Applying New Methodologies and ICTs for Effective Lecturing in Higher Education

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Abstract

The advances in new technologies have contributed to the design of novel practical-oriented learning methodologies included in current European Space of Higher Education (ESHE) studies. In this paper, we overview new learning methodologies implemented at the Universitat Politècnica de València (UPV), Spain, in different Bachelor and Master Degrees of Telecommunication, Building and Civil Engineering. Cross-disciplinary learning techniques are proposed to create cooperative learning groups comprising students from different disciplines with a common background. The results obtained at the UPV point out that both Master and Bachelor level students enhanced their learning process when working in cooperative groups. It was also observed that students' motivation increases if the students take part in the design of the lecture contents. A new methodology tested at UPV involved Master Engineering students in the preparation of a laboratory session which improved the learning outcomes. We found also important to evaluate the effectiveness of feedback and feedforward to provide useful information about the students' learning progress. It was observed that the students' motivation increases when combining traditional learning with new information and communication technologies (ICTs). In this paper we also investigate options for more effective lecture by integrating students' mobile devices (e.g. smartphones or tablets), new ICT tools like wearable devices (e.g. smartwatches or Google Glass) and social networking platforms (e.g. Facebook) in the learning process.

1. Introduction

In the past decade, the advances in new technologies have contributed to the design of novel practical-oriented learning methodologies in Higher Education. These novel methodologies have been included in the new European Space of Higher Education (ESHE) Degrees that, according to Bologna process, have shifted from a traditional teacher-centred process to a learner-centred process [1]. For this reason, during the last years, the interest in teaching methods for active learning has increased considerably. Hall et al. define the active learning methodologies as "teaching techniques that stress the student's involvement in their learning" [2]. The student performance in undergraduate science, technology, engineering, and mathematics (STEM) courses has been recently analysed highlighting that students in traditional classes were 1.5 times more likely to fail than students in active learning classes [3]. From these results, we observe that the combination of new methodologies and novel information and communication technologies (ICTs) for active learning can improve the lecturing experience and the students' learning results in Higher Education. In this paper, we overview some of the new learning methodologies using ICTs implemented in different Bachelor and Master Degrees of the Universitat Politècnica de València (UPV), Spain.

2. New Methodologies for active learning

2.1 Active learning in cooperative groups

Recent studies point out that the students' average examination scores are improved when using active learning [3]. At UPV we proposed a joint laboratory lesson including both Bachelor and Master degrees in Telecommunication Engineering. The joint-activity implements the methodology knows as "learning by teaching others" in cooperative works [4]. The students from Master degree teach the students from Bachelor degree how to proceed for a fibre fuse, and work together to the preparation of an optical network.

The results of this experience indicate that students learned faster when working in cooperative groups. Moreover, with the combination of Master and Bachelor students we observed that Master students can recall better the topics explained at this lesson thanks to the method of teaching others reducing the time needed to prepare the final exam. The pass-rate of Master students was of 100%, with an improvement of 20% compared with the previous year. In the case of Bachelor students the

pass-rate was of 82%, also with an improvement in this case of 8% compared with the results obtained before implementing the multi-disciplinary joint-activity.

The following year, we implemented in the same group another active methodology involving the students in the design of the lecture contents. A survey was presented to the students in order to evaluate their previous knowledge level about different topics –Fig. 1(a)– and to sound out their interests for a practical lesson –Fig. 1(b)–.

