Use of an Offline Video Repository as a Tool to Improve Students' Performance in Engineering Courses versus Real-Time Long Distance Courses

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***Abstract*—In this paper, a teaching model that makes use of a YouTube video repository for Engineering courses is presented. Some results show the preference of students of such a model over traditional teaching models that use live video. The proposed offline model with a video repository is presented as a better alternative for Engineering courses, improving aspects as students satisfaction and above all, the performance of students in Structural Mechanics courses where the model was implemented.**

Keywords— video repository, online education, distance learning, education model, social networks, YouTube Education Channel.

I. Introduction

Distance education has become an important tool in modern educational models. The use of real-time video conferencing to transmit lectures even to other locations within the same university campus has been widely used. There are some technical requirements for real-time video conferencing over the internet that sometimes let down the whole experience. For instance the internet connection in some areas or countries that could show intermittence could lead to an overall bad experience of a real-time course. The main objective of this paper is to complement previous work [1] done on the subject of the use of digital social networks as a tool to improve the performance of students in Engineering courses, especially the use of video conferencing and video repositories. In this work we study the preferences of students regarding the type of model for courses that rely on video technology.

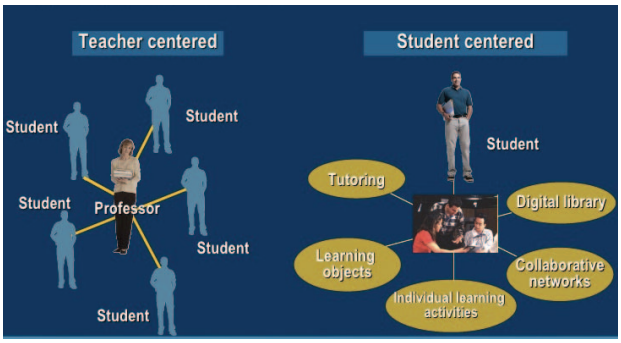

Fig. 1: Change of model from a Teacher Centered approach to a student centered approach at Tecnologico de Monterrey.

At *Tecnologico de Monterrey*, the education model has changed in the last few years. From a professor centered approach, to a student centered approach (Fig. 1).

It has been shown that the use of social networks can have a positive effect in the communication students/lecturer [2-5], including the use of Twitter and Facebook as tools in courses [6-7]. In this study we compared two of the methodologies and present how a course with a video repository is better accepted by students than a course that is transmitted in real time from a remote location. The telepresence model using holographic projection [8] is not included in the comparison.

II. Use of Video Technology for Lectures

Universities and other institutions have benefitted recently with the introduction of broadband internet and applications that are able to deliver real time video from almost any location on the planet. Before the time of internet, Tecnologico de Monterrey pushed the use of real time video in its more than thirty campuses across Mexico and even in some other countries with the use of satellite TV with broadcasts from its main campus supporting smaller campuses with programs like the Program to Support the Campii of the University System (PACSI) in the nineties and beginning of the twenty-first century.

During the adaptation of the education model to a student centered approach, several new technologies have been incorporated in courses at our university system:

a) Online courses, called "Virtual Courses" where most material is available online in platforms like Blackboard and/or Canvas

b) Traditional Lectures' Model with local or visiting professors

c) Courses with video repositories and flipped learning

d) Courses with video link in real time using internet and students from several campuses connect to one professor in real time, called FIT Courses (Flexible, Interactive and with use of Technology)

e) Telepresence courses using holographic projection of the professor in remote locations [8]

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For some courses students have the option between these several models to choose from when they enroll. Students decide what type of course is best for them according to the several factors, including the difficulty of the course, their own timetable as some of them work, and in some cases, based on the personality of the professor teaching the course. In the following sections we will present a proposed model for courses with video repositories and flipped learning.

III. METHODOLOGY

A. *The courses of study*

The selected courses for this study are courses of Mechanics of Structures that students from the majors of Civil Engineering and Architecture have to take during their second year of their programs. These courses are initial courses to the subject of Structural Engineering and usually represent certain difficulties to many students due to its numerical nature and the required problem solving competences.

