Improving Cross-Curricular Skills in Web Services: Virtual vs. Attendance Environments

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Abstract— **Web services is a mainly practical software engineering subject which is followed by Computer Science and Telecommunication Engineering students at the University of Extremadura. It is an advanced topic and therefore it is taught in the last years of the engineering, in which the student already has the capacity of learning a lot of concepts by themselves. Although the transmission of the main theoretical and practical concepts of the subject in question must remain the main focus, the improvement of students' general skills claims for special attention with a view to business requirements. Besides, the mobility of teachers and students among European universities has increased notably, which is a very positive experience for both communities. In this regard, new educational alternatives have to be found for this purpose, not only to provide the possibility of studying a subject abroad, but also to improve cross-curricular skills. It is also a reality to be taken into account that an increasing number of students are already working in the industry while following up their studies. E-learning environments are the perfect answer to these requirements, where a varied range of activities and methodologies can be used to follow the subject virtually as well as promote general cross-curricular skills such as addressing an audience, team work and preparing documentation. In this sense this paper describes the author's experiences with e-learning environments in the situations described above and compares them with previous experiences in which only attendance lectures where available for students.**

Keywords- **Virtual Environments; Attendance Environments; Web Services; Teaching Experience; Cross-Curricular Skills.**

I. INTRODUCTION

Web Services is a mainly practical subject, specially focused on the development of distributed applications which will be implemented and will communicate with each other under the Service-Oriented Architecture. It is an advanced subject which is followed by advanced students, that is, students in their last year of the Computer Science or Telecommunication Engineering degree. In this scope, it is quite common that students start working before they have finished the degree, or even that they start studying a new one once they have started working and this induces that the subject students might have schedule problems to attend the lectures on a regular basis due to their work commitments.

On the other hand, the mobility of teachers and students among European universities has increased notably: regarding the teachers they often have to attend several conferences to exchange their research ideas with other experts in the matter and it is also becoming quite common for teachers to go for research or teaching stays abroad for several months. In the case of students, the most common situation is that they are awarded an Erasmus scholarship and spend at least one year in a foreign university. Both positions are very positive for teachers and students and shouldn't be avoided for the sake of not missing lectures.

On the other hand, the European Higher Education Area (EHEA) demands the inclusion and improvement of student cross-curricular skills [2, 6]. The lack of experience of technical professors in this area, as well as the innovation of this proposal, makes it difficult the correct adoption of the named capacities by the students. Even more, since most of the cross-curricular capacities involve the interaction with other persons, the development of such abilities in a non-attendance situation becomes a real challenge.

In this regard, we have to look for new alternatives under the scope of the EHEA, so that education can be followed up without a mandatory requirement of attendance to lectures, and which, at the same time, lets us improve students' cross-curricular skills. Both tasks are already a challenge, but when faced together the challenge is even bigger. Education through e-learning environments was already approached by several authors in various interesting approaches [3, 4, 7, 9, 12] and we can also find some comparisons between virtual and attendance environments [1, 5, 8, 14]; however, most of them do not consider cross-curricular skills.

In this paper, we are going to see how this problem was tackled for an optional subject called *Web Services* offered in the Computer Science and Telecommunication Engineering at the University of Extremadura in Spain. We will describe the experience of the author and what the results obtained were. We will extend our previous work in [11] by comparing this experience with previous years experiences, in which virtual environments where not available, evaluating the benefits and drawbacks of virtual lectures versus attendance ones.

Fig 1. Activities available in the UEX Moodle environment

This paper is organized as follows: chapter 2 describes the subject Web Services according to its professional profiles and associated skills. Then, chapter 3 explains briefly the virtual environment available at the University of Extremadura. Chapter 4 explains the activities which were developed in a virtual and attendance mode in the scope of the mentioned subject during different academic years. Then, chapter 5 discusses the results of the experience and compare the two teaching ways presented. Finally, chapter 6 summarizes our proposal.

II. PRELIMINARIES

In this section we are going to describe the subject in which the e-learning experience has being carried out and which are its curricular and cross-curricular skills in order to analyse in the following sections how virtual environments could be used to improve such skills and carry out lectures virtually.

