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An Artificial Intelligence-Based Application for Facilitating Interaction and Learning Assessment in On-line Engineering Courses

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ABSTRACT

This paper describes an artificial intelligence-based application for facilitating teacher learner interactions, and learner feedback and assessment in online engineering courses. The application reduces the amount of time a teacher has to spend answering questions, redirecting students to resources and assessing learning so that a larger number of students can be accommodated in an online course without forgoing interaction and feedback. The teacher still plays an important role in an online course, but the application helps the teacher to answer routine questions and provide necessary feedback. The application also gives more control to the learner to progress through the course in a self-paced manner thereby facilitating self-directed learning.

KEYWORDS

On-line course, learning assessment; distance learning, artificial intelligence

1. INTRODUCTION

Developments in information and knowledge-based technologies are providing the impetus for transforming the teaching-learning process. New forms of producing, storing and distributing or knowledge has allowed for an increase in performance, breaking up traditional barriers to learning.

In this context, distance learning, mediated by the computer, the Internet and World Wide Web technologies has been considered as one of the most appropriate ways to reach underserved populations while maintaining quality of the learning experience. However, as the number of students in an online course increases, the opportunity for interaction goes down as well as the teacher's ability to give individual attention, provide feedback, and asses learning.

Administrators interested in investing in distance education are interested in economies of scale, and want to find out the cost-benefit ratio of distance education. An often-deliberated issue relates to the benefit of investing large amounts of money in online courses when they can serve only a small number of students. Educators on the other hand are interested in maintaining the quality of the learning experience, and recommend limiting enrollments to increase interaction and feedback to the learner.

A great deal of research needs to be carried out to make this cost-benefit relationship more appropriate. In order to address this issue, we at the College of Electrical Engineering and Computer Engineering at the State University of Campinas, UNICAMP, are studying means of reducing the number of student-teacher interactions through the use of teaching-learning processes capable of guiding the effort of the student, allowing for a smaller number of mediators to be employed to assist the distance learning process.

Although many new teaching technologies are being tested, one of them has especially been drawing attention for its potential in managing self-paced learning in the online environment. It is the application of artificial intelligence principles to online learning, now involving an array of new possibilities provided by the available technology of computer science, by the construction of the leaning content based on conceptual maps and by a complex learning assessment process.

In a general way, the model has as its basis, the diagnosis and continuous evaluation of the student's performance in their self-learning process, taking them through successive levels of knowledge, appropriate to the domain of the immediate content related to the discipline evidenced by the student during the accomplishment of their study.

The objective of the study is to evaluate whether modules developed based on artificial intelligence applications to Distance Education, may reduce the number of instructors necessary to manage an online course and allow a larger number of students in a virtual class.

2. A VISION OF THE CURRENT MODEL

The current writings on Distance Education indicate that this form of education based on communication technologies is still a social utopia. One of the main advantages of a distance-learning course would be meeting the increasing demand from students. As a limitation, a course on-line that possesses more than 20 students per teacher (mediator) becomes practically unsustainable from the qualitative point of view of the didactic-pedagogic process.

In turn, traditional face-to-face teaching, although limiting access to education, allows for better economical-financial sustainability, by permitting a larger ratio of students per

professor with a smaller investment, taking advantage of the existing infrastructure. This complex array of factors which include, new technological possibilities versus financial limitations as well as pedagogical quality issues lead to a low level of motivation for administrators of public and private schools to invest in Distance Education programs, which would make the "Technology of the Hope"[1] feasible.

Some researchers point to solutions that, for their complexity, would even make it more difficult to realize the programs with appropriate financial return, although they maintain the quality of the teaching process, as can be observed in Souza(Souza, 2000) and Hack (Hack, 2000).

One of the factors that have been considered a limitation is a single teacher's capacity to manage an effective learning assessment process, capable of supporting the relationships necessary to attain the teaching objectives in each course. Those that defend the teachers' permanent participation in the process, plead the need for the maintenance of a permanent link between the student and the content of the course, through the teacher's meditative action.

