RESEARCH ARTICLE

A novel taxonomy of student-generated video styles

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Abstract

Video is a medium increasingly used in education. The styles of videos produced for academic purposes have been studied in the literature based mainly on those initially designed by instructors for use in MOOCs. In this work, we define a novel taxonomy of academic video design styles based on the videos produced by students. We have defined 10 different styles after reviewing 105 student-generated videos over 5 years. These types of videos reflect the tastes of students when making a video, which do not necessarily coincide with those of instructors. Based on our classification, a comparative analysis was done between the types of videos developed by instructors and by students, and significant differences were found. The style most commonly used by instructors is similar to the presentation slides while students' videos are based on the integration of videos and images they search for on the Internet.

Keywords: Media in education, Student-generated videos, Instructional video, Video styles taxonomy, Higher education

Introduction

In today's society, video is an ever-growing means of expression, especially for young people. Globally, Internet video traffic will grow fourfold from 2017 to 2022, a compound annual growth rate of 33%, according to a Cisco report (Cisco, 2018), which estimates that 46 million minutes of Internet video will be consumed each month by then. In this context, many students rely on YouTube to solve problems, search for information and learn; thus, it can be used as a complementary tool in the classroom to improve the teaching/learning process (Moghavvemi et al., 2018). In addition, the ability to express oneself through video is becoming a cross curricular competence to acquire in the field of ICTs (information and communication technologies) (Orús et al., 2016; Pereira et al., 2014).

In education, the use of videos has evolved over time and has been utilised in educational contexts in different ways and in more and more areas. Traditionally, video has been of more interest in practice-oriented disciplines such as nursing (Forbes et al., 2016), medicine (Jang & Kim, 2014), psychology, teacher training (Arya et al., 2016), language teaching (Canning-Wilson & Wallace, 2000), etc. Video was intended to bridge the gap between theory and practice in these disciplines where experience is crucial

(Gedera & Zalipour, 2021). In additional to bringing theory and practice closer to each other, video has generally been used as a support element, to reinforce and complement content and also as a motivational tool (Woolfitt, 2015). Teachers can now make their students observe, learn and investigate many issues that may arise in the context of their professional practice. Advances in video production tools and the platforms available for teachers and students to view, access, share, reuse, manipulate and make videos, are leading to their increasingly widespread and pervasive use (Gedera & Zalipour, 2021).

A very general application has been to make teachers' classes available to students so that they could watch them whenever and wherever they wanted and view again what they did not understand, for example (Sirkemaa & Varpelaide, 2016). Originally, these types of videos were direct recordings of the classes with some supporting slides or whiteboard material. With the appearance of massive open online courses (MOOCs), videos have been proliferating and improving, since the technology available for these environments allows for greater sophistication (Hansch et al., 2015).

These types of videos and other videos available on YouTube channels, such as those of Khan Academy, have also been incorporated as external sources of information in education; that is, they are used for the same teaching purpose but are not created by the instructors themselves. More recently, the ease of producing and finding videos by both instructors and students has made it possible to use them together with other teaching methodologies, such as the flipped classroom methodology. In this case, before the class session, students watch videos that foster a debate or starting point for the face-to-face session (Arya et al., 2016). Other examples with instructional materials generated by students can be found in Coppola and Pontrello (2020).

Students at different academic levels access online videos to make up for missed classes, improve their learning, review exams and quizzes, prepare for classes, or learn to solve specific problems (Jorm et al., 2019). However, they are not mere consumers of videos; for them, video is a powerful means of communication, and they are regular producers of media on platforms such as Facebook and YouTube (Jorm et al., 2019).

In parallel with technological advances that allow the production of good-quality videos and their viewing at any time and any place, students are being encouraged to participate more actively in the learning process. A current trend is the use of student-generated content (SGC) for learning and teaching where students become producers of knowledge rather than mere consumers of knowledge (Bovill, et al., 2011; Doyle et al., 2021; Snowball & McKenna, 2017). Video is a specific type of SGC. In this way, students have started to become video producers in the academic context (Greene, 2014). For example, student-generated video can be used as a demo to replace the presentation of a project, to take a guided tour of a system, to exhibit works, to engage students in laboratory techniques (Gallardo-Williams et al., 2020), to develop cross-curricular and curricular competences (Orús et al., 2016; Pereira et al., 2014), to play different roles (partners, researchers, producers) in the creation phases (Chewar & Matthews, 2016; Hubbard et al., 2017), or to interact with experts in the field (Sánchez et al., 2019), such as during international video competitions (Holtzblatt & Tschakert, 2011). Videos produced can be peer reviewed, which increases effort and promotes higher-quality videos because of the social pressure of that scrutiny (Greene, 2014; Smith, 2014). Students demonstrate creativity and are able to generate

good content that can be used for learning in subsequent promotions (Arruabarrena et al., 2017), together with other active learning methodologies, such as peer assessment and flipped classrooms (Arruabarrena et al., 2019).

