MEASURING THE QUALITY OF INSTRUCTIONAL VIDEOS FOR HIGHER EDUCATION

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Abstract

The use of instructional videos to support the teaching-learning process in higher education has been increasing in recent years. Videos and all other kinds of audiovisual objects are being published on online learning platforms and MOOCs. In this context, a noticeable concern is how to produce quality material that maximizes its learning effectiveness. It is obvious that the learning effectiveness of an instructional video is affected by its contents. Moreover, the effectiveness may also be influenced by low-level technical features such as video length, audio and video quality (i.e. noise), or even the presence of postproduction items like transition effects.

This paper addresses the issue of defining what characterizes the quality of an instructional video, from the perspective of the production process. We show the results of a study conducted at the Universidad de Las Palmas de Gran Canaria (ULPGC), based on the videos created within the innovative Prometeo project. Prometeo is a ULPGC corporate project aimed at developing multimedia and interactive learning objects for university students.

During recent years, the project Prometeo has been building a considerable corpus of videos, which serves as a data source to analyze quality and effectiveness parameters. The study has delivered a conceptual model for categorizing video characteristics, and the identification of a set of technical characteristics that are judged as influential in the overall learning effectiveness of videos. The results will help to formulate general guidelines for the successful production of instructional videos, and for quality assurance procedures.

Keywords: instructional videos, e-learning, quality, screencasts, videocasts.

1 INTRODUCTION

In higher education institutions, online videos are used in several ways: as a substitute for on-class lectures for distance students; as a primary learning material delivered to students; as a communication tool (teacher-to-student or student-to-student); or as a way for students to create their own material; among other uses. Besides more collaborative or horizontal approaches to learning, many online videos are based on the delivery of contents for instruction.. This paper focuses on this class of online videos, which we will refer to as *digital instructional videos* from here on. The qualifier “instructional” signals the purpose and pedagogical paradigm in which teachers deliver learning content to their students and guide the process of teaching and learning.

A vast amount of digital instructional videos are being produced in higher education institutions, with a dramatic increase in recent years. This boom has been propelled by technical factors as the availability of free video streaming services such as *Youtube* or *Vimeo*, the steady growth in network bandwidth and low-latency for home users, and the spreading of smartphones and tablets, which are useful both to watch and to produce content. Moreover, the thriving Massive Open Online Courses (MOOCs) make extensive use of instructional videos as a teaching resource.

This widespread adoption of digital instructional videos is barely a decade old. For a majority of college teachers, the tools and methodologies to produce this kind of material are still to be learnt and mastered. Apart from learning how to use software tools to record a video podcast or a screencast, there is a need for guidelines to produce material with an adequate level of quality. This paper points to one aspect of quality: the *learning effectiveness* of the resulting product.

1.1 Instructional digital videos

For the purpose of this research, we define instructional digital videos as a specific class of learning objects that deliver a stream of digital video (and, optionally, audio) intended to contribute in a teaching-learning process. This term includes products called *screencasts, video lectures, video podcasts, videocasts, microlectures*, among others.

1.2 Measuring the learning effectiveness

The learning effectiveness of an instructional video depends on several factors. Some of them are external to the video (student skills and attitudes, teaching methodology…), while others are properties of the video itself.

A reasonable assumption about instructional videos is that their learning effectiveness is affected by the way its contents are arranged in time and space, and what presentation techniques have been applied. Under this assumption, it is desirable to obtain evidence of the positive or negative influence of each technique or feature, and how they can be combined to obtain acceptable learning effectiveness.

The impact on learning effectiveness has been studied for some specific features in instructional videos. To mention some significant recent work, Zhang et al. [1] and Merkt et al. [2] assessed the influence of basic interactivity, while Vural [3] has explored the benefits of embedded quizzes. Griffin et al. [4] and Mohamad Ali et al. [5] studied various aspects of voice narration.

Despite the existing research, many features remain unexplored, such as the presence of a human narrator/speaker in the video scene. Other key features like video duration are not clearly assessed, as Kay [6] points out in his recent review of the literature about video podcasts.