Web Services is particularly connected to three professional profiles: *design and development of telecommunication services, design of distributed applications oriented to the administration and electronic commerce* and *teaching and research for the development of new technologies and services.* The *skills specific to the qualification* which are mainly linked to this subject are *to know and design tools related to security in communications and networks, designing communication software incorporating the new technologies TIC to productive processes in the business* and *knowing and applying scientific and technological base knowledge to adapt to technological changes.*

Specifically, the content taught in this course is enumerated below:
Unit 1. Web Services Introduction
    1.1. Web Services Overview
    1.2. The Interoperability Problem: Walking toward the Web Services
    1.3. Service-Oriented Architectures.
    1.4. Adapting Architectures.
    1.5. Web Service-Oriented Architecture.
    1.6. Web Services Applications.
    1.7. Types of Web Services.
Unit 2. Web Service Standards
    2.1. SOAP
    2.2. WSDL

2.3. UDDI
Unit 3. Web Service Compositions
    3.1. Choreography
    3.2. Orchestration
    3.3. Enterprise Service Bus.
Unit 4. Web Service Modeling
    4.1. WSDL-based Approaches
    4.2. Service Component Architecture
    4.3. Model-Driven Architecture
Unit 5. State of Art of the Web Services.
    5.1. Platforms
    5.2. Advantages and Drawbacks
    5.3. Limitations
Unit 6. Building and Deploying Web Services with Java-based platforms.
Unit 7. Building Web Services with .NET
Unit 8. Building Web Service Clients for Mobile Devices.

In any case, the content of the subject is not relevant for the purpose of the paper, but the cross-curricular skills and skills are.

The *cross-disciplinary skills* related to the professional profiles to which this subject is normally linked are the following: *development I+D+I, design and analysis of telematics applications and services, managing telematics products and services, application of the learned technologies and their integration into the socioeconomic structure, interaction with users* and *responsibility for own learning*.

Based on these skills, the objectives established with regards to the academic and disciplinary abilities are the following:

- To introduce the student to the Web service technology, their standards and their development tools as well as the way to model and compose them.

- Besides, students have to be able to research on the named technologies and to be able to acquire and apply new knowledge in the area.

After studying the general personal skills of the degree and the specific disciplinary ones considered in this subject we concluded that suitable objectives with regards to personal and professional skills are the following:

- To develop the ability to understand, and enable others to understand, knowledge related with Web service technology, to be able to learn themselves about the named technology.

- To be able to work as a team effectively.

- To be able to acquire Web service related knowledge when provided in English.

III. THE VIRTUAL ENVIRONMENT

This section will describe the virtual environment adopted in the University of Extremadura (UEX) and the different modules which are available in it [16].

The University of Extremadura has embraced Moodle [15] and has offered to the university community several configurations depending on what the virtual environment is going to be taken advantage of. It is important to mention that not all Moodle modules are available for its use in the University of Extremadura system, therefore, according to
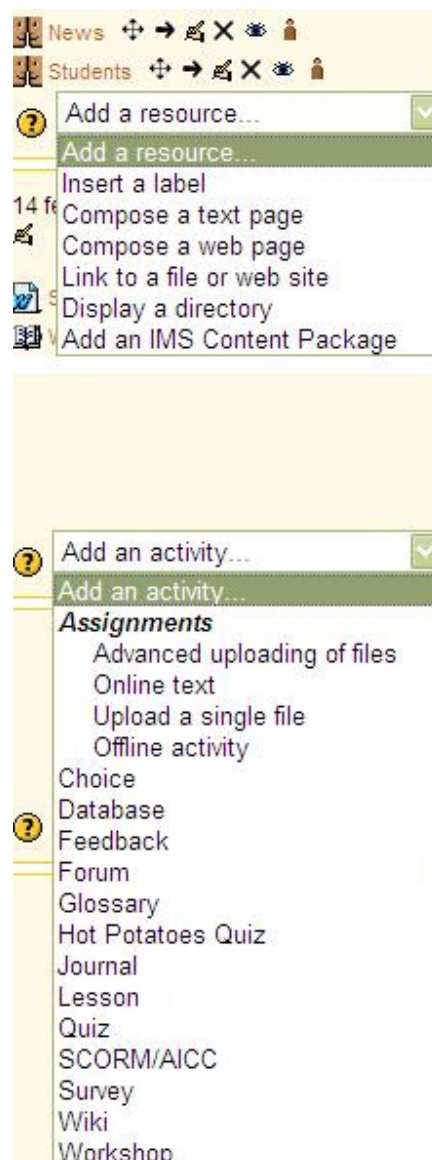

