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# Problem-Based Teaching through Video Podcasts for Coding and Cryptography †

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**Abstract:** In this work we present the development and preliminary evaluation of several problem-based video podcasts addressed to students of the subject "Coding and Cryptography". Specifically, this experiment has been carried out with the students of both the Bachelor's degree in Mathematics and the Master's degree of Mathematical Research and Modelling, Statistics and Computation, at the University of the Basque Country (UPV/EHU). Our results suggest that students found these complementary videos helpful for their learning process, indicating that this methodology could be appropriate for subjects treating complex concepts, such as those in the last years of degree or in master courses.

**Keywords:** video podcast; problem-based teaching; Coding and Cryptography; Algebra

## 1. Introduction

The process of teaching/learning mathematics is highly complex, and in order to improve its effectiveness, several methodologies have been posed. The arrival of computation has raised a new field of research regarding the use of novel techniques and environments that take advantage of these electronic devices [1]. In particular, the use of video podcasts as a complement for traditional teaching has been associated to several benefits such as increased learning performance [2] or improved learning habits [3], among others. In recent years, those advantages have been noticed, and the use of this kind of videos has increased notably [4].

Concerning mathematics, handling algebraic notions fluently stands as an essential skill for students [5], and several international studies indicated that its lack is related to a drop of scores in subsequent subjects [6], which is even more remarkable in university degrees [7]. This is, in fact, the case of the subject "Coding and Cryptography", where the underlying mathematics requires of a deep knowledge of Algebra. This is the reason why it is usually taught in the last years of university.

In addition, even problem-based learning in mathematical courses is uprising, there are not many peer-reviewed studies analyzing the use of problem-based video podcasts within this discipline [8], which opens a new field for mathematics teachers.

In this work we present, for the first time, the development and preliminary evaluation of several problem-based video podcasts directed to students of the subject "Coding and Cryptography". Specifically, this experiment has been carried out with the students of both the Bachelor's degree in Mathematics and the Master's degree of Mathematical Research and Modelling, Statistics and Computation, at the University of the Basque Country (UPV/EHU).

## 2. Materials and Methods

The current study was comprehended between October 2017 and April 2018. During this period, 9 presentations were prepared by using *Beamer* program and consequently, both the voice explanation and the presentation of each video were recorded simultaneously with the screen recording program *Camtasia* (version 7) [9]. Later, our video podcasts were uploaded to the public repository EHUTB [10] and finally, teachers informed the students about their accessibility.

We configured two groups, the first one, formed by the undergraduate students ($n = 26$) and the corresponding videos ($n = 4$), and the second one, constituted by the master students ($n = 5$) and the respective videos ($n = 5$). The durations of the videos ranged between 2′31″ and 25′23″ (9′30″ ± 7′2″, mean ± standard deviation). In Table 1, we summarize the codes, titles, number of views and duration of our videos.

**Table 1.** Views and durations of the videos.

| | Code | Title | Views | Duration |
|---|---|---|---|---|
| Undergraduate students ($n = 26$) | 2.1.1 | Even weight words in a binary code | 69 | 3′18″ |
| | 2.1.2 | Words starting with zero in a binary code | 36 | 3′51″ |
| | 2.1.3 | Code construction | 52 | 12′35″ |
| | 2.1.4 | Pseudo-primes with respect to a given base | 25 | 2′31″ |
| Master students ($n = 5$) | 2.2.1 | Even weight words in a binary code | 69 | 3′18″ |
| | 2.2.2 | Words starting with zero in a binary code | 36 | 3′51″ |
| | 2.2.3 | Code construction | 52 | 12′35″ |
| | 2.2.4 | Pseudo-primes with respect to a given base | 25 | 2′31″ |
| | 2.2.5 | Even weight words in a binary code | 69 | 3′18″ |

## 3. Results

During the period October 2017 through April 2018, we recorded, edited and uploaded to a public repository 9 videos (4 for undergraduates and 5 for master students) working concepts and examples of the course "Coding and Cryptography". Each problem appearing in the videos was explained step by step.