1.3 A classification of video characteristics

Beyond the need of more research on the effectiveness of video features, a more fundamental question arises: what is the set of characteristics that an instructional designer/producer has to take into account to produce effective videos? With a comprehensive list of video characteristics, or, ideally, a standard taxonomy, research findings could be integrated in a global map, so that it would be easier to unveil links between previously unrelated research, and allow for the emergence of more general theories.

At present, there are no standard classifications for digital video characteristics that fit in the research of learning efficiency. Yet, some effort has been performed to fill in this gap. Sugar, Brown and Luterbach [7] have built a comprehensive structural model for a subtype of screencasts. The authors assessed a corpus of screencasts used in teaching computer technology tools. As a result, they have identified a set of structural characteristics and instructional strategies that describe exhaustively the corpus. This is a pioneering work in this field, but, as the authors warn, their results are limited due to the narrow range of studied items.

In this context, our work is conceived as a contribution towards a taxonomy of instructional video characteristics. Our scope will be the learning effectiveness, from a producer's point of view. That is to say, this study focuses on how the producer can make effective products, not on how the consumer can get best advantage of the product.

2 OUR PROPOSAL

2.1 The Prometeo Project

Prometeo [8] is a corporate project started in 2008 by the Universidad de Las Palmas de Gran Canaria (Spain) to set up a service that offers lecturers a professional team to create and produce multimedia e-learning content and to develop interactive software applications. The learning objects produced within Prometeo service are also published in a learning management system for their use in teaching. The Prometeo project/service has assisted around 100 teachers, and has produced more than 500 learning objects, most of them instructional videos (480 in the period 2008-2011).

Not only Prometeo has been a production facility, it has also worked as a laboratory to learn, design and apply the methodological aspects of e-learning object production. Departing from previous work

[9], our research group has devised methodological guidelines for efficient production of instructional videos and software applications [10].

2.2 Methodology

Our goal has been to develop a conceptual model, rooted on the two main assets of Prometeo Project: a large instructional video library, and an expertise on the methodology of instructional video production.

To develop the model, we have followed a bottom-up approach, starting with a corpus of videos and finishing with the conceptual model. The first step of the process has been to identify features in videos that we consider are tightly related to the final quality of the product. This step results in a list of features. In a second step, we have tried different kinds of categorizations that group the majority of the features while keeping high internal coherence and low inter-class coupling. This step resulted in a list of categories as it is shown in this paper. In a final step, we refined the model by removing characteristics that have less relevance in addressing learning effectiveness. The final outcome of this process is the conceptual model that is described in the following sections.

3 THE MODEL

The proposed model is essentially a classification system that groups video features and attributes (*characteristics*, see below) according to a set of categories. An outline of the model is shown in Table 1.

3.1 Aim and scope

This model is descriptive, not prescriptive. That is, it makes no judgment on what features are best suited or how each characteristic should be used. Yet, this classification may help to reason and discuss on methodologies, due to the existence of a conceptual framework (provided by the categorization).

This classification covers structural components of videos, as well as production styles. There is an effort in identifying characteristics that can be measured objectively and that can be extracted from the video itself, with no need to know aspects such as the details of the production process or the authors' intentions. This classification does not cover some areas of interest: instructional strategies; contents and purpose of the video.

3.2 Model structure

The model is organized as a classification system based on taxonomical *categories*. This classification is applied to *characteristics*. These concepts are defined below.

3.2.1 Characteristics

The objects that are classified are *video characteristics*, that is, any property, feature, structural constituent, or particular data that can be extracted from the video.

Category name	Category Description	Subcategories / characteristics
Medium	How the audio-video data is stored or delivered.	Image size, frame rate Audio quality, SNR Coding algorithm Duration
Setting	Location, lighting, atmosphere…	Location, background, lighting Narrator: garment, frame, speech parameters AV settings, AV effects
Content displayers	Structural items that convey contents. Frame layout is built up on these components.	Slides, screenshots Screen captures Audio narration Onscreen Narrator Subtitles Cursors/pointers
Content flow	How content segments are arranged in time.	Continuity Interactivity Nonlinearity
Genre	Overall typology of the product.	Screencast Enhanced slideshow Lecture Podcast Cartoon

Table 1. Classification model for instructional video characteristics

There are two types of characteristics. Some characteristics are **components**, individual items that are contained in the video; while some other characteristics are **global properties** of the video as a whole. Some examples of components are: subtitles, cursors, navigation buttons or narration. Most of them are structural items in the video layout. On the contrary, global properties are attributes like duration, continuity, video genre, etc.