Fig 2. Resources and activities

the university rules, we have had to limit the use to those modules habilitated in this system.

Particularly, for the degree subjects, there are currently several virtual elements available, enumerated in the following lines - and some of them shown in the left-hand side of Figure 1:

- Files repository and resources: the teacher can upload any file and may or may not make it available for the students at any moment.

- Forums: the teacher can create several forums. For each of them he may decide between three different possibilities: forums in which only the teacher can write, forums in which the teacher is the only person authorized to start a topic and the students can comment on it and those where both teacher and students can start a topic.

- Wikis: the tutor can create wikis so that students can interact with them. The platform saves the historical data of the wiki so that the teacher can evaluate the students' progress. Usefulness of wikis has been described in previous works such as [13].

- Questionnaires: the teacher can elaborate several types of questionnaire in this platform –true/false, multiple choice, etc- The students can see at the end of their attempt the mark they got and also what would be the right answers. Limited slots of time can also be established for these activities.

- Delivery activities: some tasks may be requested by the students and uploaded onto the platform. They may or may not be set as "visible" for the rest of the students.

- Glossaries: the teacher can propose to elaborate a glossary for each lesson or for a general topic, so that the students can inspect on detail the meaning of the main terms used in the dealt scope and check them whenever they need to.

There are more resources and activities available, as we can see in Figure 2, but we are not going to describe all of them since they are not relevant to this paper.

IV. ACTIVITIES

In this section we are going to describe the different activities followed during the course Web Services: *Subsection A* in virtual environments and *Subsection B* in attendance ones.

It is important to mark that the different types of activities were being selected during the academic year: since it is a very dynamic subject, depending on the topic of the day and the previous experiences with the students, the more appropriate activities were introduced.

A. Activities in Virtual Environments

For the Moodle configuration, first of all, we opted for a weekly distribution. This way, the topic that is being worked during every week of the course could be easily be identified by those students who cannot attend the lectures. In this regard, every week there were available different kind of documents and activities. For instance, as depicted in Figure 3, first week we only have a planning of the subject and a global glossary, but in second week (Figure 4), we can already find several documents for theoretical and practical
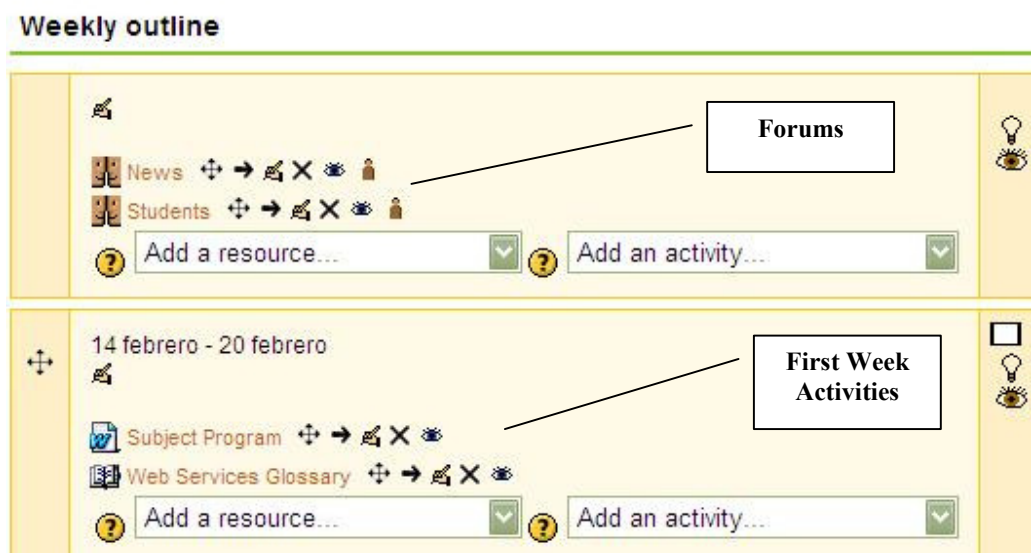

Fig 3. Forums and first week activities

lectures and additional activities, which will be described later on this paper.

