Using Multimedia Activities for Homework and in-Class Exercises to improve the results of university students

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Abstract: - A regular subject of a degree course can be split into 4 main parts: Lecturing classes, hands-on skills, homework exercises and in-class exercises. There are many researches on lecturing classes and hands-on skills and, although there are many related with homework and in-class exercises, they are focused on the methodology more than of the type of media used to perform them. Homework and in-class exercises have the objective of the reinforcement of the knowledge learned in lecture classes. Generally, these problems or exercises are presented written in a paper or, sometimes, in an electronic format using a word processor or pdf. Despite of the type of exercise or problems proposed for the students, we suggest the use of multimedia activities as a medium to propose these exercises. In this paper we will show different kind of multimedia activities that can be used for homework and in-class exercises. This classification will allow us to choose the type of multimedia activity depending on the type of knowledge that it is wanted to transfer to the student. These multimedia activities have been used in the subjects "Redes de Área Local" and "Integración de Redes" that are lectured in the third course of the Telecommunications Technical Engineering in the higher Polytechnic School of Gandia of the Polytechnic University of Valencia. We will show the measurements taken from a questionnaire presented to the students and we will discuss their results obtained. We will also compare the marks of the students in both subjects in the last two course years.

Key-Words: - Multimedia Activities, Homework, Lecturing classes exercises, TICs for the education.

1 Introduction

In-class and out-of-class exercises are one of the most used ways by the lecturers to make the students practice about the lasts lessons [1]. They help the students to revise what they have learned during the last class. The main ones are classified as follows:

1. Problems. A problem-based exercise consists on a set out situation that has to be solved by the student to achieve an objective or a goal. The resolution has to be done by using a strategy, through mental operations, developing the student's abilities to achieve the solution.

2. Study cases. It is a particular study methodology that consists on the observation of events, data and information analysis through real cases. In this case the student learns by solving what is happening in the real life and prepares the students taking into account the disagreements that could happen when they are in the industry.

3. Short questions. Through short questions the lecturer pushes the student to give the main idea of the content of the subject in the answer, and strengthening the ability of the student making summaries of the content learned. The grade of difficulty depends on different factors such as the extension of the question and the way it is approached.

4. Tests. They are formed by short questions that have 4 answers. There are 2 types: tests with only one right answer or tests with multiple answers. They can be used to evaluate the knowledge obtained by the lecture classes and the level of development of the capacities and aptitudes of a specific topic. It can be achieved because of the similarity of the answers.

5. Search for a specific information. These exercises help the students to develop the intellectual tools and the learning strategies that are needed to delimit and pose questions about a case. The search can be achieved by searching through the World Wide Web, going to libraries and reading the class notes. They will learn how to access to several sources of information, understand what they

contribute and select the contents they need. By this way, they can acquire the skills to learn autonomously and independently during the rest of their lives.

6. Draw-up a report. In this exercise, a student can express his opinion and can summary what he has learned. The student must be clear, with understandable, precise and concrete ideas, be direct, stop beating about the bush, to reason out, and to be based on reliable sources.

7. Make a summary. A summary is not an outline neither a set of ordered notes, but it is a shortening of the original text that has to be presented in clearly, logically and connected. The summary consists on the reduction into brief and concise terms the Essentials of the subject matter. The capacity to summarize is closely related to the capacity of comprehension and precision which is considered essential for the student. To make a summary is the previous step to an analysis and literary commentary, so it guaranties the comprehension of the essence of the text.

8. Brief oral presentations. The student must be turned up setting out contents structured logically. The presentations could be about information, updates and orientations that are manifested through the speech of the presenter and imply an interaction between him and the people listening to him.

9. Brief writing exercises. These exercises allow the student to condense several logical thoughts in concise paragraphs. The student has to write short answers reasoning logically, clearly and concisely. The exercise has to be corrected by the lecturer bearing in mind that the student has to explain in few sentences what he is asked for.

Although there are many more not so much known [2] [3], they are the main ones. This type of exercises could be used to motivate the students [4], to provide the students with some direction for a bigger project [5] or for exams preparation [6]. Actually, the main issue in using exercises in the classroom it the time needed to prepare them and the time needed to solve them [7]. On the other hand, there are many methodologies that can be used for in-class exercises such as active learning and collaborative learning [8].

From several years ago, there have been published some works were communications and information technologies are introduced. On one hand, some works show the use of computers to do the in-class exercises [9] [10] and to test the skills [11], others propose the use of tablet PCs to make the exercises

[12] and, lastly, there are some works that show the use of PDAs in the lecture classes [13][14][15].

