Gaps in communication and cooperation among teachers, researchers, administrators and managers, which hampers collective action that is needed to address cross-section issues related to access and successful stay in college.

Studies by the Center for Student Retention -CSCSR- indicate that despite the efforts of universities in retention policies there has not been any significant increase in retention rates. The main strategies proposed by the CSCSR have to do with the setting up of the so-called Retention Committee in institutions, which is focused on identifying both students at risk of dropping out and problems within the classroom such as a little attention, getting poor grades and little class participation, among others. Nearly one in two students drops out of high school before graduating (Busso et al. 2013) and besides the quality of the educational system this can also be affected by low self-esteem, self-motivation, study habits, persistence and frustration tolerance, expectations and student's own personal values, which makes it even more difficult for institutions to adapt their system to address these issues.

Teachers, as any other human being, are able to sense and detect affect states from their students, which relate to their attention and restlessness states, their "boredness" or their motivation towards the class. The problem arises when students are learning remotely, as in eLearning, or even in live classes while students are interacting with computational devices. In this sense, the identification of students' affect features is required. To this with this issue it is well-known that humans display their emotions through different channels, including facial expressions, body movements and physiological reactions, which have been considered as elements of the non-verbal communication forms (Pantic and Rothkrantz 2000). Thereof the idea is to collect these human features and investigate to what extent they confirm a particular affective state. To deal with this issue affective computing is currently an active research field with significant efforts and advances linked to the emergent devices and gadgets.

There have been well-known studies in affective computing and the affective relation of humans with computers, which can provide insights on possible solutions for the aforementioned problems (Picard 1997). The affective assessment, which has to deal with both eLearning and face-to-face student, could be based on using different computational equipment and approaches. Since most laptops have cameras, can be used locally or remotely to give emotional information to professors and trainers using text assessment (Shivhare and Khethawat 2012) or reading facial expressions (Adolphs 2002). The analysis of such emotional clues, generated by real-time physiological signal readings from aforementioned devices, can provide information (e.g. analytics) on students' attention and motivation. The teacher will then be able to adapt the teaching process and later report the successful methods to the community.

There is vast research including reviews on the state of the art in emotions detection beyond the aforementioned examples. For instance, a review of available works on emotions detection with facial gestures was published in (Saneiro et al. 2014). As for using more intrusive psycho-physiological sensors, in (Villarejo et al. 2013) authors introduced a commercial pulsimeter and alternatively skin conductance to detect stress, where the skin conductance presented wider differences in the relaxed and stressed stages. Here it is noticeable that most successful approaches have applied several information sources. In particular most of them comprise verbal, non-verbal and

physiological measures. Heart rate is used in (Van den Broek 2013), which is combined with speech along with the Self-Assessment Manikin scale - SAM (i.e., a non-verbal pictorial assessment technique that directly measures several emotional dimensions) (Bradley and Lang 1994). There is work that has used Blood Volume Pulse, Galvanic Skin Response, Pupil Diameter and Skin Temperature to detect stress (Zhai and Barreto 2006).

There are as well many examples on the progress of affect computing in educational settings. For instance, a framework has been proposed to recognize learner's emotions using electroencephalography, skin conductance and blood volume pressure (Jraidi et al. 2014). In (Handri et al. 2010) authors made use of the e-learning material provided to learners in relation to their galvanic skin response. Electrodermal activity was used to detect the 12 proposed emotions in (D'Mello 2014). There are also instances on using non-verbal communication, such as body movements and facial expressions, which were used for evaluating learners' states (Afzal and Robinson 2007).

Some of this paper authors are also conducting a study related to the attention evaluation of students attending e-learning courses, where such analysis is conducted using physiological measurements as ECG. This work intends to increase the efficiency of students' attention in attending courses in this case related to the aquaculture business processes of the project AquaSmart. The AQUASMART project mission is driven by the business need of the European aquaculture companies, when companies have business objectives that cannot be achieved due to lack of instruments that would enable them to manage and access global knowledge and big data, in a multi-lingual, multi-sector and cross-border setting. Therefore, although this is a completely different domain still the main objective of the study reported in this paper is focused on supporting students' motivation while achieving their learning objectives, which in this case comes from an effective knowledge transfer from a specific industry research project.

3 The ACACIA Approach

The ACACIA project defines a system to address the above-mentioned issues, thus covering organizational and technological requirements involved in dealing with the student retention. The latter is addressed by building the required technological infrastructure.