We can also see in the very top of Figure 3 that we have two available forums:

- News: this forum let the teacher to comment any new about the subject. In this sense this forum may be used not only for indicating which activities to be done are new, but also to establish reminders for those students who can not follow the subject with continuity. Besides, it is very helpful for those students who can not attend the lectures so that they do not have the feeling of being uninformed.

- Students: this forum is especially useful for students to post their opinions, comments and questions for the whole participants of the course. This way it may be the students who answer these questions to their partners or who provide comments or suggestions through this platform.

Figure 4 shows us the current development of the initial weeks of the course. Since we had to give them a theoretical and practical foundation of the course, we provided them with several deliverable documents with this purpose (Lesson 1, Lesson 2, etc). These documents are explained and discussed in the classroom, but can also be followed up by the students who cannot attend them. We can also see that

Fig 4. Activities in the initial weeks of the course

for every lesson we proposed two interactive activities to the students: wikis and glossaries:

• A wiki was created for every lesson so that the students could enlarge their knowledge on the topics treated during the lesson in question. The work is done individually but shared with the remaining participants on the course so that the knowledge is built in a collaborative way. Since there is a unique document in the wiki, the students have to read what was inserted in the document by their partners and add new information to it. It may be that some of the advanced knowledge included in the wiki has already been discussed during the lectures, and this is a way to make this information available to the non-attendance students. On the other hand, the latest may also add a different point of view on the advanced knowledge or, even if they are working in the industry, a more business-oriented vision.

• Besides they were also provided with a glossary per lesson. The glossary is also a constructive activity which has to be built in a collaborative way. The students will add all the definitions they consider important for the understanding of the lesson. It is a hard work to be developed by an only person, but when built in conjunction with the remaining partners is a light workload which reports a great compilation of definitions which suppose a wonderful help when studying the lessons.

Finally activities A, B and C are activities to be done in groups of 3 to 4 persons. This work is developed during the classroom schedule so that the teacher can observe the performance on the group. The students works this way in a more relaxed scope and feel confident to go one step forward in their opinions on the lesson, what definitely improve their knowledge. Later on, the group will present the conclusions they have obtained to the remaining of the classroom. Besides, they will make these conclusions available in the virtual platform for the non-attendance students.

Once the basis knowledge has been discussed and assumed by the students, it is time for them to work on their own. For this purpose they will develop several works (see Figure 5):

• On the one hand, they have to do various practical exercises with several development platforms (Axis, Systinet, .and Net). In order to do it they are provided with various documents – in English- with the instructions for installing the software, basic examples to get familiarized with the platform and the information related with the exercise to be developed. This information is available in the wiki and therefore is accessible for both the attendance and non-attendance students. The questions related with these activities can be done through the platform forum, so that other students who may have the same questions can see their answers.

Fig 5. Advanced weeks activities.

Fig 6. Final week activities.

- On the other, they have to do a work in a team "outside" the classroom schedule. This allows students who cannot attend lectures due to their work schedule, to meet their classroom colleagues at a suitable time, therefore improving the interaction among the classroom students. Special groups are done for those students who are abroad: they will have to do separate parts of a work and then to integrate their parts with each other through virtual or collaborative tools.

The practical exercises results will be delivered to the teacher through the platform, so that he will be able to revise them using the online platform by giving marks and making suggestions that will be available for the students who are participants of the online course. In regard with the work in team, the final document and implementation will also be available in the virtual environment, so that the remaining students can benefit from their colleagues research to learn. Besides, every team will do their work presentation to their partners and teacher, explaining the obtained results, generating a final discussion on the topic. Students who cannot attend to the scheduled presentation will be allowed to do a virtual presentation and to answer to the questions the remaining students may do through the platform. Finally, non-attendance students will comment the remaining works in a forum. The authors will also be able to answer through the forum in question (top week of Figure 6).