B. *Participants*

A total of 200 students took part in this study spanning five semesters in which results have been recorded. At Tecnologico de Monterrey students choose their major or program from the very first semester. Students that take the courses Mechanics of Structures 1 and Mechanics of Structures 2 belong to the Architecture and Civil Engineering programs and are in the third and fourth semester of each program, respectively. As mentioned before, these courses are the first courses of Structural Engineering taken by students. Most students have already taken a course in any of the modalities mentioned in the previous section. The students voluntarily chose the group and the professor teaching each course, having at least one other option. Students answered surveys on the course experience at the end of the term before their final exams.

C. *The lecture room*

As part of the changes required by the new educative model (TEC21) at Tecnologico de Monterrey, new spaces have been proposed to have a better interaction with students and new technologies, one of the spaces is the Innovate Room in which the courses took place (see Fig. 2). This room has an area of sixty-four square meters in a square factor, eight meters by side. It has three walls with white boards and four projectors so that four independent video sources can be displayed at any time. It has thirty chairs but the size of the class in each course was limited to a maximum of twenty five students. The chairs are made by Steelcase® and allow several configurations for collaborative work, as shown in Fig. 2 and Fig. 3.

D. *Mobile devices*

The use of mobile devices with internet access during a lecture has been a subject of debate with many teachers and lecturers forbidding their use in the classroom while other allow their use [9]. For this study, the participants were required to bring to class a pair of headphones and a mobile device that could be used to watch video material from the YouTube repository for the courses.

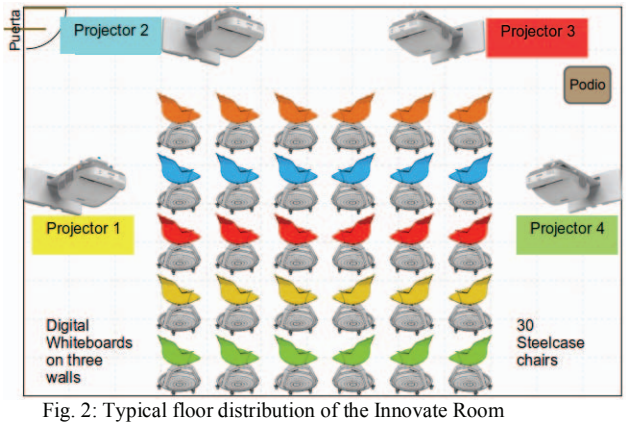

Fig. 2: Typical floor distribution of the Innovate Room

E. *Hardware for video recording*

In the proposed model, the professor takes charge of the recording of the video and it is intended to be easy to operate and with the minimum interference with the lecture or collaborative activities that take place during a normal session. Each course has two sessions of 1.5 h per week for a total of 3 hours each week. The professor would start recording with an action cam that has a wide angle lens that covers most of what is being discussed in class or the problems being solved on any of the white boards available in the Innovate Room. The camera used is a Sony Action Cam Model HDR-AS20 that allows the recording in full HD resolution. A memory card of 32 GB was used and allowed to record up to 6 hours of video. As part of the setup, the camera was mounted on a small tripod, as seen in Fig. 4.
It is important to note the portability of the video recording equipment as it allows to be moved freely during a class and it can be positioned on top of any chair. In first attempts to record lectures or class sessions, the camera setup was bulky and would in some cases obstruct the view or would require an operator.


Fig. 3: Professor and students in the Innovate Room during a typical class session, Fall 2018.

IV. MOTIVATION

Courses of Mechanics of Structures and in general, any course that requires analytical skills from students can represent a difficulty for some students and in the experience of the authors, the failing rate could be as high as thirty percent of more. It was noticed that in dates close to partial exams or

final exams, students were demanding extra tutorials or guidance by the professors of these introductory courses to Structural Mechanics.

The use of videos or a YouTube channel has been shown to help the learning process in other disciplines like the Health Sciences [10]. Other authors have also shown that when the students prepare their own videos they can improve their learning outcomes and satisfaction [11].

In order to provide a tool for Civil Engineering and Architecture students that would allow flexibility as it could be used at anytime from anywhere, provided there was an internet connection, the idea of building a repository was proposed.