3.1 The Acacia-CADEP Strategy

From the organizational viewpoint, the approach consists in supporting centers for education and professional development, which are called CADEP. It integrates modules named as: Empower ("Empodera"), Innovate ("Innova"), Educate ("Cultiva"), Support ("Apoya") and Convenes ("Convoca"), that all together create the appropriate framework for (1) monitoring students at risk; (2) providing training and supporting equally both the academic staff and technical and administrative staff of the institution;

and (3) exploring, via its laboratory system, new strategies for university teaching and innovative use of ICT in teaching practices, encouraging entrepreneurship among students and teachers. This system articulates the educational community to deal with each student's capacities and needs.

The model of CADEP is the result of analyzing multiple theoretical approaches that address the problems of student retention. Thus, it is proposed the creation of a committee in institutions for the identification and analysis of students at risk of dropping out. These committees intends to contribute for the demanding target of keeping and encouraging student's interests in an active participation in class, and empowering teachers with the skills and tools that will allow the adoption of new teaching models. This should cope in the best way with their students' differences and needs.

Innovation is an essential part of each module within the Acacia CADEP, thereof:

- Innovation in dealing with social affection issues at the university, through information systems capable of generating educational recommendations that meet the student's emotional states, which are to be detected and tracked in order to improve students' academic level and prevent dropout (Apoya).
- Technological innovation in university teaching, by using knowledge management systems and personalized solutions based on students' interaction tracking and machine learning analysis of collected data, which are to be provided with tool that detects emotions, using among others the paradigm of the Internet of Things (IoT) and the creation and reuse of applications and devices, encouraging university entrepreneurship (Innova and Apoya)
- Innovation in teaching in university environments through: the development of applications to support teaching and learning differentiated according to cognitive, affective and cultural conditions of students who achieve lower levels. Innovation in every respect to deal with individual needs and preferences, thus considering the use of 3D printers, which serve as educational support material for blind students. Ultimately the approach consists in adding new references to the current university curricula to make them more flexible and suitable to care for students with a wide variety of personal and social needs, which also implies to provide accessible learning environments for populations with differences in access to knowledge (Cultiva and Empodera).
- Innovation in the university academic management through a knowledge management system for partnership, which detects and transfers innovations related to affective, technological and didactic issues throughout the CADEP network system (Convoca).

The specific objectives of each of the modules are as follows:

Empodera: Providing training in areas of eLearning standards, accessibility and usability; Maintaining the Kit & Thesaurus ALTER-NATIVA knowledge base; as well as dealing with the creation of adaptations that cannot be performed directly by teachers, e.g. sign language interpretation.

Innova: Innovating in terms of new infrastructure, applications and programs which are developed and used to meet special educational needs and diversity, e.g. using ambient-intelligence solutions and 3D printers.

Cultiva: Training faculty through innovative programs with the support of the ALTER-NATIVA's curricular elements and VLO, which are to promote educational development of vulnerable populations from the perspective of a Community of Welfare.

Apoya: Detecting, tracking and supporting emotions of students with disabilities and critical family situations through both regular and advanced techniques (e.g. automatic emotion detection systems) to improve academic performance and avoid abandonment. And, train administrative and teaching staff, techniques and strategies for dealing with students at risk.

Convoca: Organizing and controlling the activities in the establishment of the different centers (e.g. space, physical resources and institutional rules). Addressing the development and continuous evaluation of capacity building issues though the various CADEP.

3.2 Technological Infrastructure Developed for Managing Affect

From the technological infrastructure standpoint, aforementioned developments on affect computing are expected to leverage the possibilities of taking care of students' retention. Here, the aDeNu Research Group at UNED has designed, implemented and evaluated the Ambient Intelligence Context-aware Affective Recommender Platform (AICARP) infrastructure to explore the potential of context-aware affective feedback beyond computer-based recommendation approaches taking advantage of the possibilities of ambient intelligence (Santos et al. 2015). The corresponding personalized support is provided without interrupting the learning activity by delivering the recommended action to the learner at the same time she is carrying out the learning activity (e.g. while the learner is talking, the system can tell her to slow down by switching on a light or playing a sound). This requires enriching the system with capabilities to detect changes in the learners' affective state (e.g. from physiological sensors), as well as to interact with the user through the preferred sensorial channel (e.g. sight, hearing, touch, smell). Different experiences are taking place within two related research projects, MAMIPEC and BIG-AFF, from where it is expected to progress on the results to date and thus provide valuable feedback to ACACIA (Fig. 1).