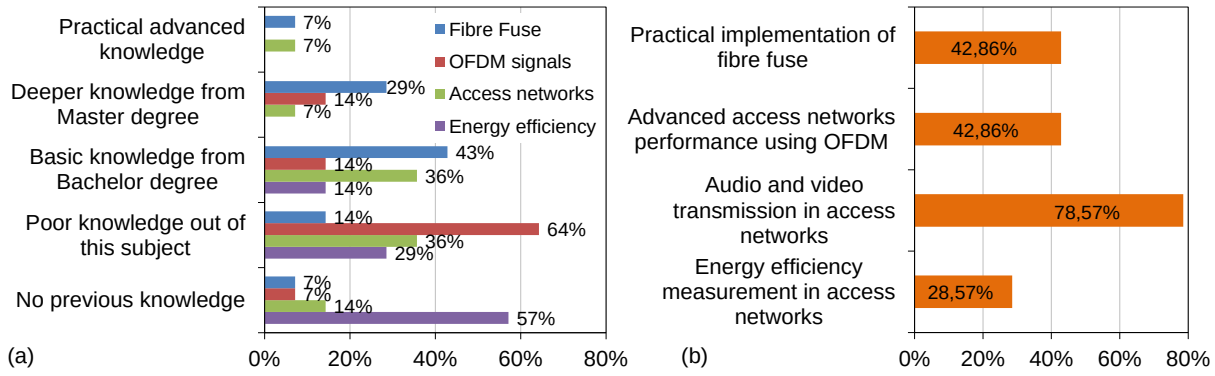

Fig. 1. Student survey results for: (a) previous knowledge about different topics and (b) students interest for a practical laboratory lesson

Fig. 1(a) shows that 43% of the students have basic knowledge about optical fibre fuse (usually they have seen videos during the Bachelor degree) but they have not carried out an optical fuse by themselves. However, in this group of students, we observed a rising in the number of students with deeper experience on fibre fuse (29%) and a 7% have practical advanced experience. This indicates that, for this group, a laboratory lesson centred in fibre fuse would not motivate the students, as confirmed in Fig. 1(b) where fibre fuse is not the preferred topic. Fig. 1(b) shows that 78.57% of the students considered that the audio and video transmission in access network was the most interesting topic for a practical-oriented lesson. Based on the results obtained with this survey, the professors designed the contents of a laboratory session. The students' motivation increased considerably when the students were involved in the design of the lesson contents.

2.2 Feedback and feedforward considering students' efforts

Another important aspect to take into account in the student's achievements is the amount of time spent by the students in each learning activity[5]. At UPV we designed and tested different survey templates for measuring the time spent and the student's opinions regarding a given task. Different surveys are defined to analyse individual and cooperative activities and also tasks performed in the classroom and at home [6]. This research provides useful feedback from the students for defining a more accurate assessment and evaluation of the learning process. Fig. 2 shows the results obtained in a group from Telecommunication Engineering degree for a writing activity and a proposed problem. We observed that the time spent reported for activities done at home was higher than the time spent by the same group of students in solving a similar task at the classroom. This confirms that students need to plan their homework more efficiently.

The survey results shown in Fig. 2(a) for a writing activity point out that 38% of the students would invest more time in searching information before starting writing the report. In a problem-based activity as depicted in Fig. 2(b), 60% of the students consider they need to schedule better the time for studying the topic and 50% consider it is necessary to study previously the provided materials before solving the problem. In addition, 50% would read more carefully the task in order to avoid misunderstandings.

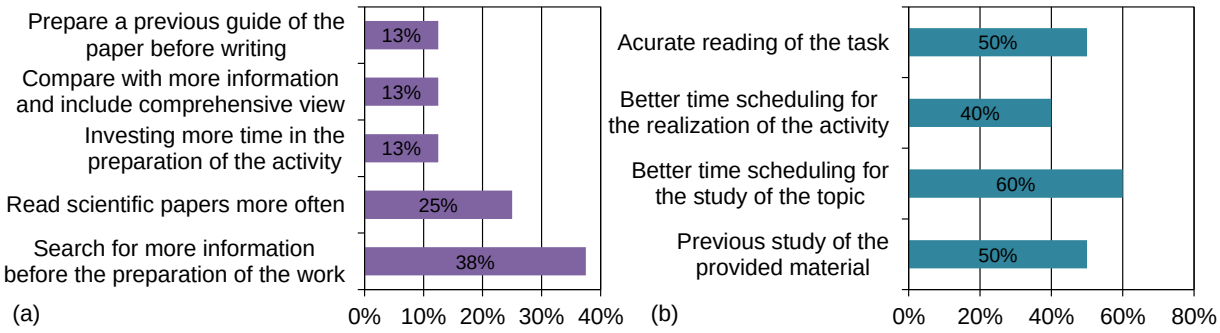

Fig. 2. Student opinions about how to improve their performance in similar activities for: (a) a writing activity, (b) a problem-based activity

The students considered the evaluation of their effort useful to prepare similar tasks after during the academic year as they learned by experience from the effort required in previous activities. With the combination of feedback and feedforward the students obtain useful information regarding their results which helped them to obtain the learning objectives [7].