At the end of the course all the students can follow a final questionnaire, in which to check the knowledge they have acquired in the subject (shown in lower week of Figure 6). The main purpose of this questionnaire is the students to realize that they do know how to answer some questions about a topic they did not know at the beginning of the year. The result of the questionnaire is a minimum part of the assessment of the student. Assessments are built based on their fruitful participation in all the activities proposed in the virtual environment.

B. Activities in Attendance Environments

Even though there is not always a clear correspondence between activities in virtual environments and in attendance ones, we explain here how do it in our Web Service module. Table 1 shows the equivalences described below simplified. Further information on attendance activities can be found at [10].

First of all, news and forums, which are easily addressed through a virtual tool, are implemented in attendance environments by simple advices or comments during lectures. This implies that for most of them no written evidence is saved.

On the other hand, attendance activities are mainly based on *magisterial lectures*. Web Services, being a third year subject, needs fewer magisterial lectures than for instance a first year subject. The same theoretical information that was provided through the virtual platform for the students to download and read it is provided here during the lecture and briefly explained to them. Afterwards, a discussion on the topic replaces the quiz we proposed for the virtual platform. A written test could have been followed for this purpose; however, since in the attendance environment we have the chance to discuss openly, we considered it more beneficial for students than the traditional written test.

Besides, in order to elaborate knowledge in common, wikis can be replaced by team work. The team can discuss on the topic during the lecture and afterwards go on

searching additional information to complement the original one. With this information they can elaborate a final document which can be presented and discussed with the remaining students during the following lecture.

Regarding glossaries, they can be implemented by different work groups and then distributed in the classroom. It is a nice option to have a printed glossary to discuss during the lecture and make notes on it, but I would say it is even better to build it gradually in the virtual platform and keep it saved for the rest of the academic year.

Additionally, several activities can be carried out in this format during the lectures such as discussion and debates. In this sense, the teacher may propose several topics for discussion and then students have argument their proposed solutions. This way, they improve the skill of addressing an audience strictly speaking, versus the option to do it through their participation in a virtual forum. Role plays are in the same line, once the roles are assigned and the problem is described by the teacher, performance can be developed during the lecture time. This activity could also be conducted through virtual forums, but with extra difficulty. Finally through judgment simulation, professional behaviours can be judged.

Students should also be able to present the learned topics correctly; to do so first of all they can elaborate a presentation through slides and present them in the slot time proposed for it during the lectures. Afterwards a discussion can be followed up. The advantage here is that the discussion is followed up exactly after the presentation when the topic presented in still fresh in their mind; in the virtual environment, the discussion lasts more time and the ideas are not fresh for everybody in order to establish a fruitful debate. However, virtual option provide the students with the possibility of reading again those parts of the presentation in which they are interested or they have doubts and they have more time to assimilate its contents to get ready for discussion.

Virtual Activities	Attendance Activities
News and forums	Advices and comments
Theoretical deliverables + quiz	Magisteral lecture + discussion/test
Wikis	Team work
Virtual glossary	Work group glossary
Virtual forum	Open discussion/role play
Presentation slides +	Presentation + discussion
forum	
Group research	Group research
Laboratory tasks + forum questions	Laboratory tasks + alive questions
Virtual test	Written tests

Table 1. Equivalence between virtual ad attendance activities

Concerning group research, in any case is done outside the classroom, so its functioning is quite similar to the analyzed in the virtual environment. The only difference is that the exposition of the developed work is not virtual. In this case the same considerations described in the previous activity apply here.

Regarding laboratory activities, the teacher can provide the students with the main principles and some helpful information and references at the beginning of the lab task. Then the students can start with the task during the lab scheduled lecture and ask any doubts they have. Afterwards they go on with their task on their own. Thus, the main difference here is that doubts are asked presently instead of through the virtual environment.

Theoretical exam and practical exam can be carried out in the traditional way, in a present session.