It is expected that monitoring students affective states, especially in what regards to their attention in classroom will become a reality in pilots for the South and Central American countries participating in ACACIA. That is an on-going process partially verified by the physiological trials performed in lab or in classrooms (Salmeron-Majadas et al. 2015), which also takes advantage of other developments such as evaluation frameworks (Marcelino-Jesus et al. 2015) or those ontologies that were successfully implemented in the project ALTERNATIVA.

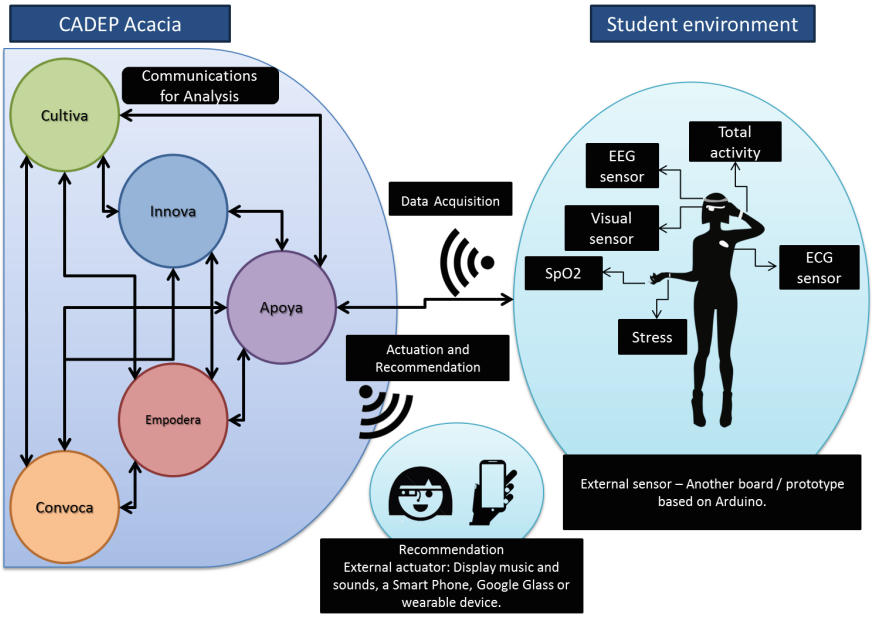

Fig. 1. AICARP platform

The approach proposed here covers both small-scaled (i.e., intra-subject) and detailed lab experiments limited in time to be carried out from the scientific viewpoint, which are expected to clarify the main issues involved, and on a larger-scale (i.e. inter-subject), try to use non-invasive measurements. As for the latter, the eye-tracker becomes one of the best options because it does not depend on wearing additional detector devices. It is also planned to use heart-rate variations and even galvanic skin response measurements, both of interest for the evaluation of emotional states and attention, which are minimally invasive, as they become part of the equipment of smart-watches and other consumer products. This work ultimately aims at providing lessons learned from the evaluation, which is expected to determine which type of detectors, contents, media and multimedia should be used in a particular class and context.

Another expected outcome of performing such studies is an increase of teachers' awareness of the actual involvement of students in class and consequently supporting their responsibility in actively assessing, adapting and developing class activities towards student's success. This way it is expected a better identification of students at risk. Thus problematic individuals can be spotted early and intervention can be readily prepared in order to improve the success rate of such rehabilitation actions.

In general, it is expected that such approach lead to a successful upgrade in the classroom towards students' commitment and success. The proposed methodology aims at making a difference to traditional classroom behavior where problems used to be identified in a too late stage or not identified at all until the student abandons school.

4 Conclusions and Future Work

The work described in this paper is a continuum from previous work developed by members of the consortium and from relevant scientific publications in the field. Thus it is consistently aiming at supporting students in their learning process and addressing specifically the problems associated with demotivation and withdrawal from studies. The proposed approach here is focused on managing affect related issues that impact students at risk of abandonment and aims at the empowerment of an attentive school community, continuously updating their methods and instruments towards its success. The objective is that the on-going work will prove its usefulness during the course of ACACIA project so that results can be made available for the community. Future work will be based on the achieved results and it is foreseen that the conjunction of self-assessment with physiological measurements will generate results that will improve the overall process. From those results, future work will aim at the selection of the best methods and eventually include new physiological measures that increase the quality and readiness of the evaluation process so that the proper measures can properly be deployed and positively help students towards success in studies and in personal fulfillment. Additionally, the work conducted will be also integrated in different projects and contexts. In particular, e-learning programs as in AquaSmart, which main objective is to develop solutions for increasing the student attention in courses and better integration of different types of materials available online. Within MAMIPEC and BIG-AFF the affect detection infrastructure will be evaluated in different scenarios ranging from laboratory to real world settings.

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