Due to the purpose of this model, we only take into account those characteristics that may have a close influence on the learning effectiveness. Therefore attributes such as author or licensing are not considered.

3.2.2 Categories

The model identifies five main categories to which every characteristic is assigned. The categories are thought to be exclusive: a given characteristic belongs to exactly one category. Each category corresponds to an observational dimension. These dimensions are tiered from a lowest physical level (medium) to increasingly conceptual levels: setting, content display, content flow and product genre.

3.3 The model in detail: categories

As told above, the model defines five categories: medium, setting, content displayers, content flow and genre. This section describes all the categories and shows examples of characteristics assigned to each one.

3.3.1 Medium

This category involves how the audio-and-video data is stored or delivered. As regards this *medium* category, the videocast is considered a mere stream of bits that provides sensorial information to the consumer.

Examples of characteristics under this category are: frame size, frame rate, color range, audio quality, signal-to-noise ratio and audio-video coding algorithm, for instance. These attributes usually come in quantitative units (number of bits, units per second…) and they often can be objectively measured.

This category of attributes is well studied in both their psycho-physiological and computational aspects. With respect to learning effectiveness, there is a relationship between the perceptual quality of the signal and its easiness to be memorized. Indeed, many modern coding algorithms take into account human perception models in its definition and parameterization.

3.3.2 Setting

This category groups properties and items that describe how the video has been set up for its shooting. It includes features like the scenery, background, lighting and narrator properties (garment, speech pace, etc.).

Our previous experience in the Prometeo Project has made us realize that this category is influential in the product quality, but at the same time it is often neglected. Several available videos in public websites show poor execution of basic audiovisual techniques such as an adequate lighting, narrator framing, background, etc. The lack of a correct setting may have a significant influence on the student's attitude towards the video, and the efficiency in the perception of video contents.

3.3.3 Content displayers

A digital video usually has a fixed layout during almost all its time span. This layout is often built up on some basic components, such as a box where text or pictures are displayed, an area where a narrator speaks, onscreen subtitles, etc. There may also exist audio components, like narration or background music. Most of these items provide information directly related to the learning goals, while other act simply as decoration, navigation or signaling some other information. The *content displayers* is the category that covers all kind of components in the video that convey instructional contents, no matter the format (text, image, audio…)

Some components that fit in this category of content displayers are:

- Slide (text only, graphic or mixed).
- Whiteboard (actual or virtual).
- Screen capture.
- Human speaker (video).
- Narration (audio).
- Pointer / cursor.
- Subtitles.
- Sign language interpreter.

This category has no global properties.

3.3.4 Content flow

This category deals with how the content elements in the video are arranged in time. We can consider the video as a set of information blocks to be shown, and there should be a plan or method for ordering those blocks in time. The method should be as simple as a fixed, pre-planned sequence of displays, as in a conventional video. But there are more ways to define a flow, for example when the consumer can control which contents she will watch or when the video itself contains multiple sequence paths and some software selects what path is played depending on external feedback.

Under this category of “content flow”, we have identified three main characteristics:

- Continuity. How *smooth* or *intermittent* is the flow.
- Interactivity. The ability to get user’s feedback to alter the flow.
- Nonlinearity. Existence of different flows in different views.

These three characteristics can be measured with an intensity scale, ranging from “non-present” to “strong”. Additionally, they function as subcategories, since some structural components and tools can contribute specifically to the flow continuity, interactivity or nonlinearity. For example, in-video quizzes are interactive components.

The subcategories are explained in more detail in following sections of this document.

3.3.5 Genre

This is the highest leveled category in this model. It is intended as a way to classify videos in a small taxonomy of well-known product styles or “genres”. At present, there is no standard typology of digital videos, as what can be found in traditional cinematography. Moreover, there is not a standardized vocabulary to name this class of products. However, we consider that it is worth to put some effort in normalization.