On the other hand, it is known that the use of the multimedia technology enhances the comprehension of the lecture because of its visual and sound impact on the student. There are many works where multimedia activities are used to support the subject [16][17][18] and for class presentations.

In this paper we will show a new type of in-class exercises that are quick to solve and easy to use (it can also be used for homework exercises). Instead of using a new software or a complete education platform to do the exercises, we propose the use of the Adobe Flash software [20]. It is versatile and allows us to deploy high quality activities that can be used in our theoretical classes as presentations, demonstrations and even for exercises while having files with very low size. This technology is actually used by virtual laboratories because they can be run either locally or remotely using a web server. We are going to use it to deploy in-class exercises.

The remainder of this paper is as follows. Section 2 describes the concept of the virtual laboratories and gives its main features. Some multimedia flash activities developed for "Redes de Área Local" and "Integración de Redes" are shown in section 3. Section 4 shows how we use the multimedia activities in the classes. Section 5 shows the student's impression about the activities and our analysis about their answers. Finally, in section 6, we will give our conclusions and future works.

2 Interactive tools, virtual laboratories and e-exercises

An interactive tool introduces new technologies into the educational methodology. It can be used as online applications, providing a positive aid to the learning tasks. There are several types of tools of interactivity, but all have in common that they don't check the knowledge of the students; they just show an animation or solve a mathematical problem. The student introduces some data and obtains a response based on the calculation, through an expression, or a result based on the items selected by the student. The interactivity of e-learning may affect how learners responding to the learning content [21]. Interactive tools and e-learning activities enhances the quality of the education [22]

An example of interactive tool for mathematics is presented in reference [23], for power electronics in reference [24], for electrical power quality in reference [25] and for Computer Graphics in reference [21].

A virtual laboratory is a local simulation that can be run locally or remotely. It allows simulating phenomenon and physical models, abstract concepts and so on [25]. It gives the possibility of showing interactively the mathematical model and the simulated model. It tries to become closer to a real environment. The virtual laboratory allows obtaining an intuitive and clear view of the phenomenon helping its understanding.

A virtual laboratory shows the instruments and devices through dynamic objects (Java applets or flash, cgi-bin, javascripts,...), images or animations [26]. The virtual laboratory uses the computer processing capacity and computer calculus in order to show the numerical and graphical results of the simulation.

Some of the main benefits of the virtual laboratories are the following ones:

- Makes easy and gets closer the experiences to great number of students because they have not to be in the same place at the same time [27].
- Students can make changes without any risk.
- The laboratory will have a flexible time, so the overflow is avoided.
- Reduces the setup and maintenance cost.
- It is a self-learning tool where the student varies the input variables and configures the new experiments.
- Students learn by proving and solving mistakes repeating the practice as many times as they need.

But, on the other hand, virtual laboratories have several drawbacks:

- A virtual laboratory doesn't substitute the practical experience. The virtual laboratory just complements it.
- A virtual laboratory has to be accompanied by a guide to avoid having the student as a spectator and driving him to achieve the goal of the practice.
- Because the virtual laboratory doesn't use real devices, the student misses a little bit of the reality

This type of technology can be used to do in-class exercises. One of the main issues in in-class exercises is that writing takes too much time [28], so we should consider other strategies to use inside the classroom such as e-exercises.

On one hand, Web-based Learning Environment gives several benefits to the students such as interactive relationship, self-directed learning and personal development [29]. On the other hand, Sylvia Encheva and Sharil Tumin showed in [30] that there are several multimedia factors that facilitate the learning. They are the Visual and auditory inputs, the Interaction, the Learner styles and the Content delivery and content exploration.

e-Exercises (also called online exercises) are self-quizzes that give the opportunity to increase the student's skills in many areas. E-exercises have to be done in a computer and they can be placed locally like at home, computer laboratory or classroom, or in a remote server. The main feature of the e-exercises is that they are easy to use and don't need too much time to be solved.

The e-exercises increase the teaching diversity and act as an efficient complement of the most conventional methodologies. E-exercises help to achieve the objectives pursued for the subjects. They can even used as a learning objects in e-learning platforms [31].

3   Multimedia flash activities as e-exercises

Adobe Flash is an edition tool that allows the designers and developers to create presentations, applications and much type of contents to interact with the users. Flash projects can cover from simple animations to video content, complex presentations, questionnaires or other related utility. Independent fragments of content created by Flash are called applications. All Flash applications allow a great variety of multimedia content such as images, sound, video and special effects.