V.   RESULTS OF THE LEARNING EXPERIENCES

In this section we are going to describe the first impression from the results that were derived from the teaching procedure in the virtual environment (subsection A), then we will compare the results with the ones obtained when teaching the same subject in an attendance environment (subsection B) and finally we will summarize the lessons learned.

A.   First Evaluation of the Results using Virtual Environments

With the teaching methodology followed through the use of the virtual environment we obtained the following results:

- First of all, the students could successfully improve their cross-curricular activities, thanks to their practice during the virtual environments, in which they had to acquire knowledge by themselves (in English or Spanish), to talk to an audience (small when working in teams, bigger with the whole course), working in team (with and without supervisors), etc.

- Students who were working and had schedule problems to attend the lectures or students who were abroad, that in other situation wouldn't have been able to follow the

subjects, finished it normally and even they got good marks. Most of time happens that working students experience in the industry gives them quite a higher view on the subject-related knowledge and therefore, even though they have the handicap of not being able to attend the lectures, they normally are very successful with the subject.

- On the other hand, we are all aware that most of the students are reluctant to participate during the lectures. The virtual environment makes this labour easier for them, since they can take their time to express what they think and then write it in the forum or in the wiki. Besides, once they get comfortable with the interactive activities, and especially when they know that the participation is mandatory, they start providing very interesting comments and analysis.

- Eventually, although they have to work harder from the very beginning of the academic year, they realize that they learn and acquire more concepts more easily than they used to. They soon feel confident enough to ask any doubts; and this is not quite a usual atmosphere in the university scope, even through a virtual environment.

Once the year ended, the results showed that all the students who followed regularly the subject passed it with a good mark. The ones who decided not to participate in the weekly activities did not even show up in the exam. Besides, the students showed a great improvement in cross-curricular skills and self-learning from the beginning to the end of the year, especially in talking to an audience. In this regard students cross-curricular skills were evaluated through their participation and behaviour in the different activities proposed during the module; the results obtained were

around 10% better than in previous years, in which they followed a unique final assessment. Therefore, we can affirm that the methodology presented improved not only cross-curricular skills, but also efficiency in learning the subject contents through virtual e-learning environments.

B. Comparing Results using Virtual versus Attendance Environments

On the one hand we can compare the marks obtained by the students. According to the Spanish scale, marks are subdivided in the groups shown in Table 2, where marks below 5 are failed, and 10 is the best mark which can be obtained.

Value	NP	[0,5)	[5,7)	[7,9)	[9,10)	10
Mark	NP	S	A	N	S	MH

Table 2. Equivalence between Numeric Assessments and Final Marks

The marks obtained by students in two consecutive courses, the first with attendance lectures and the second with virtual ones, are shown in Figure 7. In it we can see that the percentage of students who decided not to follow the subject and not to present their tasks is bigger in the attendance mode (NP). Some of these students were already working in the industry and they could not attend lectures, therefore it was not easy for them to follow the subject. The students in that situation in the virtual subject, could follow it through Internet and finish the subject successfully.
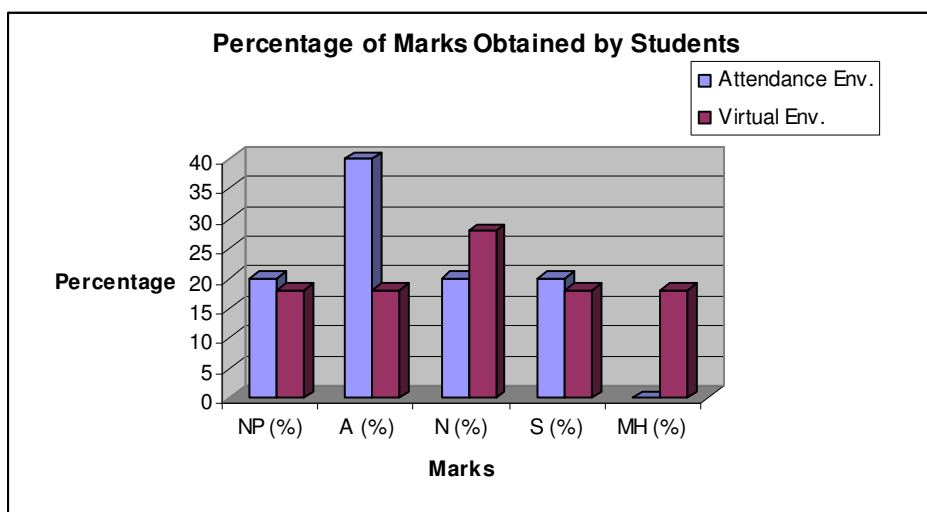

Fig 7. Percentage of Marks obtained by Students in Virtual And Attendance Environments.