In addition, student-generated videos allow the evaluation of transversal competences such as communication and collaboration (Jorm et al., 2019). These, along with content generation, are digital skills that are necessary for social and professional success in the modern world (Chiecher, 2020). Current students perceive themselves as experts and competent in ICTs, although mainly from self-taught learning (Pérez-Escoda et al., 2016), which can produce heterogeneous levels of mastery in certain contexts and activities (Chiecher, 2020; Pérez-Escoda et al., 2016). Using video technology to socialize with friends is not identical to utilizing video for learning and developing critical thinking or communication skills. Students, however, perceive that they have the resources, knowledge and skills to be content generators and consider this activity useful for their learning (Persada et al., 2020).

It should be noted that the current generations of students belong to the so-called Z and Alpha generations. A common characteristic of these generations is their early familiarity with the Internet (for which, in addition to being digital natives, they are also called the Internet generation, Google generation, etc.) and the ability to manipulate screens and multiple devices from young ages (Chiecher, 2020). These are highly technological generations known for their ability to quickly locate the specific information they need (Persada et al., 2020). Another remarkable feature is their preference for visual information rather than textual information (Pérez-Escoda et al., 2016; Ramadlani & Wibisono, 2017). Visual forms of learning, such as videos, seem to be interesting and effective for this generation (Chun et al., 2017).

Presently, instructors and students belong to very different generations from a technological point of view; these differences have led the authors to wonder if their styles differ when making academic videos. For example, Santos Espino et al. (2020) revealed differences between secondary school teachers and university students in terms of video style preferences due to their different field of knowledge and experience with ICT. Therefore, it is possible to ask whether there exist differences in the video production style of students and university teachers.

In the literature, there is considerable interest in classifying types of videos used in education according to different criteria (design, production method, purpose, etc.) and different video repositories such as YouTube or MOOCs. All these classifications are based on teacher or instructor generated videos. However, to the best of the authors' knowledge, there is no video classification that takes into account the videos made by students in the academic environment. This work aims to help fill this gap in the literature. A classification that captures the types of student-generated videos is of interest for future work regarding which type may be more effective for learning or more suitable for a particular pedagogical approach (Chorianopoulos, 2018; Guo et al., 2014). It may help teachers to select a style of video or a combination of styles according to their objectives or abilities (Chorianopoulos, 2018). This could also be used to carry out studies to better understand students' preferences when creating or classifying videos generated by their peers, or to find out whether the format or content of the video has a greater influence on their assessments. A better understanding

of the characteristics of student-generated videos can be taken into account when commissioning such activities.

In this context, the goal of this study is to define a taxonomy of academic video design styles based mainly on those chosen by students when asked to produce a deliverable in video format. The authors believe it is important to take students' points of view into account when defining types of student videos. Specifically, in this paper, the authors aim to answer the following research questions:

RQ1: *Which styles of videos do students develop when generating academic content?*
RQ2*: Are there differences between the styles of videos that students and teachers use to communicate academic content?*

To answer question RQ1, the authors will use previous classifications and these will be modified to adjust to the styles of student-generated videos across several subject areas.

To answer question RQ2, the authors will apply the resulting classification from "RQ1" to videos generated by students and videos made by teachers in a limited context. Student videos are generated for a subject on computer engineering project management and teachers' videos are produced for computer engineering educational workshop (JENUI, 2020). Although, the student and teacher video purposes are different, they share some characteristics that allows the comparison. The production of the videos falls within the same area of knowledge, with freedom of format, similar duration and all made in the first half of 2020. In both cases (students and teachers), the script of the videos usually includes the main points and problems of the topic, results or consequences observed and some conclusions.

Previous classifications

While there are different classifications of video types used in education in the literature, in reality, none have been unanimously accepted. In addition, the style names do not usually coincide, even if they describe the same video style. In any case, none of them includes student-generated videos. Those that in the opinion of the authors may be relevant are reviewed below, and additional information is included in Table 3 in the appendix.

Many of the classifications of existing video typologies in the literature are based on videos available in MOOCs. One of the most detailed is in Hansch et al. (2015), which considers 18 production styles according to the way they are visually organised (see Appendix Table 3). This broad categorization of video types is based on a review of 20 courses and interviews with MOOC designers and instructors. The article includes a description and some questions to be asked about the suitability of the chosen format for video making. The objective of the article was not to create a taxonomy but to present an overview of the use of video in MOOCs and to assess the value of developing a set of recommendations that stimulate critical reflection on the role of video in online learning. Thus, a variety of video styles was considered.

