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Incorporation of constructivist techniques for the improvement of the tutored teaching in computer based classrooms

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Article Information

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Abstract

Purpose:
The purpose of this article is to study the teaching dynamics in practical classes and the study of the academic results evolution after the introduction of constructivist techniques in a university class, where traditionally it was strictly used a constructivist method, based on guided teaching using tutored practices.

Method:
The study focuses at study groups of a class with a high number of practical exercises, which started to use a new tool ICT (eTUTOR), developed by the authors of this article, in order to improve documents management and students' queries management. This tool made it possible to gather data from the students´ works and their interaction with the teacher during the practical classes.

Result:
During the research the analysis of the obtained data suggested modifications in the teaching methodology. Those were applied in the last academic course of the study, leading to improvements in the students´ academic results.

Discussion & Conclusion:
After the research the authors propose the introduction of the new constructivist methods in order to improve even more academic efficiency of the students, stimulating self-learning and decision-taking, which are fundamental in technical studies.

1 Introduction

Superior education is and must be in a continuous process of improvement and updating. Teaching innovation is necessary during all the learning stages. We, the teachers, have a moral obligation to try to improve, class after class, the learning results of our students, increasing thus their knowledge level and skills in the matter dealt with. Currently, the beginning of the new teaching plans, the low curriculum incentive that mean good teaching practices and budgetary cutbacks cause that majority of professors reconsider the situation and concentrate their efforts at other, more "productive" tasks. Nevertheless in this article we would like to demonstrate that innovation in the class in order to improve the students´ academic performance is possible, by releasing the teacher from the tasks which he is not supposed to do in his daily teaching work.

During the last fifteen years the ICT tools have been leading players of the above mentioned innovation [1]. Nonetheless, despite wide availability of computers and internet connections in our universities, it can be said that only in few occasions this capacity of the computing technology is enjoyed and made the most of for the real teaching tasks [2]. Numerous international studies and quantitative surveys tried to describe the necessary conditions for introduction and adaptation of ICT in the schools and universities [3, 4, 5].

In technical studies teaching, which is supposed to prepare and train professionals who will coexist (in their future work) with computing technology as work instrument, the importance of computing management (concepts, or skills) is not reflected in the studies plans. We can confirm that technical studies students in general are not able to make the most of their present and future working tool. We are doing something wrong. We tried to promote the use of computing technology within our working group with examples and awareness-raising of its importance. As Technical Drawing teachers, we want our students to know and skillfully manage current computers-assisted drawing methods, without forgetting sketching.

The origin of our work, which we consider "Teaching Engineering", consisted in the introduction of an ICT tool with the aim of improving our teaching methods, especially the practical sessions. Our group introduced into one practical session class at the university an unbiased system managing queries eCRONOS® [6], which is able to register the number of queries raised by the students during the practical sessions, together with the waiting time before they were attended and time needed to finish one query. That research led to new development of the tool and further studies, described in the present article.

At the beginning, when the EHEA was introduced at our university, we developed a new document management

system, which integrated the queries management system with the correction of the errors, detected during the previous studies. The new tool, called eTUTOR, helps improving the communication between the students and the teacher during the class. Moreover, after the first year of data compilation on the students' behavior during the practical sessions, we could establish a series of procedure parameters in order to improve our teaching activity and the students´ learning results. Those parameters made it possible to answer the following questions: Would it be possible to automate the solution of the most common students´ queries? Could the teacher focus at the solution of the more complex queries and motivation of the student during the practical sessions? As a result, during the second investigation year, the focus of the study was inclusion of constructivist techniques into a class, where traditionally behaviorist techniques were used.

2 Material and methods

The teaching plan model used at our teaching sessions is under a behaviorist framework based at tutorials, contents planning and correction of the finalized practical exercises. In this scope, the knowledge of what really happened during the class allows the teacher to modify the methodology or to correct possible errors in the contents planning. The eCRONOS® system, developed and used by the authors between 2007 and 2011 changed completely our teaching experience during the practical sessions, becoming a germ of an idea of a new system called eTUTOR.

The whole teaching research related to eCRONOS® and eTUTOR took place in one class taught at our university, with 26 workstations, one teacher workstation and one file system server connected via Ethernet network (fig. 1). This kind of equipment is commonly found at majority of university computing classes. The introduction of eTUTOR system coincided with the studies plans modification at the Spanish universities in 2010. The study groups described in the present article study the subject Technical Drawing, first year of Engineering Studies, during 2010, 2011 and 2012. Each group was formed by 20 students, realizing 2 hours of practical studies, using the drawing software Autodesk® AutoCAD.