On the other hand, the current and emerging technologies still don't make viable the construction of self-maintainable courses. The more critical scholars defend the increasing need to use methods capable of sustaining the learning without the pressing participation of a teacher's mediation, allowing for the accommodation of a larger number of students per group in each course.

3. PEDAGOGIC CONTENT SUSTAINED BY THE LEARNING ASSESSMENT

In order to invest in distance education, it is necessary to establish practices and methodologies that make the system financially viable as well as maintain quality of the learning process.

Taking into account the previous discussion related to limitations associated with assessing learning in an online course which require a very high involvement on the part of the mediators, one possible solution would be the adoption of tools that could accomplish a portion of this assessment allowing the teacher to assume a more distanced position, intervening only in specific cases when such intervention is necessary. Such an approach to allow the learner to proceed in a self-paced manner, drawing on his or her self-directed learning skills.

Analyzing the reasons that require a low number of students in on-line classes in order to not compromise the quality of the learning process, it seems that the primary reason is the large quantity of interaction needed between professor and student. When contemplating the teacher's basic functions in the on-line classes, they can be described as: a) to motivate the students; b) to answer questions; c) to assess learning; and d) to redirect students to the available content.

In general, the learning content made available in the on-line courses are presented in a static way. Usually, such content is divided into several modules, with

[1] Professor Arnaldo Niskier, in his book "Distance Education: the technology of hope, São Paulo: Loyola, 1999", named the Distantce Education as "Technology of the Hope".

formal learning assessments in the end. The illustration below (1) shows this general outline.

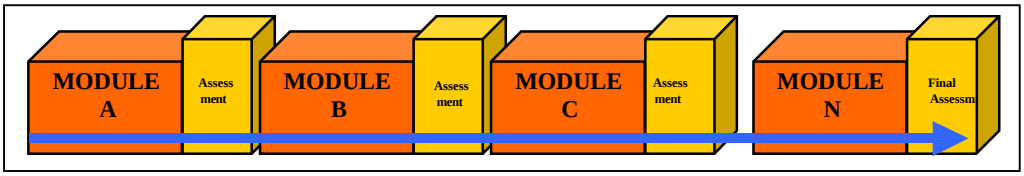

Illustration 1

The teacher works closely with the students, motivating them, assessing learning, answering eventual questions and redirecting them to the available content as well as introducing them to other experts. At this time, the teacher also makes use of other resources, such as books, websites, and videoconferences. This way, the static model gains mobility (Illustration 2).