Fig. 4. Action camera used to record lectures and problem-solving activities

A. *Real time courses with video transmission?*

As it was mentioned in previous sections, at *Tecnologico de Monterrey* students have a wide variety of courses they can enroll and one of them includes video transmission in real time but for courses of Mechanics students were still favoring the selection of traditional courses. A survey was applied to students on what type of courses they prefer after taking courses in each model: video in real time with lecturer in a remote location or a course with a professor in the classroom but that would provide recorded material in a repository.

One of the questions students were asked had to do with the type of course they prefer after having taken the courses of Mechanics of Structures with video repository and other type of courses, such as the real time video courses from a remote location and traditional courses. It is clear from Fig. 5 that students, all of them prefer the type of course where they have the professor locally and the material seen in class is available as video rather than having a course transmitted from a different location to them, even if the video is also available. With this initial result, in the following sections we will show results on more factors that affect the decision of students.

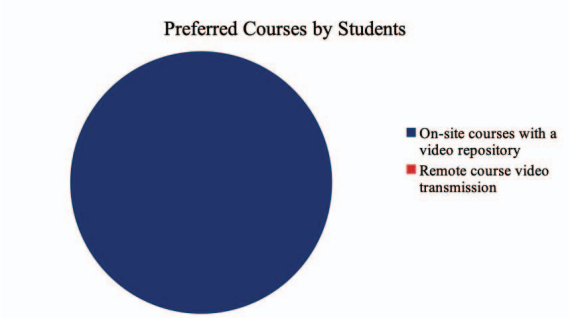

Fig. 5. Students preference of the types of courses that use video technologies.

B. *Disadvantages of courses with video in real time*

When analyzing the factors that make students not prefer remote courses with real time video transmission, the results are summarized in Fig. 6. From it, we can identify many factors that affect negatively the success of a lecture/course transmitted from a remote location to other cities, even if the material is later available as a recorded video. Students consider that the lack of interaction with professor is the most important factor with over fifty percent of opinions mentioning it as something that makes them choosing a different type of course. When students were asked what type of course were more likely to recommend for a Mechanics of Structures course, they consistently recommended the on-site course with video repository with more than ninety-five percent and the rest for traditional courses with even zero video content over the remote courses with video transmission.

C. *The need for a video repository*

One of the main reasons students do not prefer the courses with video from a remote location even if the professor is connected with the whole class through apps like Zoom® or Skype® in real time besides the technical difficulties such as bad quality of audio or video due to a poor internet connection, is the lack of interaction with the professor in the classroom with 52 percent pointing it as the main reason to dislike such courses (Fig. 6).

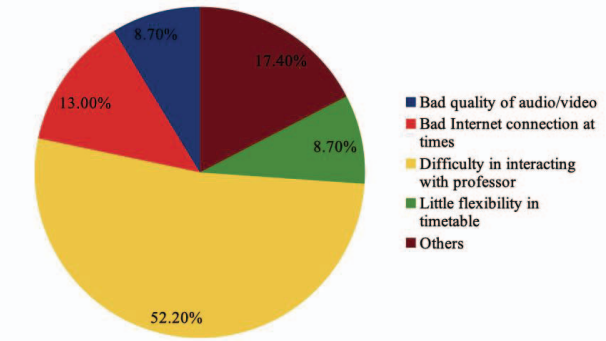

Fig. 6. Factors that affect negatively a real-time video transmission of a course.

V. Proposed Model to Incorporate a Video Repository in an Engineering Course

A. Type of video resources preferred

In order to incorporate a video repository into an Engineering course, it was necessary to see what the students were preferring as videos in their courses [1]. A survey was applied in previous semesters to students who were enrolled in Mechanics of Structures courses to see the type of video content that they would prefer to have in such courses. Fig. 7 shows the results of what a total of 160 students answered for their preference of video tools in a course. The vast majority of students wanted to have a course with the professor physically present in the classroom but with the possibility of exploring more material in a video repository. A few students declared to prefer traditional courses with no video at all.