Our concept of “genre” is a distinguishable set of style, form and content that is identifiable by consumers and allows for a clear classification of the products.

We have identified five specific instructional video genres:

- Screencast.
- Enhanced slideshow.
- Lecture capture.
- Podcast.
- Whiteboard cartoon.

This classification is not exhaustive, though we consider that it covers a great majority of current instructional videos. Moreover, we believe that it has a reasonable descriptive power to figure out the style of a video labeled with this system.

3.4 Content flow subcategories and characteristics

As presented below, the *content flow* category includes at least three aspects or subcategories: continuity, interactivity and nonlinearity. This section describes them in more detail.

3.4.1 Continuity

Continuity expresses the pace at which the pieces of contents are shown over time. The flow may be discrete, with pieces of information showing up in bursts, as in a conventional slideshow. The opposite is a continuous, seamless flow of information where there are no obvious transitions.

Some characteristics that match this subcategory are:

- Components: transition items and effects, such as titles, closing credits, fading between scenes, etc. These artifacts help in making the information sequence path explicit.
- Global properties: overall degree of continuity, ranging from discrete to continuous.

3.4.2 Interactivity

Interactivity is the ability of receiving external feedback from the user in order to alter the information flow. Nowadays, one may assume that most digital videos show some degree of interactivity, since users usually can control the play with play-pause buttons and the like. Apart from this, there are higher levels of interactivity that can be enabled. In instructional videos, inserting forced pauses at some selected points is becoming widely used, so that the user stops watching and performs some task (reflects on the previously shown concepts, answers a given question, etc.). In some cases, the video can only resume playing if the user solves a simple quiz that provides feedback about her understanding.

Some examples of components dealing with interactivity are:

- Play control panel.
- Forced pause.
- Interactive quiz.

3.4.3 Nonlinearity

Nonlinearity is a measure of how many different time orderings are allowed for the information segments, especially when the video is played under different conditions or stimuli. The conventional videocast is absolutely linear, designed to show a single sequence of content segments (the user may move forward or backwards on the sequence and thus skip some contents, but a sequential plan prevails).

Nonlinearity can be introduced in videos in two levels: intra-video and inter-video.

Inter-video nonlinearity is the most common case. It comes in the form of hypermedia. The full video product is segmented in autonomous clips that can be watched independently. The user can navigate across the clips by using some mechanism such as a control panel or hyperlinks that appear at specific times. The user may have some freedom to navigate, or the system may have restrictions, usually based on previous achievements or task completions.

Intra-video nonlinearity may be enabled by processing input from the user and displaying different contents according to the results. This can be as simple as showing a quiz to the user at some point and then take different story paths depending on the user's answer; or as complex as integrating the user's profile (geolocation, history of past videos watched, student profile…) and the environment and computing the most adequate path.

Nonlinearity is strongly related to interactivity, since most feedback should come directly from user input.

Examples of characteristics belonging to this category are:

- In-video hyperlink.
- Videoclip navigation panel.
- Multipath story.

4 DISCUSSION AND FUTURE WORK

This model shows a conceptual framework that facilitates the discussion about the quality of instructional videos. The categorization allows to group features that share common goals. Thus, it avoids improper comparisons between unrelated characteristics. Moreover, the five levels of categorization match with different professional roles in the production of the instructional video: audiovisual professional for the *Medium* and *Setting* categories; instructional designer for *Content Displayer*, *Content Flow* and *Genre* categories or a computer engineer for complex *Content Flow* features. This separation of roles favors future development of specific process guidelines for each category.

The boundary between a digital video and a software application is being blurred as more content flow features are added to videos, especially regarding nonlinearity. We believe that our model will adapt well to this trend.

This model is still an ongoing work. Some future tasks to be performed are: to complete the list of characteristics; to validate the model against a wider range of videos; and to expand the model so as to include the pedagogical dimension (instructional strategies).

5 CONCLUSIONS

A classification model is presented to help in the research on what characteristics in instructional digital videos are relevant to produce high quality material. The model is focused on the learning effectiveness potential of single features in videos. The model provides a simple but powerful conceptual map to discuss about video features in this field of knowledge. We hope this work will contribute to achieve a more standardized framework that addresses instructional video design, production and quality assurance.

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