

TRANSFERRING EXPERIENCE IN DIGITAL BOARD AND CLASSROOM RESPONSE SYSTEM FROM THE COMPUTER SCIENCE FACULTY TO HIGH SCHOOLS

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Abstract

From the university point of view, the European Higher Education Area requires additional techniques to improve motivation of students in the theoretical sessions. In addition, the change of the Spanish Universities system following the European Credit Transfer and Accumulation System (ECTS) is imminent. This change brings the need of a change of orientation in lectures, and the adaptation of former teaching methodologies into different active learning based ones. From the perspective of High School, it is also found the same problem to improve the motivation of students in the classroom. For that reason, we believe that is necessary application of new techniques to develop lessons and issues theoretical practices, more attractive and interesting for students. It has been found both in the University experience as the experience in the High Schools to define teaching more focused on practice, use cases and activities, which involved actively to the students in order to encourages their motivation, participation and thus improve their learning. This paper presents an analysis of our experience with portable digital boards and classroom response systems, which is compared with classical digital boards. This is presented and evaluated how useful are these new technological tools in the classroom. On the one hand, the proposed work improves the experience carried out in the implementation of Problem-Based Learning (PBL) in the field of Electronics Technology at the University of Murcia. Specifically, our experience has been using portable digital board and a classroom response system. First, teachers and students can move around the classroom while leveraging the capabilities of an interactive board with the portable digital board, which is like a "tablet" wireless. The results have presented that the methodology is positive for students and teachers, since this enhances the involvement of students in the stages of the PBL in the theoretical and practical sessions. On the other hand, this experience and work has also been implemented and evaluated in a High School, where teachers with more than 20 years of experience have incorporated in their class the use of the digital board. The results at the High School have been positive as in the university. Following the students and teachers opinion, the conclusions is that in both scenarios should be promoted the use and integration in the classroom of the new technologies.

Keywords: Innovation Active Learning, Collaborative and Problem-based Learning, European Higher Education Area.

1 MOTIVATION

From the University side, we are defining new teaching models in order to adapt the current system to the defined in the Bologna declaration of the European Space for Higher Education (Bologna model), also known as, the European Credit Transfer and Accumulation System (ECTS). This new conception of the higher education is defining a substantial set of changes to the current model. For example, new tools, methodologies and teaching techniques are emerging in order to address and satisfy the requirements of the Bologna model. The new active teaching methodologies [1] are designed to involve to the students in their own learning process [2]. In order to reach this purpose, the lectures from the professor as medium to carry out the teaching process are being relegated, in order to open the opportunity to the new learning models focused on the student participation.

From the High School point of view, it is found a decrease in the level of student attention and interest in their learning, which is due to a lack of motivation [3]; this is leading in most cases in school failure [4]. For that reason, the main goal of our research is to increase the student motivation as such to reach from the students a higher dedication and interest for learning [5, 6].

The method used in our project is based on: on the one hand, focus on the contents and hours used for experimental training based on instrumental, procedural and attitudinal content, since this part of the subjects, where the student is in direct contact with real developments, real solutions and real use of their knowledge are more interesting for the students, what means a greater transcendence in their learning. On the other hand, the evaluation criteria established has been adapted to the redefined methodology, taking into account for the evaluation activities based on the digital board and the use of the new technologies. In the paper is presented some of the new evaluation activities based on digital board. Finally, it is being developed a set of applications and activities to use the digital board and the computer lab. Remark, that in order to evaluate the methodology with diverse skills, it has been considered for our study in the high school the next different areas: mathematics, computer science, social language and sports.

Both models, the focused on the University as the focused on the high school, aim is to define new teaching methods that encourage the student's motivation, cooperation, and assimilation of content i.e. understanding. Specially, since our background is from the computer science area, our approaches are based on the use of new technological tools that are coming into the classroom. Specifically, from the University since it has been evaluated a novel portable digital board, which is as a "tablet" and a classroom response systems, based on IrDA, and from the high school the use of digital board.