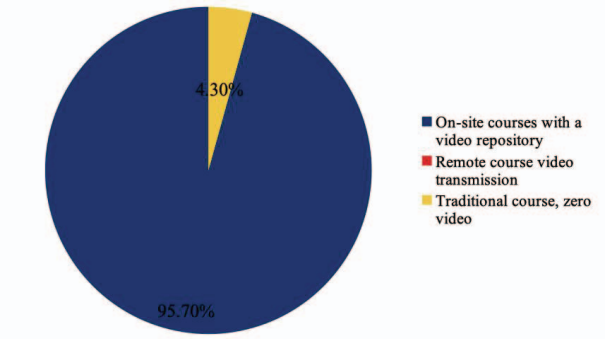

Fig. 7. Type of course that students recommend for a Mechanics of Structures subject.

B. Proposed model

For the video repository, YouTube was chosen as the platform for video uploading and sharing. The idea was not to have just the lectures or sessions recorded without any further interaction with the professor or the students. A model that is shown in Fig. 8 basically works in this way:

1. Class session that can be a session to present a new topic within the syllabus, a session for group problem-solving or work in small projects.
2. If student missed the session, the student may contact the professor to get advice on what to review before she/he attempts to solve the given homework. Professor can "prescribe" a playlist from the video repository to help the student recover what she/he missed in the session.
3. If student attended but considers more help is needed, she/he may contact the professor to get help as tutorial or visit the video repository for the recommended topic.
4. Student works in homework or collaborative activity before next session.
5. Repeat for all topics in course.

This simple procedure has worked well for students as they know that if one day they miss a lecture they can almost inmediately catch up with the content of the course as the professor uploads the session at the end of the day and there are sessions from previous semesters already in playlists for the different topics covered in the Mechanics of Structures courses.

C. Communication tools

For steps 2 and 3 of the proposed model, the communication with the professor can be done through messenger apps if students decide not to visit the professor during his tutorial hours. Facebook was chosen as the preferred communication technique, over email or Blackboard tools, available in all courses for professors and students.

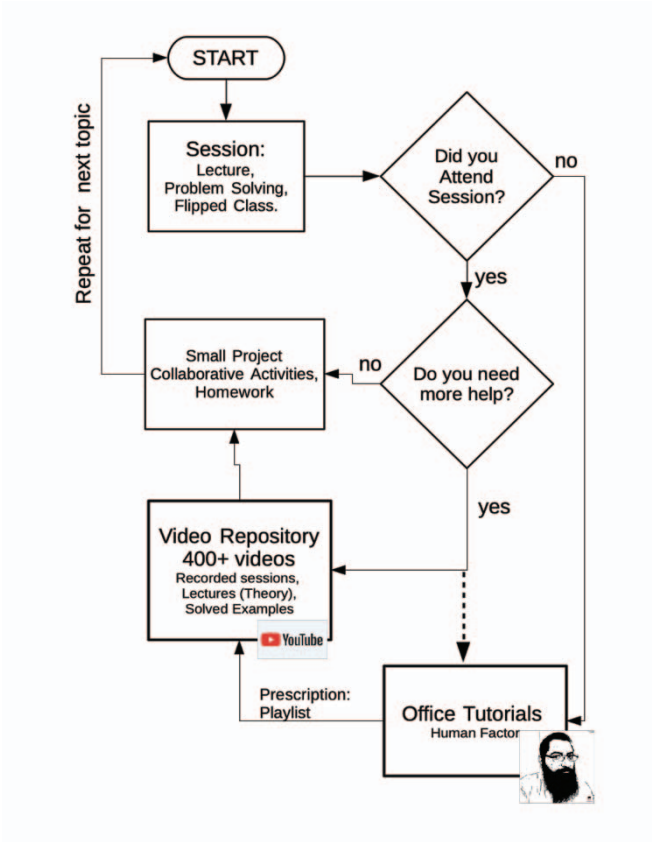

Fig. 8. Flowchart of the model that incorporates the use of a YouTube video repository into a Mechanics course.

It is also important to mention that the number of visits to the office of the course professor for tutorials or clarification has reduced, especially during the days prior to a partial or final examination.

VI. Analysis and Results

A total of 200 students answered the same survey after taking the course and before the final exam. The following results are very positive and provide a good insight on what can be improved for future implementations of the model in other subjects.