Flash is the most used technology used in web pages for the creation of animations. One of the greatest benefits is that the files used to do it are not too much larges in size, so it is not needed so much time to download them by the Internet navigator. In order to provide files with low size it uses vectorial graphics because that type of graphics does not need too much memory and storage sizes that bitmap images (images are represented by mathematical formulas instead of large sets of data).

The Flash Player is a simple and useful player for viewing flash on your computer freely without any cost. It can play any .swf file in any platform, navigator and devices (mobile devices included). Flash Player is distributed with the main software companies such as Microsoft, Apple, Netscape, AOL, Mozilla Firefox and so on, so flash animations can be viewed by the most common web browsers.

Adobe Flash [20] allows to create interactive multimedia, including audio, video, animations, puzzles, games, user interfaces, flexible message areas, dynamic internet applications and so on.

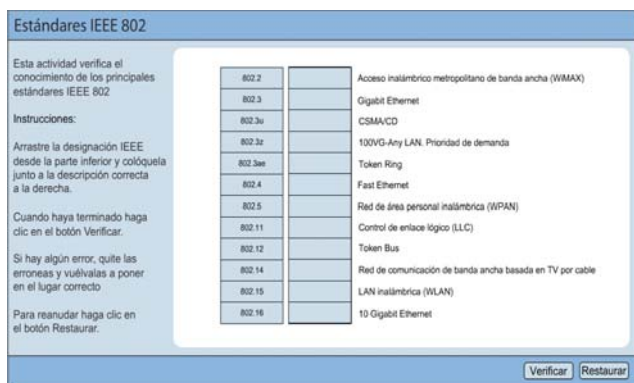In order to develop a Flash activity, a developer must follow the following steps:

Figure 1. IEEE standards.

Figure 2. Encapsulation steps.

1. Decide which basic tasks the application must do.
2. Create and import the multimedia elements such as the images, video, sound, text, etc.
3. Organize the multimedia elements in the Macromedia Flash software environment and in the timeline. The developer has to define when and how they are going to appear in the application.
4. Apply special effects to the multimedia elements as it is wanted.
5. Write ActionScript code in order to control the behavior of the multimedia elements and their response to the user interactions.
6. Add interactive elements like text fields or buttons in the application.
7. Add a short program to implement the functionality for the textfields and/or buttons.
8. Test the application in order to determine how it works and to find possible errors.
9. The edited flash document is in .fla extension, so it is needed to create the compressed version in a .swf file in order to show it in a web page and to play it using the Flash Player.

We have developed several multimedia flash activities. We have found many benefits using them:
- Lecturers can check the students' knowledge.
- Students can check their knowledge.
- Students can use them to practice what they have been learning last days.
- Students can practice with exam-type questions.

Figure 1 shows a multimedia activity used to relate the number of the IEEE standard with its description. In this activity students must move the number of the standard to the correct box. There is only one number for each description. Once all the numbers are moved to the boxes in the right, the student have to click on the verification button. A green mark appears when everything is right, but if any box is wrong, it is marked with a red cross.

Figure 2 shows an activity used to know the procedure that has to be performed in each step when an e-mail is sent. In this activity, the frame encapsulation steps are reviewed. The student has to move all boxes in the right to the correct place to make sense. Once they are placed, the student has to verify the activity by clicking the verification box.

Figure 3a, 3b and 3c show an activity that is formed by several slides. In the first slide the student has to choose the type of medium, the type of connector and the maximum speed for some IEEE 802.3 variants, for the IEEE 802.5 standard, for some FDDI variants and for the 100VG-Any LAN standard. The student has to drag the box from the right side (medium, type of connector or maximum speed) and drop in the box of the appropriate column. In the second slide the student has to give the same parameters for some IEEE 802.3u and IEEE 802.3z variants, and, finally, in the third slide, it is the same but for some IEEE 802.3ae variants and for the IEEE 802.11a/b/c. Each slide is validated separately and wrong boxes will be marked in red. S

In figure 4 we can see 3 buttons. Depending on the button clicked, the student will have to solve the specific part of the problem. Figure 4 a) shows zone 1, figure 4 b) shows zone 2 and figure 4 c) shows zone 3. In each zone, the student has to choose the MAC address and the IP address for the source and the destination field of the frame. Only when the correct fields are placed, appears an animation indicating that the frame travels from the source to the destination.

Figure 5 shows figure with a topology where the student has to write the number of nodes, number of links, the grade of the nodes and the diameter of the topology. When the verification button is clicked, the system gives the student which values were wrong. This activity has 32 different topologies and the student can go to anyone of them by clicking the "next" button. Figure 6 shows a topology with higher grade of difficulty. In this case, the number of nodes is higher and the topology has been created randomly.

Figure 3 a. IEEE variants, slide a.