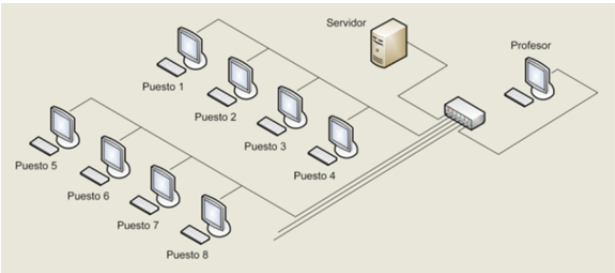

Fig. 1 Interconnection of computing equipment

2.1 eCRONOS® system

The first eCRONOS® implementation consisted of a server and a client programs, executed at each student´s workstation. CRONOS 1.0 was a simple queue management system, inspired by the studies of [7, 8, 9, 10, 11, 12] and by queues management systems commonly used in many business and administration services. It was only showing on the screen of the server computer (fig. 2), visible from the whole classroom, the number of the student workstation requesting help. CRONOS 1.0 established the order in which the help requests were generated and showed on the screen the student workstation requesting help and to be attended next. At the end of each query the teacher indicated to the server program that the query was finalized and that they were available to attend the next student. Then the server program displayed on the screen the next workstation to be attended.

Fig. 2 eCRONOS® screen in a class

The second implementation renamed eCRONOS®, included a possibility of recording waiting times and time spent with every student, as the teacher indicated then they started and when they finished each query (fig. 3). The experience of eCRONOS® application showed that the system could become a powerful tool for studying the dynamics of the practical sessions, related with the student queries. Indeed, since the moment when this ability to record waiting times and queries duration was introduced, eCRONOS® was able to provide process statistics

Fig. 3 eCRONOS® interface for a help request

2.2 eTUTOR system

eTUTOR system is a group of practical sessions management computing programs which leads the student through different tasks he or she is supposed to carry out during the session. The system takes control automatically when a session is started at the student workstation, asking the student to introduce their ID number and password. At the beginning eTUTOR informs the student about the state of their practices record, which practices are they supposed to carry out in the current session, how much time they have to do so and their partial qualifications. Once the session has started, the system leads the student through the first part, where new concepts and/or skills are used, leaving the control to the student in the second part.

The presentation of the tasks to be carried out during the practical session and of the tutorials how to accomplish it is based on a sequence of pages containing working units (fig. 4). The first page contains the statement of the

practice, the second a general description of the concepts to be dealt with during the session and the third and the following ones contain the steps to be followed in order to accomplish the session (each page contains one step with the description of the task and explanation how to achieve it). In the second part of the session the pages only contain the tasks to be achieved and the student has to solve the exercise applying the knowledge and the skills acquired in the previous sessions and the concepts learned in the first part of the session.

Fig. 4 Presentation of a page in eTUTOR

As a complement eTUTOR counts with a help module, so that the student can look for a solution to problems that may arise during the session. That module is fundamental for the teaching research. A help was introduced concerning general concepts (theoretical and practical), that the student should already know, but that they can consult in order to reinforce their knowledge. Another kind of help, called specific, was also introduced in order to complete the learning of the new concepts (theoretical and practical), which are being acquired during the corresponding practical session in a tutored way.

eTUTOR help consists from three levels of hierarchy. The first level presents general subjects of the course (theoretical and practical). The second level is divided into the previously studied themes in order to make the student distinguish in his search. Finally, the third level contains information about the chosen theoretical or practical subject (fig. 5).

Fig. 5 Second and third level help in eTUTOR

In every moment, if the student needs it, he or she can access the main help or a specific help menu of eTUTOR in order to solve a doubt or a problem during the practical session. If this help of the program is not enough, he or she can request the presence of the teacher via managing consults module (eCRONOS©) incorporated in the system. With the objective of encouraging the search of the solution, the student must have consulted the third level of help of eTUTOR in order to be able to request a consultation to the teacher. Till then, the program keeps the option of help request disabled. Once the teacher´s help is requested, the student can keep on searching in the help menu or to try to solve the problem until being attended by the teacher. In that moment the teacher has to press a key in order to indicate to eTUTOR that the request has started and the system shows on the screen of the student the help page from where they made the request. This allows the teacher to evaluate the quality of his or her search and to determine if it is necessary to repeat the search process. If the student solves the problem before the teacher arrives, they can cancel the help request and to continue with their work.

eTUTOR system has a register of the progress of each student. It stores the consulted pages, the time spent on each page, the search of help on determined concept and/or ability and help requests of the teacher (with the associated waiting times of the student and their attendance time). The process of all this information makes viable the statistical studies of learning dynamics and of ratings based on the number of requests in the help menu of the system and to the teacher.