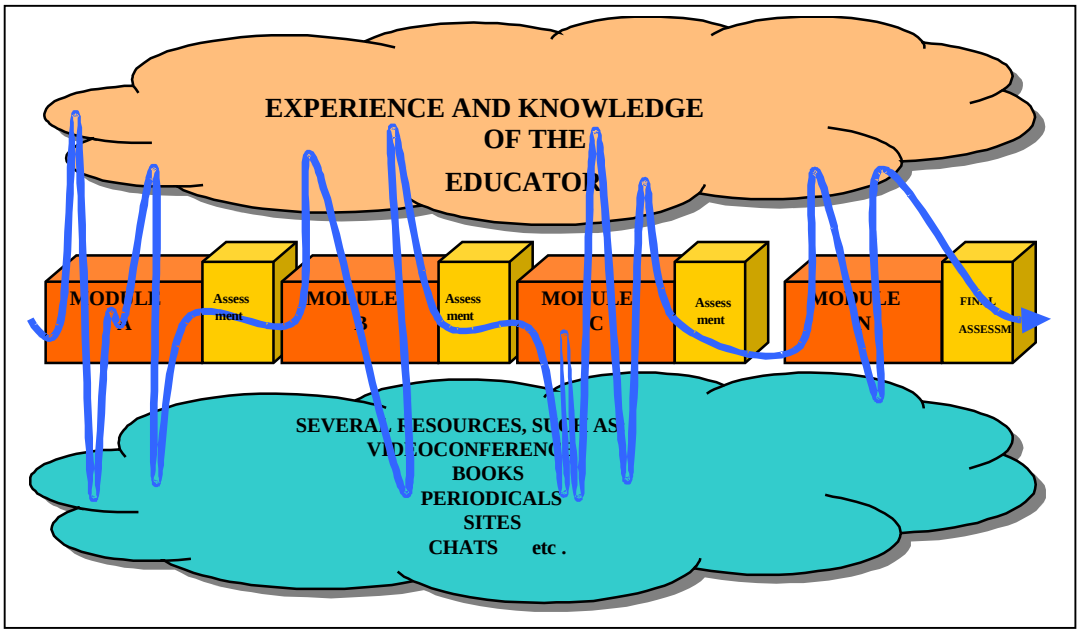

Illustration 2

As can be observed, this mobility is based on the teacher and in the resources that he or she can direct learners to. This leads to as one can notice, a great deal of the teacher's time to assist the needs of the students' individual learning.

Very often the kind of assistance the teacher gives the learner is based on the kinds of information that is already present in the course. The teacher has to re-package this information in a different way to satisfy the learner's curiosity. Students often want to verify the same information over and over again.

Using the educational objectives classified by Bloom for the cognitive domain and incorporating the three evaluation types for the assessment of these objectives (Bloom 1976), the following format was adopted for the organization of the content and

assessment methods in the artificial intelligence-based application. This removes from the teacher the operational load of making the teaching-learning process flexible (shown previously in the illustration 2) and transfers this function to the content itself using the application. That does not mean that the teacher's role is eliminated in the assessment process, but it does mean that the application relieves the teacher from answering routing questions or questions based on the same content, thus allowing the teacher more time to address more important questions related to the learning process. It will be the job of the development tool for the distance learning programs to offer the basic conditions for the elaboration of "assessment curtains"[2], capable of automating most of the activities related to the correction and reorientation of the roads to be traveled by the students during the accomplishment of the courses.

The adoption of artificial intelligence-based modules would be, in this case, an effective tool, since they possess the following characteristics:

- Capacity to evaluate the student's performance continually;
- Diagnosis based on the conceptual map previously elaborated where the student is guided to a new study module considered more appropriate to the level of demonstrated knowledge, allowing him or her to learn the content better;
- Redirection will happen to guide the learner to new content areas if the assessment module notices deficiencies that should be corrected;
- Opportunity to use a variety of media that will be available to facilitate the interrelation between the student and the several concepts, allowing him to choose the best medium for understanding the concepts.
- The system itself will guide the form in which the content should be presented, always looking for the most effective form for the attainment of the learning objectives;
- Once the minimum requirements for learning are met, the system returns to the basic module allowing the student to continue their study, taking the shortest road as reference.

Illustration 3 presents, in a schematic way, the conceptual structure of the relationship between the module at the basic level and the successive higher levels possible according to the student's development.

[2] The metaphor of the curtain derives from the idea of something that separates an environment from another, preventing the sight of what is beyond, but that allows going through without a lot of effort.