Figure 3 b. IEEE variants, slide b.

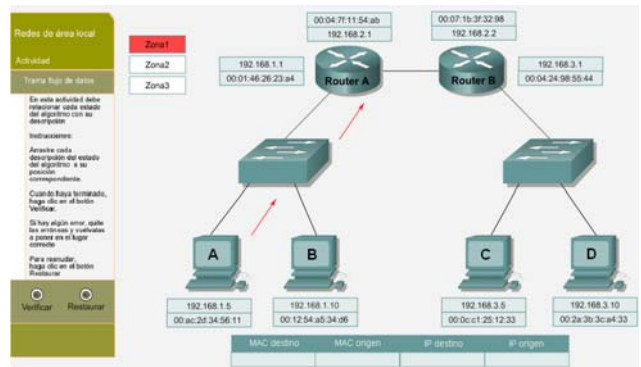Figure 3 c. IEEE variants, slide c.
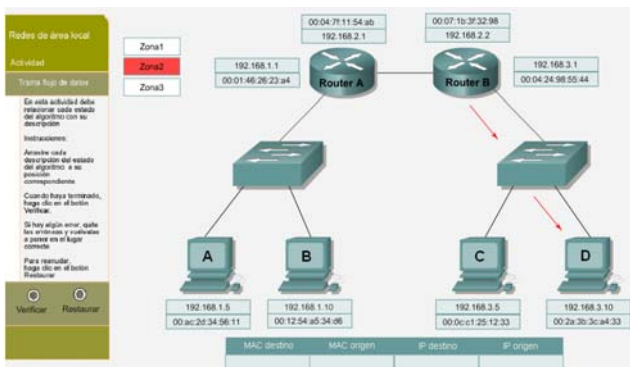

Figure 4 a). Frame fields in zone 1.

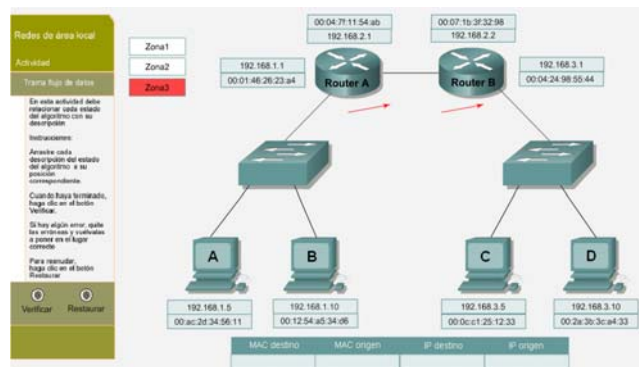Figure 4 b). Frame fields in zone 2.

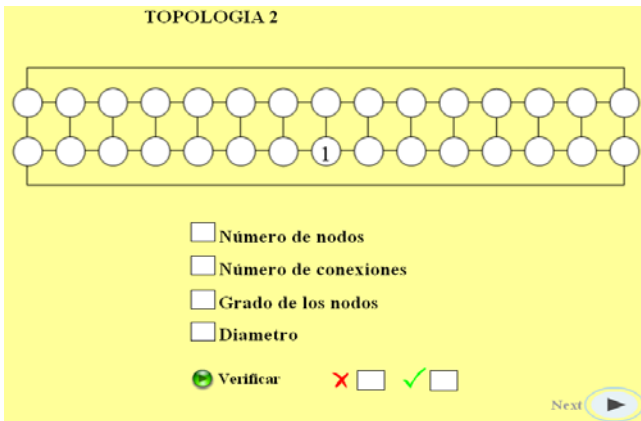Figure 4 c). Frame fields in zone 3.
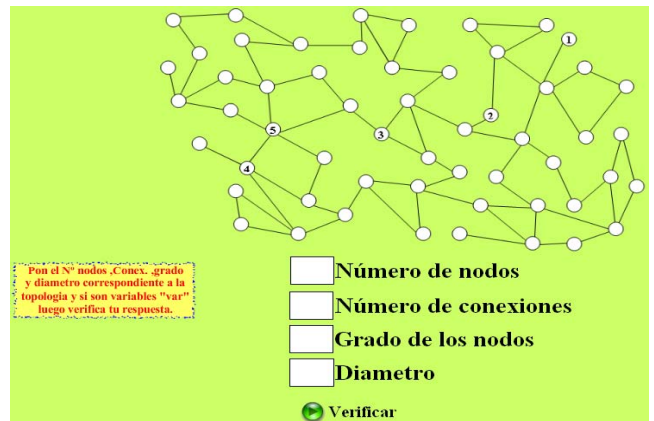

Figure 5. Topology parameters.