3. Employing ICTs for effective lecturing

Incorporating novel ICTs to Higher Education lecturing also improves students' motivation [8]. The possibility of real-time interaction with the students during a lesson was enabled recently due to the pervasive presence of widespread mobile technologies such as laptops, smartphones and tablets. In this section, we summarize different ICT usage examples implemented in lectures at UPV Degrees in Telecommunication, Building and Civil Engineering.

Fig. 3. Examples of using ICTs at UPV: (a) employing students mobile devices for solving short exercises during the lesson, (b) wearable devices for more effective lecturing and (c) social media for faster communication

Employing the existing infrastructure in Higher Education classrooms combined with widespread mobile devices encourages the students' participation in class and helps the professors with the extra monitoring work required for ESHE formative evaluation [9]. The combination of education with ICTs permits correcting tests and exercises in real time, providing a quick feedback to the students. Fig. ***3***(a) shows an example of online application used to present educational content to the students and interactive exercises during a laboratory lesson in Telecommunication Engineering. Data gathering can be obtained using interactive tools that record the students' answers during the classroom as it was proposed in [10]. Using ICTs also enables capturing handwritten data –as shown in Fig. 3(a)– which reduces the time spent in solving the exercises and permits finishing the task during the lesson. With these novel technologies, it is also possible to obtain the corrected results to provide a faster feedback to the students. Fig. 3(b) shows an example of using wearable devices for more effective lecturing. Smartwatch technology enables changing automatically the slides while freely moving around the classroom. Using a smartwatch the professor can control the time spent in each concept and activity proposed in the classroom. Intelligent glasses (e.g. Google Glass) can be used to check in real time the academic profile of the students or their latest activity results. With this data on the

glasses screen, the professor can adapt the explanations to achieve a more effective knowledge building [11].

Inside ICTs, social networking applications have grown rapidly in popularity on the Internet in recent years [12]. In the educational environment, Facebook is also used for social interaction, in most of the cases with students that are also friends outside the classroom [13]. Fig. 3(c) shows an example of Facebook communication implemented at UPV Building Engineering degree. In this case, 64% of the students considered that using social networking fastened the communication between students and also with the professor [14]. It was interesting to notice that including ICTs in the lecturing improved the relation between the professors and the students and obtained higher participation and, in most of the cases, better results.

4. Conclusion

In this paper, we include an overview of the new learning methodologies implemented in different Bachelor and Master Degrees of the Universitat Politècnica de València (UPV), Spain. We evaluated the results of active learning using cooperative groups. With cooperative learning, the students work in groups to develop and maximize the concrete learning of each member of the group. The time spent by the students in completing a given task was monitored, considering individual and cooperative activities, as the amount of time spent by the students in each learning activity is another important aspect to take into account in the student's achievements. The effectiveness of using feedback and feedforward in Higher Education was also evaluated in this analysis.

Different examples of employing new ICTs in Telecommunication, Building and Civil Engineering degrees were implemented at UPV. A content distribution network was used to present interactive exercises during the lesson. ICTs can be used for the automatic assessment of students' results which enables the continuous evaluation of large groups of students as required in new ESHE degrees. Wearable computer devices, such as intelligent glasses or smartwatches, also enhance the lecturing experience. In this work, we show an example implemented at UPV using a head-mounted display and a smartwatches to perform an automatic tagging of the educational contents explained by the professor in the classroom. Finally, using social networking platforms like Facebook during the learning process was also evaluated as a good option to make the communication between professors and students more dynamic. The results reported in this work confirm that the combination of ICTs with active methodologies improves the learning process effectiveness in Higher Education.

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