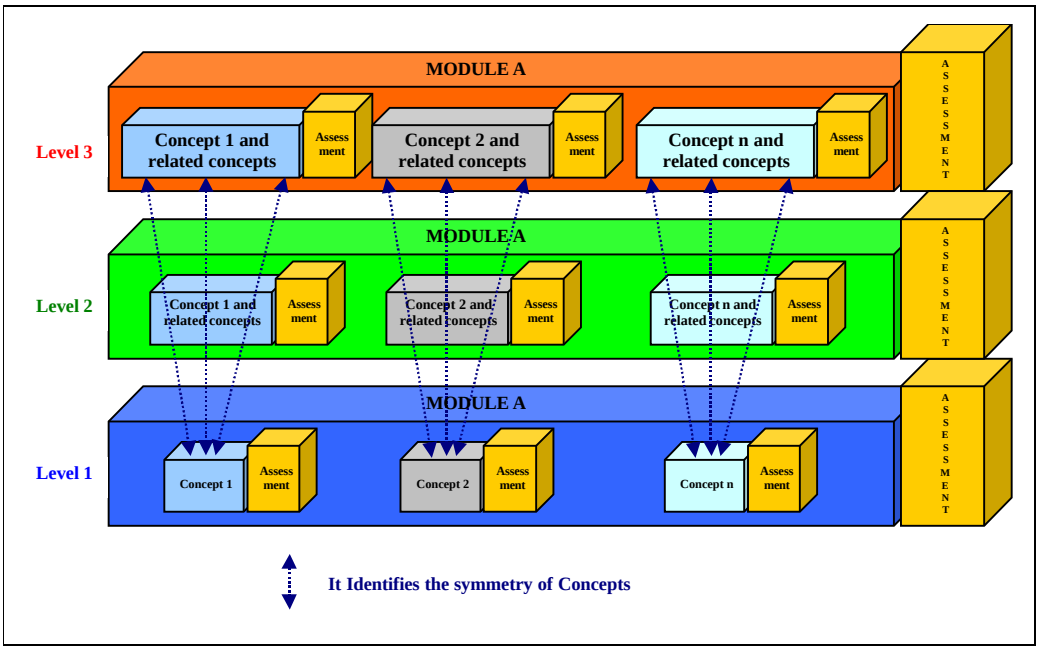

Illustration 3

It can be noticed that at the end of the learning process of a certain concept, the student will take a formative assessment, which will identify the learning of such content. In case some deficiency is noted in the conceptual symmetry, the student will be sent to a higher level in order to develop the same concept, however in a different way (incorporating more media and sub-concepts) than the one presented in the previous level. This way, we are able to diagnose eventual flaws in the teaching-learning process. We have, then, implemented the Diagnostic evaluation.

It should be understood that each concept has its own assessment form, presentation of educational materials and mediums. Therefore, in the computer implementation of such a concept, it will be necessary to make it possible for the teacher to adhere to these requirements. A simplified model of content organization of each concept is shown in Illustration 4. A synthetic vision of the way the nucleus of inferences of the system manages the assessment process is presented, integrating the studied concepts. As can be identified, a Concept is composed of three basic parts: Pedagogic Proposal; Pedagogic Contents and Mediums, and Questions for Verification of Learning.

All those contents are stored in databases that facilitate their maintenance and subsequent and constant recovery. For the recovery of such information, techniques of artificial intelligence are used, specifically Case-Based Reasoning (CBR). This will solve the problem of symmetrical migration among the concepts, given a learning problem.

In order to provide automatic learning assessment, the teacher should supply the most appropriate Criterion of assessment for that specific content. If there is compatibility between the base of questions and the assessment criterion, the system will set the assessment up automatically.

Once in the assessment process, the student will have two exit situations. In the first one, he or she is able to successfully complete the proposed questions. This way, he or she will have marked in the report card that such a concept was assimilated (OK). The second exit will identify that the concept, in the presented conceptual level, was not assimilated. This way, if there is any higher conceptual level of content, the student will be sent to that one. In case is the student is already at the last level, it will be marked in the report card that such a concept was not assimilated (X), and the student will be directed to either a “real” or “virtual" contact with the teacher. So it is in this successive fashion, concept after concept, level after level, module after module, that the course is built by the teacher and later presented to the student.