The rest of the paper is organized as follows; Section 2 presents an introduction to the digital board and portable digital board, and its applications for the Learning Based on Projects methodology (PBL). Section 3 describes the teaching methods used in two of our subjects from the area of Electronics Technology: Home Automation and Microprocessors. Section 4 describes the methods followed in the subject of social language in the High School. The results of our experience have been assessed through surveys to the students; they are discussed and presented in Section 5. Other issues observed, experience and lessons learned are discussed in Section 6. Finally, Section 7 concludes the paper.

2 DIGITAL BOARD

Digital board have enabled to the computers to be able to display multimedia content over the classroom wall using a projection system [7], in addition this allows to interact with the content, enabling direct action on the surface [8] to annotate, highlight certain parts of the image, etc. The emergence of the interactive digital board in classrooms has marked an important change in the methodology and expectations that are placed on the new technologies for teaching. In [2] is presented empirical results of the advantages of the digital boards in the U.S.A., UK and Australia, concluding with the reached increase of the attention and motivation in the classroom from the students. The proposal presented in this paper is defined in two very well differenced scenarios, on the one hand, the integration of the interactive digital board in a high school, and on the other hand, the integration of the evaluation of the digital board in a portable digital board [9].

The portable digital board offers to use its own surface to interact, instead of the projection surface on the wall. Since, the tablet is portable; this allows to the professor use it in different classes, which is very interesting at the University, since it is usual that each lecturer and subject have its own class. The work described in [10] presents an example of a similar application for the teaching of electronics. The advantages from this portable digital boards are, first, this allows to make interaction with the common viewing area to all students since it is avoided that the students need to approach to the large-format board which difficult the vision of the board. Second, It allows participation of multiple students in its multi-user mode, with different portable digital boards. This facilitates the integration with an additional classroom response system, which is going to be presented in the next section. Third, the mentioned multiple student participation allows defining collaborative and competitive activities. Finally, when some student presents some physical disabilities, this solution makes able to them the participation.

3 IMPLEMENTATION OF PORTABLE DIGITAL BOARD FOR PROJECT BASED LEARNING (PBL) AT THE UNIVERSITY OF MURCIA

In the Electronics Group of the Computer Science Faculty at the University of Murcia has been implemented the Project Based Learning (PBL) as a method to increase engagement, participation and motivation of students. PBL has a new teaching model where students "learn to learn" in

workgroups [11]. The main difference with the traditional teaching, where teachers/professors make use of the lectures at the beginning, and the application of the knowledge is a posteriori, is that with the PBL the students receive at the beginning only some initial concepts and then a task is defined, which they need to solve, i.e. find a solution. This task is done cooperatively in small groups, this methodology improves the development of their knowledge and skills since this is reached through themselves effort and with the motivation of solve the task successfully. PBL has been already evaluated in Spain, the first place was the Polytechnic University of Catalonia, where it was integrated in some of their subjects from the Computer Science Faculty [12], it is also being extended to other universities in Spain, and finally the University of Murcia has also a long experience with PBL [1, 14]. In addition, the University of Murcia is evaluating how to improve the PBL with tools such as the mentioned portable digital board and classroom response system. The main reason to include these new tools, is that it was identified a problem in the PBL implementation for the initial theoretical explanations, i.e. lecturers. The aim of this paper is to combine the use PBL with a portable digital board and a classroom response system, in order to encourage student motivation, since it is addressed as one of the main areas and objectives to achieve by the professors at the University [15]. Other studies have been based on the use of new technologies for course management [1], or the use of Internet services [16]. In this paper we conclude that the use of portable digital board and classroom response system complement to the mentioned electronic tools and reach that students involve in their learning. The initial objectives of the project were focused on doing more entertaining, engaging and interactive the lectures with the use of these new technologies. The next sections explain our experience at the University of Murcia, and how it was transferred to the Monte Azahar High School.

3.1 Methodology used in Microprocessors and Home Automation

The experience with PBL in the subjects of Microprocessor (MIC) and Home Automation (HA) is described respectively in [17, 18]. Both subjects are limited to fifteen students, what has made easier the integration, experimentation and evaluation of the methodology. Our experience with PBL is from the academic year 2004/2005.