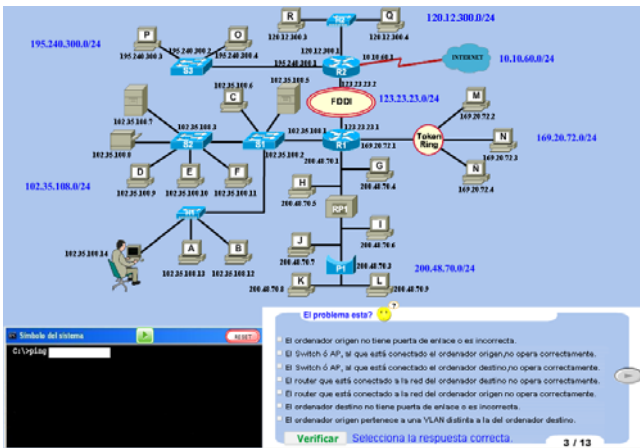Figure 6. Topology parameters. Higher grade of difficulty.
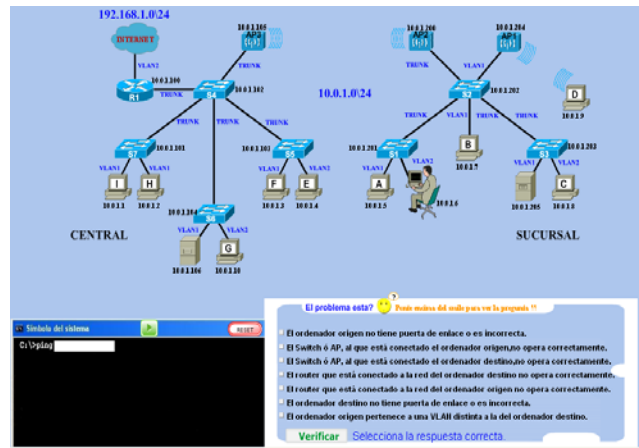
Figure 7 a). Troubleshooting 1.
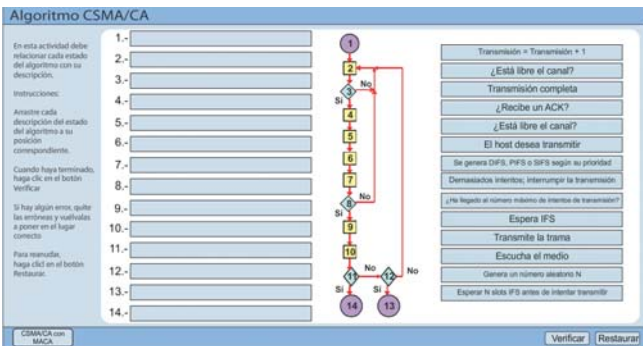

Figure 7 b). Troubleshooting 2.
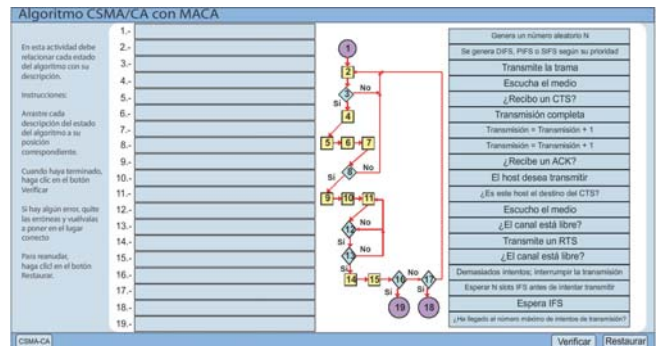

Figure 8 a). CSMA/CA Algorithm.

Figure 8 b). MACA Algorithm.

Figure 7 a) shows a troubleshooting multimedia activity where the student has to find which device has failed in the network from the laptop, where the man is sited, to a specific destination. The question of this activity is shown when the mouse is put over the question mark of the figure. The student has to ping the devices till he/she finds which part of the path is wrong and decides what the problem is. In order to ping the devices, the IP address of the device has to be written in the black box in the left-down side of the screen and then click on the play button in green. Once the student has tested the network, the correct answer has to be elected from the choices shown in the right-down side of the screen. Then, the student can verify if the chosen answer was right by clicking in the "verificar" button. With this exercise the student learns how network devices such as hubs, bridges, switches and routers work.

Figure 7 b) shows another troubleshooting multimedia activity, but this time wireless devices have been introduced to the network, giving more grade of difficulty to the exercise. The procedure to test and verify the network is the same as it has been explained for figure 7 a).