A grouping of these styles is proposed by Santos-Espino et al. (2016). They bring together under a common name some video styles of Hansch et al. (2015) that are very similar to each other in terms of the chosen communication style. They discard some,

such as the so-called Demonstrations and Animation, because they are considered testimonials in MOOCs. They modify the names of others, probably because they consider them too specific (Udacity-Style Tablet Capture and Khan-Style Tablet Capture). Thus, they consider only seven styles: Talking Head (which may include some text to reinforce key ideas but very little in relation to the video length), Live Lecture (one lecture), Interview (can be with or without the interviewer), Slides (also includes the so-called Head and Slides and Picture-in-Picture styles), Screencast (voice narration over a computer session), Virtual Whiteboard (similar to Khan Academy), and *Documentary* (narration over filmed material). The aim of their study is to see which styles are most present in MOOCs from seven different areas (arts and humanities, business and administration, social sciences, natural sciences and mathematics, medicine and health, everyday life). Three evaluators are involved in their classification, and each course is independently classified by two evaluators who agree on the type of video in case of discrepancy. The most commonly used types are Talking Head and Slides and a combination of the two. They find some differences between disciplines, such as arts and humanities videos using the speaker-centred style more often but engineering and science using videos more focused on instructional content.

A previous study (Guo et al., 2014) on student monitoring according to the type of videos used in four MOOCs offered by three different universities distinguishes six styles. Some of the styles coincide with those of Santos-Espino et al. (2016), though they use other names, except in the case of Slides. Thus, they distinguish Code (instead of Screencast), Khan-Style (instead of Virtual Whiteboard), Classroom (instead of Live Lecture), Studio and Office Desk (for Talking Head). They conclude that to achieve greater student involvement, teachers must design their lessons specifically for an online video format. Another conclusion is that informal videos are more engaging to students.

The seven styles of Santos-Espino et al. (2016) are also similar to the six styles of production considered in the study of Shoufan (2019) on 105 videos. This video style nomenclature includes: Khan style is Khan Academy, Slides is PowerPoint or similar, Head is Talking Head, Paper is using paper or board to explain a concept, Anim is using animations, and Class is a class taught in front of students. The aim of the research is to study the cognitive value of the video, not only the style. As a result, they find, for example, that videos in which the speaker draws diagrams manually have less cognitive value than videos in which the speaker explains diagrams already drawn.

In the taxonomy of Crook and Schofield (2017), whose purpose is to compare video lecture design with traditional education, they find 16 design formats by analysing 200 videos from 50 MOOCs in both social sciences and technology and science. The 16 formats are grouped into five categories according to whether the video focuses on content or on the instructor. In category A, all four formats include content, but no instructor is present, while neither of the two formats in category E includes content. In the intermediate categories (B, C, D), the formats include instructor and content in different ways.

In Rahim and Shamsudin (2019), two studies are performed on 90 videos based on the taxonomy of Crook and Schofield (2017). They add new categories, even though some are variations or combinations of others, such as writing over video. The most innovative categories include the video type called Animation, where the presence of

an instructor is replaced by an animation, and what they call Screencast (videography), a demo recording or the use of background videos. However, the new categories are not described in detail nor grouped in the same way as in Crook and Schofield (2017). Furthermore, these categories were already included in the classification of Hansch et al. (2015). Rahim and Shamsudin, (2019) agree with Chorianopoulos (2018) that the creation of new types of video will continue as experience grows and available technology changes.

Another very complete study is the one undertaken by Chorianopoulos (2018), which reviews other studies carried out for this purpose and analyses videos taken from various sources. He proposes a taxonomy based on two axes, human materialisation and instructional media, with different values ranging from the most artificial (or digital) to the most real (or physical). Human materialization can include animation, the appearance of an instructor, the instructor's hand, etc. Instructional media can include animations or objects manipulated by the instructor or the blackboard. This taxonomy provides a landscape of available video styles and provides ideas for new styles. Nevertheless, it is difficult to use this taxonomy to classify and compare types of videos.

A similar idea is adopted by Díaz Velasco et al. (2016), who include a classification based on five content-related types (writing, images, PowerPoint, application and experiments) and then distinguish whether it includes a person, a hand or nothing. They take into account and describe the characterization of five styles that they believe appear the most in MOOCs: hand-drawn explanations with drawing software (Khan Academy), virtual backgrounds with animated presentations (Chroma Effect), talking head with slides (Talking Head), computer screen capture (Video Tutorial) and traditional elements of master teaching (Master Class). The last three are the most commonly used according to their study.