MIC methodology follows the philosophy of PBL, through a process of gradual implementation over the past five academic years. The most important adaptations to the PBL include development of tasks by workgroups, definition of a project/use case and definition of a set of deadline for the deliverables of the solutions for the project. The lectures have been limited to the initial class for introduction to the concepts from the area. This allows that the rest of the can be used for workings with the groups inside of the laboratory. They need to deliver small reports/deliverables during its development, in addition with the purpose to guide to the students, it is eventually performed the allocation of special sessions, where the groups discuss with the professor about his projects in front of all the members of the class, in order to clarify any initial doubts that may arise. The final correction of the project is conducted by the professor over the final report and a public presentation.

HA methodology is based on, on the one hand for the introduction to the concepts and theory part have been defined a set initial of 4 lectures, which are combined with exercises guided by the professor. These exercises introduce to the student in the scenario of the real project. On the other hand, for the training part, these are defined different workgroups in order to promote the interaction between the students; it was decided to only two groups of eight participants since the reduced number of vacancies available for this student. A weekly session is used to track individual and groups progress, solve questions, and answer questions to the professor about the chosen approach. In addition, to ensure that all the students contribute to the workgroup, it has been defined that each student presents his contribution during the current week and what's going to do for the next week.

Remark that HA and MIC maintain the lecturers, although it has been reduced, the goal is to enhance students' ability to manage projects with their own resources and knowledge, with the difference to the real world, that the professor is there to support when they need to solve questions or need to discuss about some decisions. This methodology is achieving to improve their self-sufficiency attitudes [19], which they are going to require in their real professional life. The next subsection presents as these sessions have been improved with the use of portable digital board and classroom response system.

3.2 Examples of application of the portable digital board and classroom response system

Portable digital board can be used at many stages of the educational process. In this work, it is presented its application in the initial theoretical sessions and specific explanations during practice

sessions. A traditional method to increase student participation is through general surveys or individual questions, but these methods usually involve only to a reduce number of the students. For that reason, it has been also considered the inclusion of the classroom response system. This system allows making a survey of all the students very quickly, which allows checking whether students have reaching a good understanding, discovering the opinion for specific questions related with the topics addressed etc. In addition, when some student wants to add some clarification about the question, he is able to use the portable digital board. Remark that this methodology allows that the answers are built by them in a collaborative manner. In addition, this opens the opportunity to discuss about the topic between the students and the professor. This constructive methodology ensures that students assimilate concepts much more effectively and to maintain a more active attitude in class. The methodology for the evaluation of some basic concepts on the subject is:

- Definition of test questions, with four possible answers (choices).
- Survey of students' opinion with the classroom response system.
- Offer the portable digital board to one student that answered the correct option, and another one that did it wrong.
- Justification of the response by both students.
- Open discussion with other students about: which is the good reply?

Finally, the professor explains the solution with the help of the portable digital board. The portable digital board used is the model Interwrite Mobi, and the classroom response system is Classroom Performance System IR also from Interwrite. The Figure 1 presents an example from HA, where is asked about the gas properties and its relation with the gas sensors.

1. ¿Dónde se acumula el butano cuando hay un escape?



- | | |
|--|--|
| a. Hacia abajo porque el gas butano es más denso que el aire. | c. Hacia abajo porque el gas butano es menos denso que el aire. |
| b. Hacia arriba porque el gas butano es más denso que el aire. | d. Hacia arriba porque el gas butano es menos denso que el aire. |



Figure 1. Example of survey with the Classroom Response System.

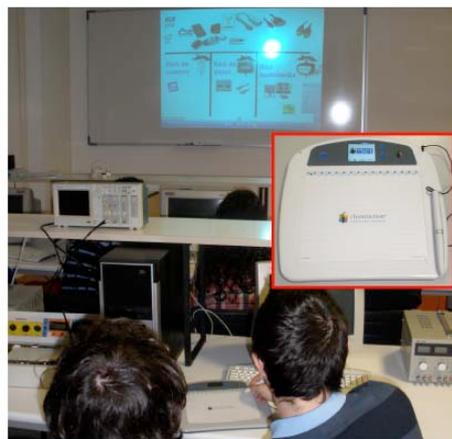


Figure 2. Example of competitive activity with the portable digital boards.