Figure 8 a) shows the CSMA/CA Algorithm. This algorithm is used in wireless networks. Once the theory is explained in the classroom, this activity can be used to reinforce the knowledge of the students. The boxes placed in the right side have to be dragged and dropped in the correct number of the algorithm, so, the algorithm should be understandable and should be followed in a sequential manner at the end.

Figure 8 b) shows MACA Algorithm, which is a little bit more complicated than the CSMA/CA algorithm. The procedure to solve this exercise is the same as it has been explained for figure 8 a). Both are inside the same e-exercise. They are interchangeable by clicking in the button placed in the left-down corner.

We can observe that all the activities shown in this section have an explanation of the procedure to solve the activity. Each activity has different way to be solved, so this information is needed.

As it has been explained before, they have been developed with Adobe flash, so it can be viewed in any internet navigator that has a flash plug-in and, when it is installed, is able to open swf files (Internet Explorer, Mozilla Firefox, Netscape Navigator,…).

The e-exercises can be done in-class, at home, or in any site, but it is needed a computer to realize them. It is not needed Internet connection to do the exercises, because the swf files can be copied locally.

4 Educational methodology

The educational methodology used in the classroom was as follows. Every time a chapter is finished we present these activities to the students requesting their participation. It can be in the last 15 minutes of a class or it can be the whole hour of the class. It depends on the number of activities available for that chapter and on how is going on the schedule time of the subject. When a student answers correctly the activity it receives 0.2 points as quick as the question is answered. Although the answer of many activities can only be right or wrong, depending on the answer of the student and on the student's reasoning, 0.1 points could be added. No more that 1 point can be gathered by just one student. It allows balancing the number of points among the students.

A student can't answer an activity day two times the same unless no other student wants to answer the activity. It allows giving the opportunities to all the students, not only to the ones that give fastest reply.

The points obtained through the course are added to the student's final mark only if the student has more than 4 points out of 10 (in Spain an exam is passed if the student obtains more than 5 points).

Then the e-exercises are sent to the students by e-mail. Now they can practice ant home or in any computer class.

5 Measurements and analysis

In order to check the performance of our new methodology, we gave the students a questionnaire to gather their opinion. It was given in two classes (first one was in the first semester of the course and the second one in the second semester). Then, we measured and analyzed the answers of the students.

On the other hand, we measured and compared the marks obtained by the students in January 2008 and January 2009 in "Redes de Área Local" subject and in June 2007 and June 2008 in "Integración de Redes" subject. It allows us to know if the multimedia activities have enhanced the marks of the students in both subjects.

5.1 Questionnaire

First, we gave 8 questions to the students and they had 5 possible answers to mark them (1 = None, 2 = Little, 3 = Some, 4 = Quite, 5 = Very Much). The questions given to the students were:

1. Do the multimedia activities have helped you to understand better some concepts of the subject?
2. Are they easy enough to understand and to use?
3. Do you consider that to give points to the final mark for good answers in the multimedia activities is a good idea?
4. Do you think that the number of multimedia applications presented in class is enough (or would it be better to add more)?
5. Do you think that it could be a good idea to place these multimedia activities in an on-line server and the answers will be sent to the lecturer when the students carry out them?
6. Could the multimedia activities be used as method of the students' chapter evaluation?
7. Do you prefer to do the multimedia activity instead of doing the same exercise writing them?
8. Do you like how the multimedia activities have been corrected (in the class and with the presence of other students)?
9. What do you think about the different format of the multimedia activities (moving blocks, etc.)?
10. Do you think that to carry out multimedia activities after concluding each chapter is good?

5.2 Questionnaire results

The questionnaire was performed in both subjects, the first one was "Redes de Área Local" from the first semester and the second one was "Integración de Redes" from the second semester of the third course of the Telecommunications Technical Engineering of the "Escuela Politécnica Superior de Gandia" of the Polytechnic University of Valencia.

Figure 9 shows that the 78% of the students consider that the multimedia activities have helped them very much to understand the concept of the subject, the 22% helped quite and there was not any % in the other options.

Figure 10 shows that although all the multimedia activities have an explanation of the procedure, they are not too satisfied about the explanation given because just the 56% of them graded this question as quite or very much.

Figure 11 asks the students about giving points when they solve the multimedia activity during the classroom. Almost all of them were satisfied with this decision, just the 6% of them did not agree. It seemed to be because they prefer to do them alone, not with other students present.

Figure 12 gives us their interest to have more multimedia in-class activities during the lecture class. The result shows the 66% of them selected "some", "little" or "none", so we are quite approximated to the appropriate number of multimedia activities.