Next, we made a preliminary estimation of the usefulness of the videos, as a function of the number of reproductions and the number of students. First, we approximated the number of times that a student used certain video podcast by dividing the number of views by the number of students of each course (Figure 1a). Afterwards, we estimated the utility of the podcasts for each group, averaging the number of views of all videos and dividing them by the number of students (separately for each course), which gave 1.75 ± 0.7 and 2.04 ± 0.7 views/student, for undergraduate and master students respectively. Additionally, the median value (i.e., the central value of the distribution) was 1.74 for undergraduate students and 2 for master students. Then, the distribution of the values of the two groups was compared with a non-parametric test (Wilcoxon ran-sum test), which gave a $p$-value of 0.73. This indicated that even if the median for the master students was higher, the difference between distributions was not significant enough.

In order to give a graphical representation of these statistics, two charts were illustrated: the first one is a bar graph where the number of reproductions per student is represented for each video (Figure 1 panel a); besides, the average values for the undergraduate group (blue line) and the master student group (red line) are represented. The second one, a box plot illustrating the distribution of the values for the two groups individually (Figure 1b); in short, the blue boxes represent the distribution of the central 50% of the values, the red lines represent the medians and the rest of the values are represented by the black arms.

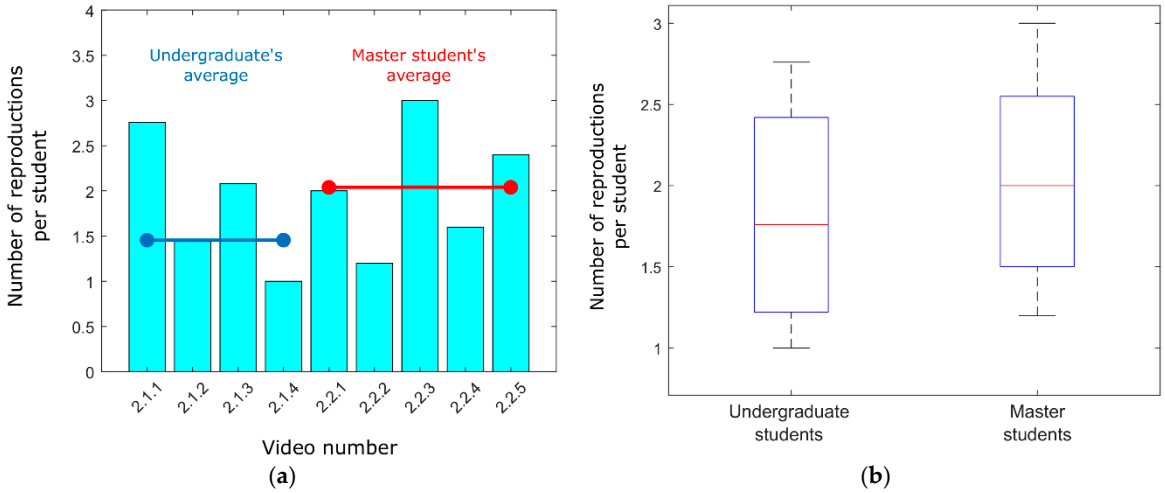


**Figure 1.** Metrics of views per student (**a**) Bar graph representing the number of reproductions per student for each video (denoted as in Material and Methods section); in blue, the mean value of views/student for undergraduates, and in red, the average for master students. (**b**) Box plot describing the distribution of views/students divided by groups.

## 4. Discussion

In this work, we have presented the first study addressing the usefulness of problem-based video podcasts for students attending "Coding and Cryptography" subject. Our preliminary results suggest that students found these complementary videos helpful for their learning process, suggesting that this methodology could be appropriate for courses treating complex concepts, such as those in the last years of degree or in master degrees. Moreover, this analysis suggests that master students found this tool more useful than undergraduate ones, but further research would be needed to affirm such statement.

However, we acknowledge the limitations of this preliminary study, on one hand, because the videos were uploaded as the courses lapsed and not since their beginning, and on the other hand, because the number of students attending "Coding and Cryptography" in a single year is relatively small. Finally, we consider that in order to evaluate the aforementioned teaching technique, we will need to elaborate several more videos, and perform, during several years, a complete survey about students' opinion, activities that are currently planned as future work.

**Author Contributions:** The five members (J.G., L.L., I.M. (Iker Malaina), I.M. (Iraide Mardones) and LM.) conceived and designed the experiments; L.L. and L.M. performed the experiments; I.M. (Iker Malaina) analyzed the data; the five authors wrote the paper.

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