In addition to the classroom response system, such as mentioned it has been defined other activities based on the portable digital board. The activities defined are divided into two groups, on the one hand collaborative activities, and on the other hand competitive activities. These activities are supported since the screen can be divided to two or more groups. These mechanisms give the option of a further discussion on the proposed questions. The methodology followed in these cases would be based on two groups to solve the exercise, which is finally analyzed by all the students and the

professor to detect errors and suggest improvements. Figure 2 presents how the screen is divided into two groups. The left side of the Figure 2 presents a cooperative activity, which is based on the classification of different technologies depending on the type of home automation network to which belong (data, control or multimedia). The right side of the Figure 2 presents a competitive activity based on the definition of the right location for home automation sensors.

4 IMPLEMENTATION OF DIGITAL BOARD FOR COLLABORATIVE LEARNING AT THE MONTE AZAHAR HIGH SCHOOL OF LAS TORRES DE COTILLAS

Digital board is a very common element in the in the classrooms of the high schools. The editorials are starting to define a big amount of educational content to adapt the sessions to these new technologies. In particular, this study analyzes the experience with digital boards transferring the methodology and experience from the University of Murcia to the high school, since two of the teachers/professors involved in the project are working in both sides (University and High School).

During the academic year 2009/2010, after that were introduced the new digital boards in the classroom. It was decided to conduct a pilot assessment to determine the interest of its use from the side of the students, and the other teachers. The experiment was conducted with the collaboration of teachers from different areas and experience with new technologies. In particular the roles were defined: First, a teacher with over 20 years of experience in the area of geography and social sciences not used to new technologies. Second, a teacher with less than 10 years of experience in the area of sports science, and Finally a novel teacher of Computer Science and Mathematics, who had previous experience in the digital board at the University of Murcia, and with high experience in new technologies. With these roles were pursued to determine how for each of these areas/subjects could be included the digital board as an educational and motivating element in the classroom.

4.1 Methodology used in Social Language

The subject "Social Language" is one of the core subjects of the adaptation program to students diversity. Diversification is characterized by is focused on students who in most cases despite have normal intellectual capabilities and in some cases over the average, and lack of interest in the academic issues have lead to reduce its knowledge level with respect to the other student. It is one of the main reasons, because these groups of students have been chosen for this study, such as mentioned at the beginning of this paper, the main objective to be achieved with the new technologies is to increase the student's motivation, make more understandable the knowledge and improve the attitudes acquired.

The current methodology follows the guidelines defined by more than 20 years experience from the teacher; basically the methodology follows the next structure. At the beginning of each lesson, it is done a scheme on the blackboard, where are summarized the main concepts to be addressed. The students copy this in their notebooks, thereby they need to read and understand the topic to be addressed in that lesson. The main strategy of this methodology is to be very schematic in all the levels and at all times, thereby it ensures that the student is able to quickly find the information, which he needs. Once explained all the concepts and schemes, a set of exercises based on classification enumeration and list of concepts are performed. Thereby, the students have to work with these new concepts and include them in their knowledge. Finally, teacher performs oral and written evaluation on these concepts, in order to verify that the students have understood and acquired the new concepts.

The incorporation of the digital board in the mentioned methodology can be carried out in any of the three phases (initial explication based on the scheme, activities and evaluation). It has been focused primarily for the development of concepts through sorting activities, as that will reflect as a example in the next section, it was carried out from two perspectives, on the one hand, for training i.e. exercises and activities, and on the other hand, as an evaluation exercise based on the classification of three rivers, three mountains and three cities by each student.

4.2 Examples of application of the digital board

Digital board applications are relevant at many stages of the educational process, as seen in its application at the University. In this work, in particular, it is presented its application in those phases of the learning process, where the student should participate actively in solving exercises and development of the concepts explained in the theoretical sessions by the teacher.

In particular, the activity defined for evaluation was an active review of the main cities in Spain on a physical map, and rivers and mountains on a geographical map. Figure 3 presents a snapshot of the activities on the tool Interwrite tool.