Figure 13 shows that they are interested on having those multimedia activities online in order to practice whenever they want.

Figure 14 shows that they will agree to have the multimedia activities as a medium to evaluate the chapter because 77% of them answered "very much" or "quite".
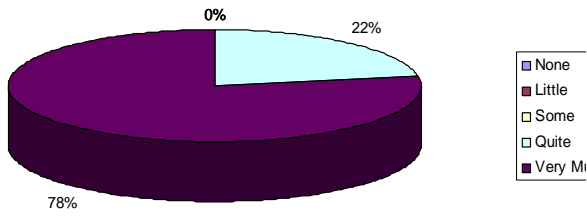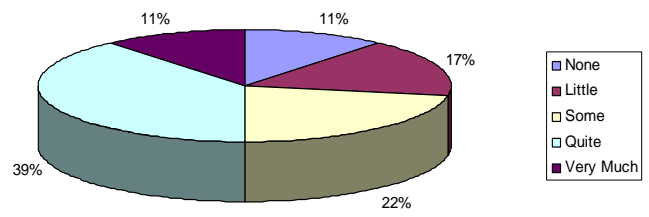
Figure 9. Results of question 1
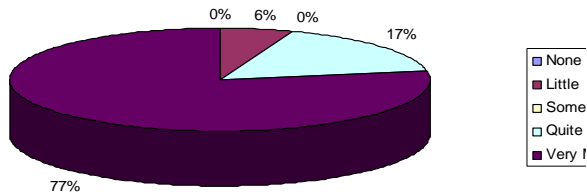
Figure 10. Results of question 2
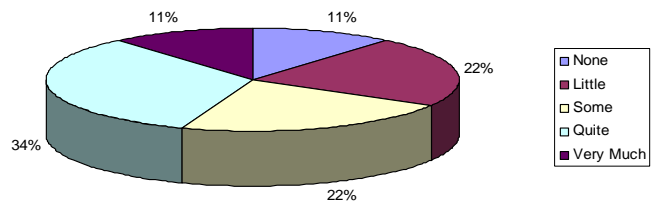
Figure 11. Results of question 3
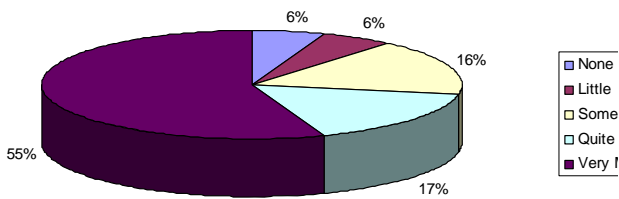
Figure 12. Results of question 4
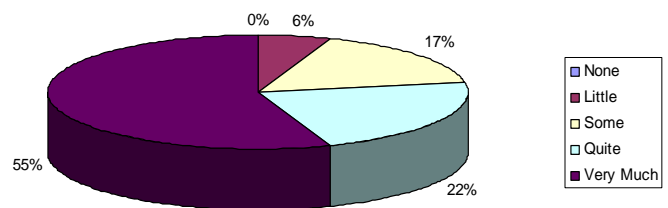
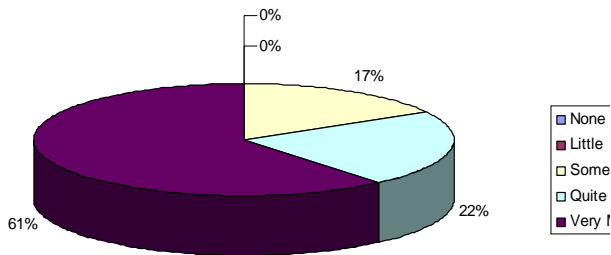Figure 13. Results of question 5