A module of the program eTUTOR processes in real time a part of the data on the students´ progress, showing the teacher on the screen of his computer the “density of requests” per workstation and per time unit (session, subject or course). This function of the system, called “Mapa de Densidades del Aula”, MDA (Classroom Densities Map), allows the teacher to visualize which students have more difficulties to carry out the practices and therefore to focus the attention at them, so that they would not slow down their continuous learning (fig. 6).

Fig. 6 MDA during a practical session in class

In order to check the acceptance grade of the new system implemented in the classroom, the students were asked to fill out a survey with 10 questions related with the practices of the course and eTUTOR. Thanks to that survey, we were able to evaluate the interactivity of the system, the quality of the contents (both of the tutorials and the help menu), compatibility level compared to the rest of the course, general satisfaction and its acceptance by the students, among others.

3 Results

When the new eTUTOR system was designed, the authors hoped to improve the document management of the practical sessions by incorporating the request management system eCRONOS©, used in the previous courses. The new functionalities of the practical sessions management system introduced in the 2010-11 class of the Technical Drawing of EHEA course achieved the proposed objective of improving the documents management used in the practical sessions. They also allowed getting new data about the teaching dynamic during the sessions, which reflected problems of the used didactic model.

During the first analyzed course the students used the eTUTOR help system during an average time of 12.6 minutes, which means 10.6 % of the total working time per session. Regarding the requests for teacher help, there were 56 requests in average per practical session. A high percentage of the students´ requests, close to 64%, were directly related with the doubts concerning the use of the program [AutoCAD], which was used in the practices: How to access an order of the program? Or how an order is managed? This kind of questions, which we call Quick Questions (CRs), is answered very quickly. The average time of attention for this kind of questions was 23 seconds.

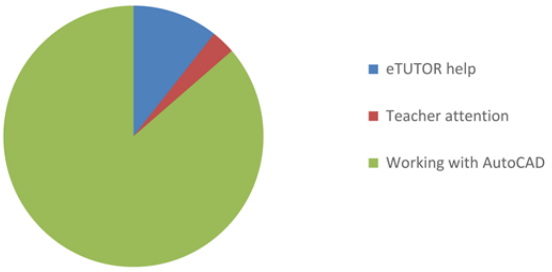

Fig. 7 Working percentages · AY 2010-11

Those data suggest a need to reconsider the help module of eTUTOR functions and the methodology used by the teacher to attend the students. Most of the CRs (Quick Questions) should be solved automatically, thanks to the help system. The academic results of the first course students did not show significant changes compared to the previous years, except for a notable improvement of the dropout rate in the practical sessions. It passed from an average of 22,3% during the last 5 courses to 7.1% during the course of this research.

During the second analyzed course the methodology used by the teacher to attend the students was modified in order to avoid the students requesting help from the teacher with every kind of problem or doubt they face, without dedicating the necessary time and trying to solve it by themselves. Since then, in order to ask for help from the teacher, at the moment of the request the students are obliged to visualize the third level help page directly related to the request they were about to make. That way, until the student does not find the help in the eTUTOR system related to the request, reads it and tries to understand, the teacher does not attend them. The students who solve their problems by themselves with the help of eTUTOR get better final qualification at the end of the practical session. It is a way to encourage effort and self-study.

The statistical results of the requests made to the help system and to the teacher changed visibly with the modification of the methodology used by the teacher to attend the students. The consultation time to the help system of eTUTOR grew 72%, dedicating around 22 minutes per each session. This means 18.3% of the total working time. The number of times where the teacher attended a student decreased 23% and the number of CR went 50% down. Those data are linked with learning improvement of the students, reflected in an improvement in their qualifications, both in the practical sessions and their final grades.

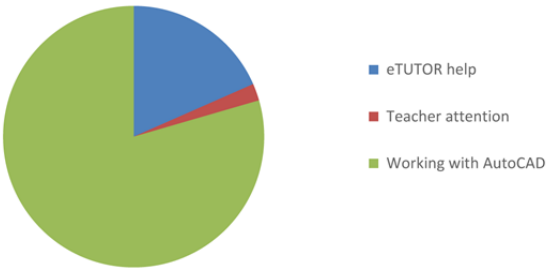

Fig. 9 Working percentages · AY 2011-12

In the evaluation of the system and the used methodology by the students, made with help of a 10 questions survey concerning eTUTOR modules (presentation of contents, help, request for teacher´s help,…) were obtained the following results: for the first class of the study the global evaluation by the students was 8.2 points out of 10. For the second class it decreased to 7.6 points out of 10. The variation between both classes was mainly due to the methodology used by the teacher to attend the requests.