Figure 3. Example of activity with the digital boards.

On these maps the student moves with the pen the name of the element indicated by the teacher, allocating it in the corresponding position in the map. Figure 4 shows to two students working with the digital board on the physical and geographical maps.



Figure 4. Example of students allocating the cities/rivers/mountains indicated by the teacher.

Once placed the solution, students can check the result defined by the teacher, enabling a hidden layer. Thus, layered workspace that provides the tool allows to the teacher defines on the same activity different levels of information to be displayed. Figure 5 shows to two students enabling the hidden layer.



Figure 5. Example of students enabling the hidden layer to check their solution.

Finally, once enable the hidden layer; the students are able to check visually their response, what also facilitates their learning. Figure 6 presents to two students checking the solution and to the teacher explaining because some part of the solution is wrong.



Figure 6. Example of students checking the solution and receiving explanation from the teacher.

5 RESULTS

In order to collect the opinion from the students and teachers about the experience at the University and the High School, it was carried out a survey where were defined the next blocks of questions:

- Opinion about the use, with general questions about the acceptance on a scale (0-5).
- Technical problems found. It was defined with a set of issues, where the student select the score of the level in which has found that problem.
- Learning problems, difficulty in understanding how to use it.
- Overall rating of experience. At the end of the survey asked a score (0-5) about the experience.

5.1 Results at the University of Murcia

The results at the University of Murcia are presented in the Table 1. The general opinion about the use of the portable digital board is good (3.55 out of 5), although the classroom response system receives better acceptance (3.84 out of 5). This may be due to the emergence of more technical problems (0.54 out of 5) and learning difficulties (0.38 out of 3) with the portable digital board than with the classroom response system (0.08 and 0.31 out of 4, respectively). Technical problems observed in the portable digital board are focused on the skills needed for the management in tasks as such as the configuration. The learning problems found in both are low.

In general, the overall rating for the classroom response system is better than the portable digital board (4.23 and 3.31 out of 5, respectively), but both present a high acceptance what indicate that their use is recommended and interesting to continue with this new tools.

Table 1: Results from the Home Automation subject at the University of Murcia.

	Portable digital board	Classroom response system
Opinion about the use	3.55 (0-5)	3.84 (0-5)
Technical problems	0.54 (0-5)	0.08 (0-4)
Learning problems	0.38 (0-3)	0.31 (0-3)
Technological evaluation	3.31 (0-5)	4.23 (0-5)
Overall rating	3.69 (0-5)	

5.2 Results at the Monte Azahar High School

The results at the Monte Azahar High School are presented in the Table 2. The general opinion about the use of the digital board is as good as for the classroom response system and portable digital board (3.36 out of 5). This may be due to the emergence of more technical problems (0.90 out of 5), the two main technical problems encountered are, first, the reflection of light, mainly in the shade on the board of the student as is apparent in the images in the previous section (see Figure 4, 5 and 6), second, the use of the pen, even a student told us that by dragging the stylus to move the tabs get stuck a little, and we had to find the proper pressure level to get a good flow on the board along with a good

response in the monitoring of the pointer to the pen. With regard to learning difficulties, the results are equivalent between the two environments and different technologies (0.40 out of 3), this aspect was of great importance to check the rapid learning of technology by students, as well as the ability resolution of some unexpected events that knew little to solve without having seen before in an intuitive way, so learning it does not pose a real problem.

The overall assessment of the digital board is 4.40 out of 5. It has been found a good acceptance from students to these new technologies.

Table 2: Results from the Social Language subject at the Monte Azahar High School.