We can also appreciate in the mentioned figure that the marks are significantly better in the virtual environment academic year (nearly two points over the attendance year). We consider that this figure is due to the freedom the students feel in order to participate in the activities when working with a virtual tool. We all know students may feel insecure of themselves and are reluctant to participate actively during lectures because of this reason. When they have the option to meditate or document their opinion about a subject previous to their participation (i.e in a virtual forum) they feel more confident and their participation increases.

We can also analyze how they worked and improved the cross-curricular skills mentioned in Section II, taking into account that assessments related to cross-curricular skills are based on the evaluation of their activities in the virtual tool or during lectures:

- *To develop the ability to understand, and enable others to understand, knowledge related with Web service technology, to be able to learn themselves about the named technology*: in both experiences the students had to present their research on a specific topic to their colleagues. Even though, in virtual environments they got better abilities in expressing their opinions and refuting others arguments with good criteria, in attendance environments they got better improvement on their
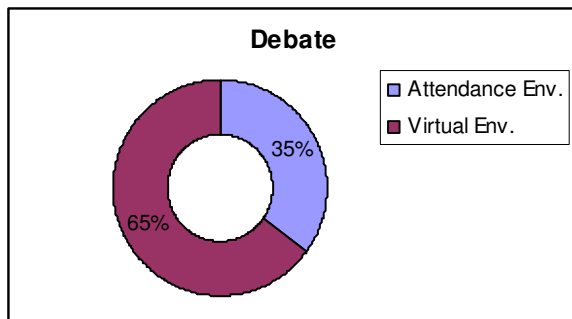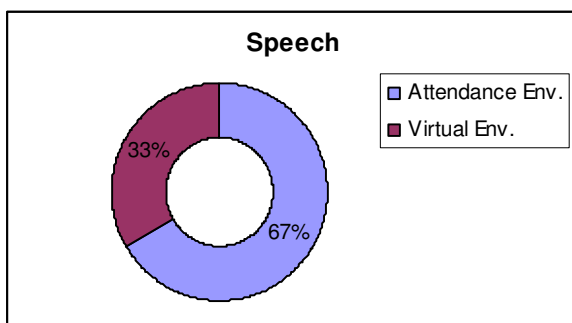

Fig 8.1. Debate Ability Improvement.

Fig 8.2. Speech Ability Improvement.

Fig 8. Debate and Speech Ability Improvement in Virtual and Attendance Environments.

ability to address an audience. This fact is reflected in Figures 8.1 and 8.2, respectively.

- *To be able to work as a team effectively*: in both cases they did it properly; they demonstrated to be able to coordinate and deliver a task in the team both having virtual and attendance learning. Nevertheless, it could be appreciated a slightly better distribution of tasks and roles in the attendance option, as shown in Figure 9.
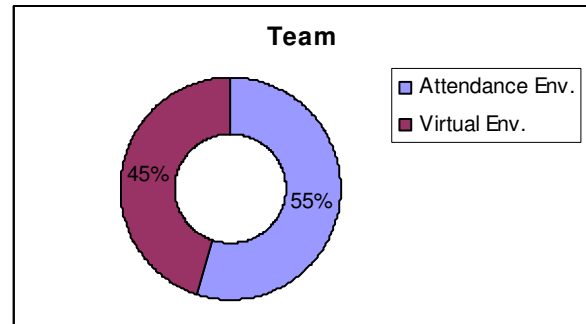

Fig 9. Team Work Ability Improvement in Virtual and Attendance Environments.