A. *Advantages of using a video repository*

Students were asked what they considered to be the main advantage of having such a model implemented in the course, grouping the answers in the following five categories:

1. Flexibility of time. Students like to have control on when to watch the material and where they watch it. Some of them even commented that they used they daily conmmute to review material for the course.
2. Lecture reposition. When students do not come to class or are traveling for university teams (participation of students in cultural and sports activities is encouraged) they can review the missed session while on a trip.
3. More solved problems available in the video repository. As mentioned before, the material is accumulative and videos from previous semesters are available as the problems are new each semester.
4. Exam review. Before each partial exam the professor produces a playlist of the minimum content they should review before the exam. Each student decides how much of the playlist they need or on what particular subject.
5. Reviewing by watching videos was found to be easier than using textbooks.

Fig. 9 shows the distribution of categorized answers and it is important to note that reviewing is the most important factor for students as 52.75% of answers indicate that they prefer to review with videos rather than books. Another 19.44% found videos very important when preparing for an exam. The percentage of students using videos for class reposition (13.89%) coincides with the number of students in each group belonging to a university team (approximately 15%). At *Tecnologico de Monterrey* we believe in an integral education model where sports and cultural activities are very important and each student is encouraged to participate in them. Providing an alternative for the students who are enrolled in university teams that have to travel very often during the semester is another advantage of this model and is very appreciated by students and university sports coaches.

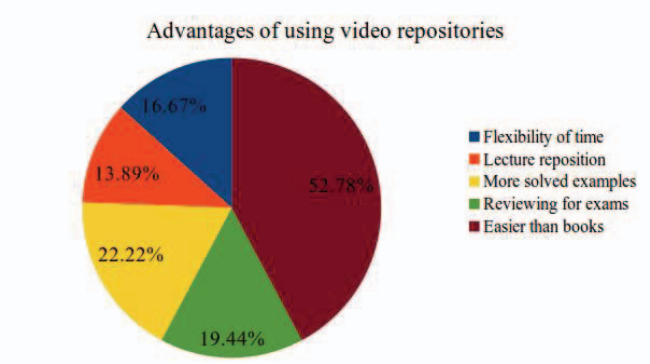

Fig. 9. Advantages of using video repositories according to students.

B. *Number of courses that should include video repositories*

After the experience with the course with a video repository, students give their recommendation on what percentage of courses they would like to see implementing such a model for their whole program, Architecture or Civil Engineering, in this manner:

1. No recommendation of videos at all. This category received no answers.
2. Students give low importance to videos and consider than less than half (<50%) of their courses should implement a model with a video repository. The results indicate that 16.67% of students think that at most a quarter of their courses should include videos using a similar model as the proposed one in this work.
3. Medium importance. Students chose this category considering than more than half their courses should include video repositories but less than three-quarters of them. The students answers show that 41.67% of students consider that up to 50% of their courses should be in this format.
4. High Importance, students consider that more than three-quarters of their curricula should be taught using a model with video repositories and a local lecturer. 41.67% of students have their opinion in this category.

If we consider categories 3 and 4 of the above list, more than 83% of students believe that video repositories in current curricula has an importance from medium (>50% of courses) to high (>75% of courses). This is an important figure since not all professors feel comfortable in front of a video camera and some training might be required for the lecturers and professor who would like to adopt the model. See Fig. 10.

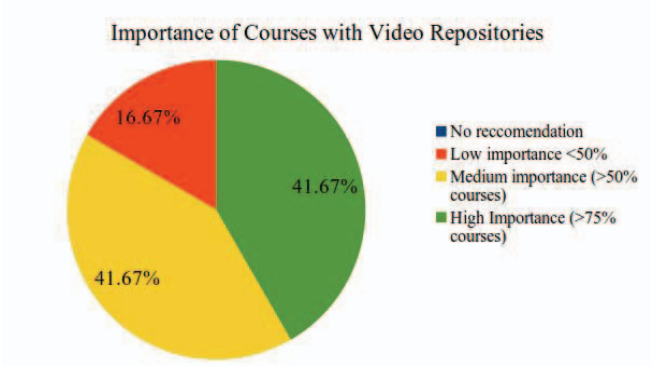

Fig. 10. Students perception on what percentage of courses should have video repositories available.