	Digital board
Opinion about the use	3.36 (0-5)
Technical problems	0.90 (0-5)
Learning problems	0.40 (0-3)
Overall rating	4.40 (0-5)

6 DISCUSSION

In addition to the mentioned evaluations from the students presented in the Section 5, it was considered an additional evaluation with the teachers and professors involved in the subjects, using a similar survey with the next main points of discussion to consider: identifying the main advantages and disadvantages in the use of the portable digital board, comparing with the common digital board, and emphasizing the improvement in the implementation of PBL at the university and students' motivation in both the High School and the University. The next paragraphs present some of the conclusions reached:

Number of students involved

The portable digital board enables interaction of more than one student. The digital board only allows one student, although the new digital boards support up to two (dual versions), the right now available at the Monte Azahar high school does not support it. Otherwise, the portable digital board allows until 9 users simultaneously, although practically, it has been identified that the involvement of more than two students and a teacher can cause attention problems due to reduced per-user workspace.

Encouraging participation

The portable digital board and classroom response system allow to the students more introverted participating, since they are not exposed in the front of the rest of their classmate. Although it has been found in surveys that there is still some tension, but with these techniques the 'shy' students involve more in the activities. Therefore, the portable digital board encourages the active participation in class. Otherwise, the digital board increases the experience of the students to face the public, which can promote attitudes to talk and work in public. In conclusion, on the one hand, portable solution solves the problem of participation of shy students in the classroom, but does not encourage the student to improve their attitudes; on the other hand, the digital board encourages the student's attitudes and experience of students to work in public, although initially it is an effort to overcome the shyness.

Use of the hardware experience

Portable digital board does not have an embedded screen; therefore the professor must always return the head to the projection screen or computer monitor which is connected to the board, forcing some no ergonomic postures in some cases.

The time needed to acquire the skill in handling the tablet, this is different depending on the student's ability, but this requires some time, which makes it complex to use it for the students in the initial sessions. In addition, we have detected some technical problems when linking the portable digital board with the computer.

The digital board also presents some problems in the communication board / computer, but these have been very specific. The other problem encountered, as mentioned during the evaluation related with the pen, since it has some drawbacks to slip on the board, but a few minutes of experimentation is enough to learn how to use it properly.

Cooperative activities and competitive activities

Portable digital board allows configurations where a group of students can solve a problem as a group in a collaborative way, or two groups simultaneously to solve an exercise under competitive conditions. The digital board does not offer a flexible solution for organizing such kind of activities.

Students' attention and interest

The use of the classroom response system for the survey of students allow to everyone to be active and alert, since with this solution it can be known quickly what students are failing, what could mean that teacher ask him about why he chose that option.

Efficiency of the explanations

Portable digital board allows greater control of the space, since the digital board the up area is usually out of the student's coverage (because their tall). In addition, configuration problems found with the digital board at the beginning of the sessions are also solved with this portable technology. .

7 CONCLUSIONS

This paper presents, on the one hand, an experience of implementation of portable digital board and classroom response system to improve the understanding and motivation of the students in theoretical explanations i.e. lecturers, from the Project Based Learning applied at the University of Murcia, on the other hand, the implementation of the digital board at the high school. The methodology developed is focused on increase: motivation, interest, competitiveness, and open discussion/debate.

The portable digital board has shown to facilitate teaching tasks, which is a perfect complementary tool for the Project Based Learning. The digital board has been very well received, and has demonstrated the ease of the students for its use, although they have found it difficult to perform for an entire academic year, since the development of the activities for these new technologies require a higher investment of time with respect to the classical activities. However, to solve this, it is expected that the editors offer a suitable content, which can be used directly by the teacher.

The methodology has been implemented at the University of Murcia in two subjects within the field of Electronics Technology: Microprocessors and Home Automation, and the subject of Computer Science, Mathematics, Sports and Social Language at the Monte Azahar high school.

The described methodology followed in each scenario, explaining the use of the new technologies in the different stages of the learning process. On the one hand, it is used for the initial lecturers and activities at the University, and on the other hand, it is used for the activities and evaluation stages at the High School.

The results reported directly from the students' survey reflect a positive opinion about the methodology and the technologies.

Ongoing work is focused on the evaluation of the methodology in parallel courses, with one based on the PBL model described above without new technologies tools, and another focused on portable digital board, in order to be able to compare the methodologies with and without these technologies. In addition, it is going to be developed an application to support and manage the classroom response system. Finally, remark that the digital board is going to be extended to other subjects, carrying out a process of training to the other teachers at the Monte Azahar High School.

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