4 Discussion

Time ago, the use of digital technologies was characterized by the teaching focus of the traditional "teaching machines". Due to the growth of the computing technology in the personal environment during the 90's this view turned into a more important emphasis of the constructive and communication potential of the TIC [13, 14]. In the case of this research, the philosophy of the "teaching machine" is partly regained in a certain way, with the use of the tutorials, as a previous step for the structure of learning. Although the intention of the authors would be to work with this base, related with behaviorist models, it was proved that the introduction of certain constructivist parameters improves the learning experience.

The studies about the learning methodology based on constructivist models suggest it. The constructivism is a theoretical framework based on a model change from education focusing at the teacher to another focusing at the student [15]. The constructivism theory, influenced by the work of Piaget and Vygotsky [16, 17], stimulates the students in order to build their own cognitive schemas based on their individual experience and on the application of the gained knowledge directly at their environment. Constructivism directs the students to participate actively in the learning environment, to develop social and interpersonal skills, to enjoy the learning, to understand the content being taught and to learn to think in an efficient manner [18]. The pedagogical practice, from a constructivist point of view, indicates that the method of the cognitive construction is more important than the learning of the contents itself. If the first is mastered, the second arrives naturally.

The introduction of the eTUTOR system in the classroom modifies the pedagogical action plan, assimilating a self-learning stimulus to the student, who thus improves directly and indirectly the cognitive development. Directly, multiple studies, including the present one, confirm that self-learning visibly improves the academic results of the students. Moreover, the methodology applied with the help of eTUTOR system makes it possible for the teacher to focus at solving the more complex doubts and to motivate the students during the practical session. Thanks to the eTUTOR real time display module, the teacher can adjust the time unit in the system parameters in order to visualize the number of questions per session, per didactic unit or per academic course. Thereby the system quickly identifies the students who have or had more problems to complete the practices of the subject. This, together with the fact that the teacher has more time to develop his teaching activities, allows him to monitor in a more exhaustive manner the students with problems.

The students´ evaluations of eTUTOR and of the methodology applied during the second academic course could indicate a poor functioning of the implemented system. However, the academic results of the students improved visibly, which makes us convinced of the effectiveness of our system. Possibly the student is not sufficiently prepared to face this learning model, therefore we should try to improve the communication with them in order to motivate them even more. The application of the continuous evaluation methods in the EEES in a subject with such a high practices content turns out to be complicated, due to the volume and the qualifications management which need to be done. This complexity affects the students, who sometimes feel overwhelmed and discouraged, because of not knowing clearly their learning evolution.

In the current academic course a new TIC communication tool, eCAMPUS, is being tested between the teacher and the students, together with eVALUA, a technical drawing exercises automatic correction system based at AutoCAD. We expect that those tools will improve the general quality of our teaching and increase the motivation of the students. The correction system frees the teacher from the qualification tasks. It enables him to concentrate his attention at the guidance of the student. For its part, eCAMPUS allows the student to follow their learning progress in real time and from any electronic device. The student receives notifications and personalized exercises according to his or her progress.

The ultimate goal is to reach a balance where the teacher only needs to act like a guide, offering to the student a learning tool. Once the student is capable of managing the tool of the practices with ease, AutoCAD in the case of this study, it will be possible for them to use it to solve complex engineering problems, where they are free to choose the steps to follow and thus improve their autonomy and their decision-making.

5 Conclusions

Introduction of new technologies to the teaching activities does not always imply improvement of academic results. Sometimes it only facilitates or simplifies the teaching tasks inside or outside the classroom. It is even possible that a teaching improvement does not conclude in what was initially expected from it, worsening the learning results. However, in the case of study presented in this article the introduction of the eTUTOR system in the FLUOR CAD classroom meant a notable improvement of our students´ learning. At the same time it freed the teacher from the task that he was more commonly doing and had no reason to do. This way eTUTOR allowed us to go further in the teaching dynamics knowledge during the practical sessions. We could also refocus our teaching activities towards constructivist models of guiding and helping in the self-learning process of our students.

Despite the decrease in the valuation by the students of the methodology used in the classroom, we consider that we have to continue the process of introducing new constructivist techniques, in order to strengthen autonomous and interactive learning of the concepts and skills in our courses.

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