C. *The personality of the professor in a course with video repository*

One important aspect when implementing this type of course model is the personality of the professor who should be

willing to record videos and interact not only with the class around but with the camera itself, as some of the videos will be watched after the session and the video has to be attractive to students and with a certain speed and motivation included [12].

Students were asked about the professor personality in the following four categories, whether they think the personality of the professor is of any importance:

1. No importance at all. This category received zero answers.
2. The personality is important but content of the video is more important (importance < content). Results show that 19.44% of students have their opinion in this category and not paying too much attention to the professor's performance in front of a camera but instead, focusing on the content.
3. Personality is more important than content. Video could have good content but with a professor that feels uncomfortable in front of camera video is not a good one. 36.11% of students think this way.
4. Personality is 100% important. Not all professors should follow this model as you need to have certain skills in front of camera. 44.44% of answers were in this category.

The results shown in Fig. 11 indicate that for a course model involving video repositories, the professors should feel comfortable in front of a video camera and able to interact with it. This could be one of the main obstacles in implementing this kind of model in more courses since not all professors have experience recording videos. At *Tecnologico de Monterrey* new university professors have to follow a set of courses to adapt to the technologies that the new educative model Tec21 will require from them and the use of video cameras and how to present when a the session is recorded have been suggested for this program.

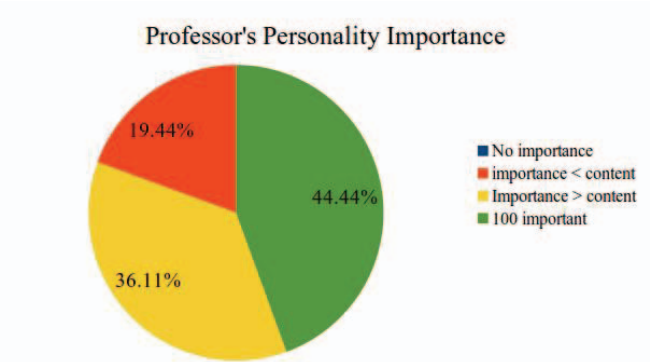

Fig. 11. Opinion of students on whether the professors personality has more importance over content.

D. Preferred courses for video repository model

User engagement and participation is an important aspect of any YouTube Channel and more importantly for the Education Channels [13-14]. Another aspect to consider in the implementation of the model is the type of course that is better suited for a video repository. We asked the students to give an opinion on the type of courses they would like to see with this model, dividing the courses in four simple categories:

a) No course should use the model

b) Theoretical courses. For instance, history courses.

c) Maths, Physics, Structural Engineering courses. This type of courses usually represent the major challenge to students.

d) All courses should implement this type of model.

The results of the students opinions are summarized in Fig. 12. Maths, Physics and Structures Courses got the vote of students as courses in which the university should definitely implement a model with a video repository with 58.33% of opinions in this category. According to 33.33 % of students all courses should have this kind of model. Theoretical courses only got 5.56% of opinions. There were not answers indicating that the model should not be implemented at all.