- *To be able to acquire Web service related knowledge when provided in English*: in this case, having a virtual or non-attendance environment does not influence the result, since the texts that they have to read and the knowledge they have to acquire by themselves in English is the same. Thus the percentage is the same for both values in Figure 10.
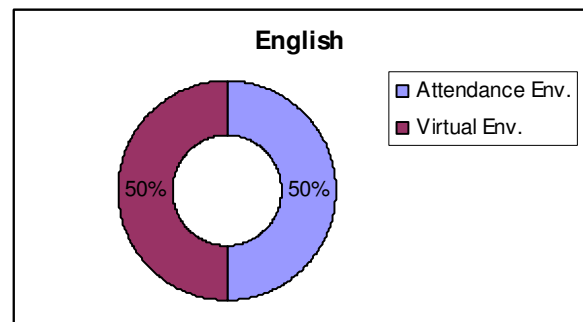

Fig 10. English Ability Improvement in Virtual and Attendance Environments.

C. *Lessons Learned Through the Experiences.*

Students' first reaction to any change in the educational methodology is always negative since they feel very secure doing what they have always done (mainly attending magisterial lectures and studying on their own for a written exam).

Initiatives for the improvement of cross-curricular skills, implement new methodologies which make them participate more during lessons, being especially encouraged by the virtual format, therefore bringing them back from their passive behaviour. Obviously, this also implies a very negative attitude on their part when moving on to a new methodology. Nevertheless, once they get used to it and once hearsay has run from one year to another, they understand there is no other option and face the subject with a much more positive attitude.

However they still have their preferences: it was noticeable that they got used to develop tasks in groups after two or three lessons; however those activities which were developed casually (role play, judgements, PBL, etc) still somehow scared them since they are not used to them and feel out of their comfort zone, therefore lacking confidence to complete the tasks naturally.

In any case, after the experience one can decide which activities work better for the subject and type of students in question, so some of them may not be used some years, to be included other years when the circumstances are more appropriate. An activity which may result in an interesting experience is to organize a simulation of a research conference and assign the different common roles in conferences to different groups of students (program committee, organizing committee, authors, keynotes and so on), the topics being the contents of the subject. This way, as they learn the main concepts of the subject, they work as part of a team and have to talk to an audience. If the experience works it can also be very fulfilling for them to see how they have been able to organize an event with the whole group.

Eventually, although they have to work harder from the beginning of the academic year, they realize that they learn and acquire more concepts more easily than they used to. They soon feel confident enough to ask any doubts and to make comments in the forums, even to spontaneously rebate about a topic to one of their partners; and this is not quite a usual atmosphere in the university scope, even through a virtual environment. This change of mentality alone would make the effort of improving the teaching methodology worthwhile, however, as we well see in the following section, this is not the only improvement.

On the other hand, they seemed to be very surprised when they were told that they did not have to attend lectures regularly in the virtual subject, and they even thought that they might not learn the subject contents properly. However, as soon as they started doing the virtual activities, they realized that they still had to work hard on the subject and that indeed they were going to acquire the correspondent knowledge.

VI. CONCLUSIONS

Virtual environments may not be suitable to any subject, especially if consider cross-curricular skills as specific targets to be met. There is no doubt that these skills will improve our students' training and education, but they make even more difficult to follow a subject objectives in a virtual scope.

However, the greater mobility for both students and teachers and the increase of working student made us consider this option. In this regard, we have presented a case study in which we followed the subject Web Services through a virtual environment and compared its evolution with the experience of teaching the same subject in an attendance way. The results summarized in the previous section let us assert that with our proposal not only do we work cross-curricular skills, but we also dynamize the subjects in question in a virtual environment, providing the possibility of choosing the subject to those who cannot do it presently, and not interrupting lectures during possible teacher absences. Besides, e-learning activities let us focus on students' personal work, and improve their cross-curricular skills, which are useful for their development both at professional and personal level. These methodologies make them participate more during lessons, being especially encouraged by the virtual format, therefore bringing them back from their passive behaviour.

In our future work we plan to follow additional experiment with other modules taught at the University.

VII. ACKNOWLEDGEMENTS

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