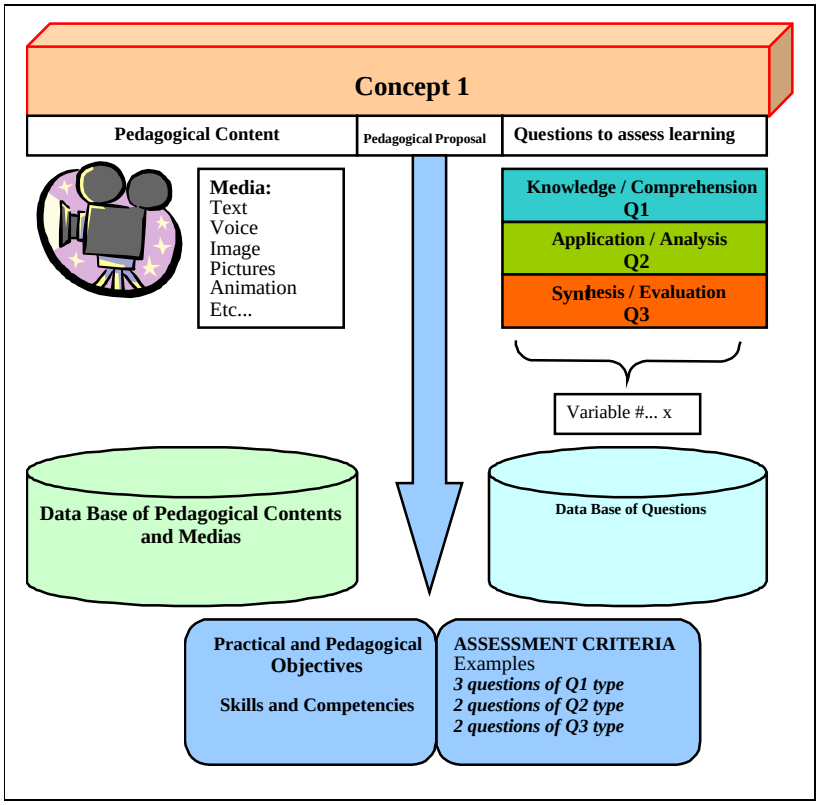

Illustration 4

It should be pointed out that the adoption of artificial intelligence tools will facilitate the development of applications in Distance Education with pedagogic content capable of sustaining its own assessment process, managing the learning better, leaving the teacher more time to, intervene in cases that are identified by the system itself based on the established conditions.

The possibility of generating different content for each teacher, similar to the development tools described based on the methodology of “assessment curtains” will bring not only larger pedagogic flexibility, but also allow for the creation of courses that will meet the unique needs of learners and educational and training organizations.

4. CONCLUSION

This paper proposed an artificial intelligence-based application to provide the learner-instructor interaction and teacher feedback and assessment that is so critical to the learning process in distance education. This application will relieve the teacher from answering routine questions or questions that have already been addressed in the content, and provide the teacher more time to address more fundamental questions related to learning. The application will diagnose student problems and provide feedback and will only direct the more difficult questions and issues for the teacher to address. The application when utilized well will be a major time and cost saver for distance education.

The challenge is to make sure that there is an appropriate balance between machine-student interaction and assessment and teacher-student interaction and assessment.

5. REFERENCES

BLOOM, B.S. et al. **Taxonomia dos objetivos educacionais - domínio cognitivo**. Porto Alegre-BR: Globo, 1976. (Translated from: BLOOM, B.S. et al. ***Taxonomy of Educational Objectives, Handbook 1: Cognitive Domain***. Addison-Wesley Pub Co; ISBN: 0582280109, 1984.)

HACK, Luciano Emílio; GELLER, Marlise; TAROUCO, Liane M. R. **O processo de avaliação na Educação à distância**. Proceedings of the 4º Workshop de Informática na Educação **.** UFRGS: Porto Alegre-BR, 2000.

NISKIER, Arnaldo. **Educação à Distância: a tecnologia da esperança** , São Paulo:Loyola, 1999.

SOUZA, Telma R. P. **A avaliação como prática pedagógica**. Available in http://www.abed.org.br/artigos.htm

6. BIOGRAPHIC

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