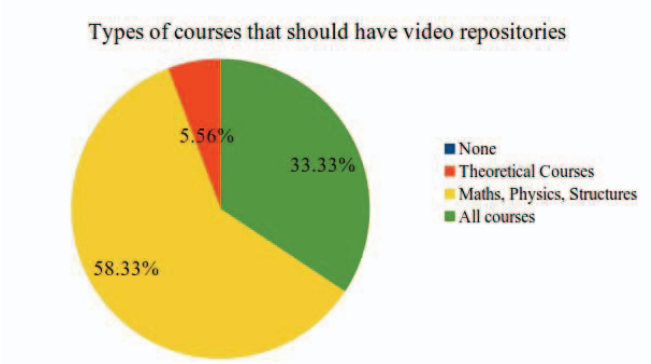

Fig. 12. Opinion of students on which courses should have video repositories

E. On the preferred duration of videos

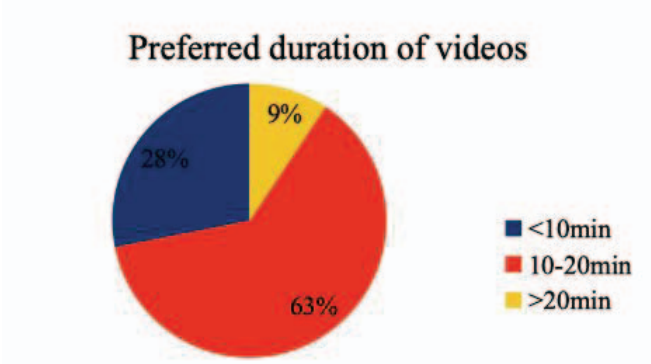

Fig. 13. Opinion of students on the preferred duration of videos.

Fig. 13 shows the opinion of students on what should be the ideal duration of videos. It is important to note that videos of more than 20 minutes of duration are the less preferred by students.

F. Success of the model

One way of measuring the success of a course is the performance of students, namely, the passing rate. The video repository was implemented in the spring of 2016 as a tool in the course and since then, the final mark of students have been compared to results of previous semesters. Fig. 14 shows the comparison of the failing rate. We can identify an improvement from semesters prior to Spring '16 where the failing rate was over 30% of the students. Since the implementation of the video repository model, the failing rate has decreased to the order of 12% in the last semesters. It is also important to mention that students from both programs, Architecture and Civil Engineering programs have to take a National Examination prepared by an independent board, the National Center for Evaluation. In this exam the results of both programs in the subject of Structures has always been excellent with 100% students passing this subject.

Another aspect to consider a success of the model is how quick the groups that are offered to students with this model get filled during enrollment each semester. The capacity of the group has been kept constant to an average of 25 students per groups. The Innovate Room has 30 chairs but for the purpose of this study the population of the groups have been kept at 25 students which is also the average population for any given group at the School of Engineering at Puebla Campus.

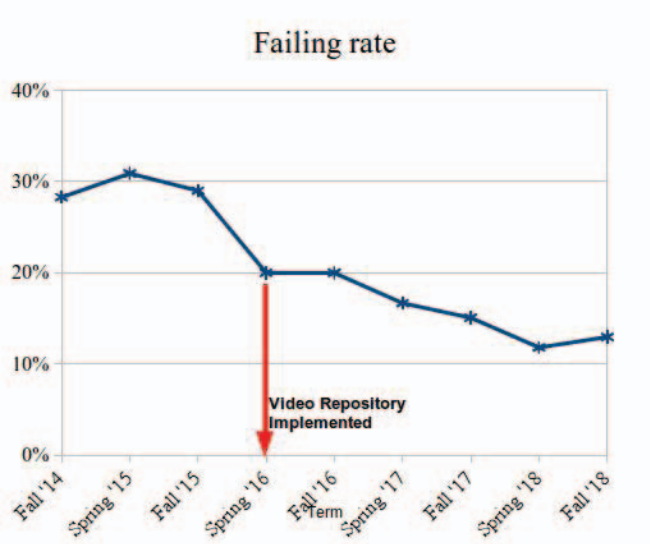

Fig. 14. Failing rate, as percentage of class size.

VII. Conclusions and Future Work

In this article we have shown the preferences of students of an hybrid model that includes a video repository and their perceptions on how it can improve the teaching of usually complicated subjects of Structural Engineering. The results show that new generations of students prefer video repositories over other tools when they are reviewing for exams. Another aspect that has improved through the use of a YouTube video repository for Mechanics of Structures courses is the average grade of students. Results show that students prefer the flexibility of this model since the videos can be watched at any time and place compared to a model that is transmitted "live" over the internet, with the difficulties that could arise from a poor internet connection.

The model presented in this paper also takes into account the human interaction professor/students in a classroom and in tutorials as the video repository is not the full model but an element of it, where the presence and personality of the professor still plays a very important role in the success of the model.

The results can be used to design hybrid models of teaching of Engineering courses that are currently taught in a traditional lecture schemes and it has shown in several semesters at *Tecnologico de Monterrey* that it can have positive effects in students' satisfaction and overall, in the passing rates of the courses where the model was used.

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