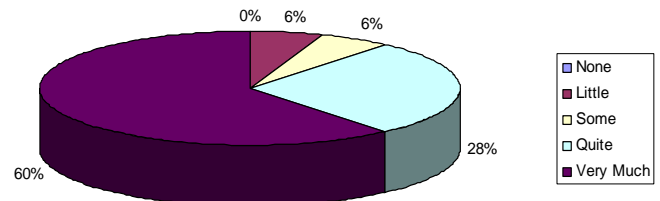Figure 14. Results of question 6

Figure 15. Results of question 7

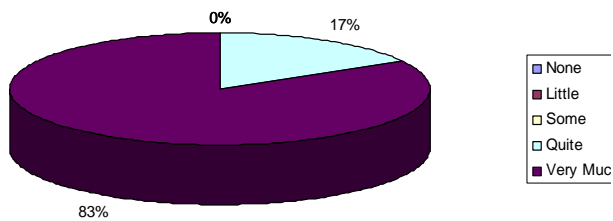Figure 16. Results of question 8

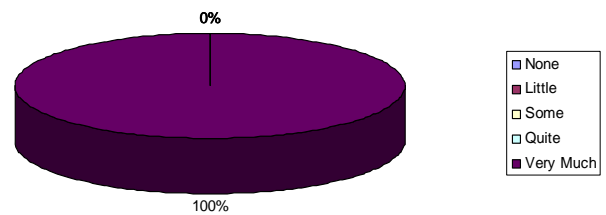Figure 17. Results of question 9

Figure 18. Results of question 10

Figure 15 shows that the 83% of the students (those who answered "very much" and "quite") preferred multimedia activities as in-class exercises than written exercises.

Figure 16 gave us their opinion about correcting the answer of the multimedia activities with the presence of other students. Although most of them are shy, almost all of them preferred to do the exercises inside the classroom and answer with the presence of their partners (60% answered "very much" and 28% of them answered "quite"). They preferred to learn from the answer of their partners than die of embarrassment.

Figure 17 shows that to build different types of multimedia activities was a good idea. They are grateful on the imagination using on building different type of exercises.

In figure 18 we can see that all of them liked to carry out multimedia activities after concluding each chapter.

5.3 System evaluation and marks

Both subjects have three main parts: the lecture class, the laboratory class and the homework and in-class exercises. The lecture class is graded through a written exam which is composed by several types of exercises (brief writing exercises part, the problem exercises part and the test part). The laboratory class is graded through a collaborative exam in the laboratory. A group of students have to implement a network with specific features (more information about this methodology can be read in reference [32]). The in-class and homework exercises are composed by the multimedia activities shown in this paper.

We have compared the marks obtained by the last two courses of "Redes de Area Local" (January exam). Although in the course 2007-2008 we presented some multimedia activities to the students, they were very few. Figure 19 shows the comparison of their marks. In 2007-2008 there were 3.6% of students (approximately) with marks between 9 and 10 points and between 7 and 8.9 points (out of 10), but more students have passed the subject (in Spain, a grade higher than 5 means that the student has passed the subject).

Figure 20 shows the comparison between the marks obtained by the students of the subject "Integración de Redes" in June 2007 and June 2008. This time, the first course didn't have any multimedia activity during their lecture class and the second class had quite a lot. We can observe that the methodology used have enhanced the marks of the students.

6 Conclusion

We have shown a new methodology based on the utilization of multimedia activities during the classroom. The multimedia activities have been built using Adobe Flash. We have built different types of exercises in order to present different ways to present an exercise to the student.

The questionnaire presented to the students show that it has been a good initiative to improve our classes. The values obtained from the questionnaire answered by the students of both subjects are shown in figures 9 to 18. They show the grade of satisfaction of the students. Just in question 2 and in question 6 the most masked answer was "quite", in the others was always "very much".

Results obtained from their marks shows that the marks have been better since this new methodology have been implemented.

The multimedia activities can be used as an online system for testing and evaluation as the proposal shown in reference [33]. Now, we are changing the code to send the result of the students by e-mail when they realize the multimedia activities at home.

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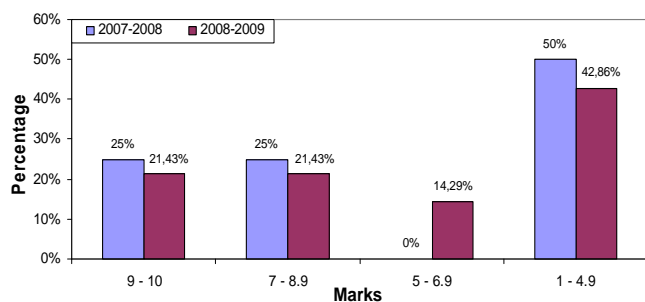
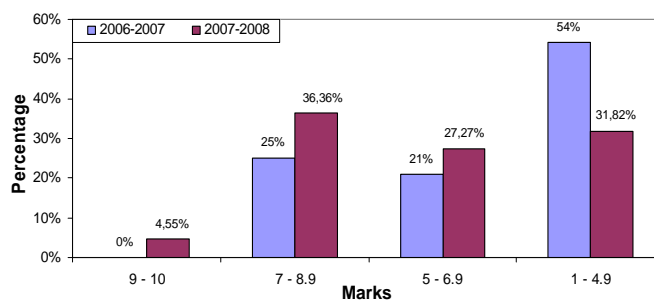Figure 19. Comparison of the students' marks in "Redes de Área Local" subject.

Figure 20. Comparison of the students' marks in "Integración de Redes" subject.

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