Most studies include a specific set of styles, even though the denomination varies. Nevertheless, none of these classifications previously presented takes into account videos made by students. In Köster (2018), a study of instructional video types reveals six general categories rationalized according to the type of production and distinguishes 26 different styles. The categorization is quite similar to that shown in Hansch et al. (2015) but includes, for example, the integration of videos with other media to achieve more interactive videos. In addition, it specifies user-generated videos as a specific category, which can be student videos or low-production-cost videos including presentations, reports and projects, but it does not identify which type of communication is used. Moreover, all of student productions are grouped in a single style.

In this scenario, we hypothesize that there are differences between the types of videos that students use to communicate and those used by teachers. The classification shown in Snowball and McKenna (2017) is the unique found that refers only to videos made by students. The study focuses on the use of student-generated podcasts as means to take advantage of the diversity on student experiences. The goal was to see, through a survey, whether students learn by doing and watching. Although it was not an objective of their study, they found only four different styles among the 57 videos made by students on a macroeconomics topic, without specifying how many of each or in what proportions. Their four styles and descriptions are as follows:

- *Talking Heads:* students themselves explaining a concept, sometimes with the aid of diagrams or accessories;
- *Filmed Reality*: usually in and around the university campus and town, with a voice-over or a descriptive paragraph that uses theory to explain or interpret the material;
- *Acted Scenes*: students script a brief 'play' demonstrating some concept and then perform and film it; and
- *Montages of Existing Videos and Photographs:* obtained from the Internet with added text or sound.

The first two styles are clearly present in the other classifications mentioned, though described differently. The third could also be associated with Hansch's Demonstration style. However, the last one is different from those listed in other classifications. The styles do not include Slides or Talking Heads that appear in the other classifications.

Materials and methods

To define a new taxonomy of videos that takes into account those made by students, we will start from some styles collected in the literature. This initial classification will then be applied to a set of videos generated by students to be classified. Between five and seven classifiers will be involved, and each video will be catalogued independently by at least four of them. Each video will be classified in only one style, even if the video combines several styles, and classifiers may select two styles, if they wish. In such cases, the style that all classifiers include will be chosen.

The typology of videos will be refined until a classification is obtained that clearly includes all the styles used. The initial classification will consist of six styles: four styles detected by (Snowball & McKenna, 2017) considering student videos and two more. Thus, Slides present in all the classifications studied will be added, as well as a style called Digital Animation. The latter refers to presentations made using a computer tool such as Powtoon or Xplee, which are widely used by students to achieve more dynamic exhibitions with different and more striking effects. In addition, the section Others will be kept to integrate styles that do not fit into any of those proposed.

Different viewing sessions will be carried out with a subsequent discussion to detect ambiguities in designations or descriptions or to study the possible existence of videos that do not fit any style and, thus, to refine the classification. Only in the case of unanimity will the video be considered classified. If there is no unanimity, the video will be classified in a subsequent iteration until unanimity is achieved. We will apply the usual methodology and extend it (Rahim & Shamsudin, 2019; Santos-Espino et al., 2016). Thus, instead of seeking consensus after a single iteration, we will add several iterations in case there is no agreement because the model must be refined in parallel to the classification.

In our study, 105 student-generated videos on five different subjects, all within the field of computer engineering, from three universities (University of La Rioja (UR), University of the Basque Country (UPV/EHU), University of Pau and the Pays de l'Adour (UPPA)) have been used (see Table 1). They correspond to five academic years from 2015/16 to 2019/20. The subjects are Database Administration (DBA),

Table 1 Videos of students involved in this study, distributed by subjects and academic years

Subject	2016	2017	2018	2019	2020	Total
DBA	5	4	5			14
TuP	6	6	6	5		23
PM	2			18	33	53
SE			6	6		12
WS		2	1			3
Total	13	12	18	29	33	105

Project Management (PM), Software Engineering (SE), Web Systems (WS) and Tutored Project (TuP). The last one is taken in the first year at UPPA, and the others are taken in the third or fourth year at UR and UPV/EHU. All subjects are of a technical nature, oriented towards the use and development of quality software and applying technical and behavioural skills in team and individual work. In all the cases, and without providing students any formal instruction about video creation, they must produce short videos (2 or 8 min depending on the subject) in free style and must upload them on a free-access platform, published under a Creative Commons license. In none of the subjects, students had problems in developing video deliverables within short time frames (around two weeks) and tight schedules.

The topics of the videos may be related to the specific content of the subjects in some cases (DBA, SE, WS) or more general topics (such as IT security or sustainable development) to work on project concepts and teamwork (PM, TuP). Usually, student-generated videos present a problem and possible solutions. In some cases, video generation is optional (SE and WS), and in the others, it is compulsory. Except in WS, where the videos were made individually, the videos are the result of teamwork between 2 and 4 students. The videos include all those made in SE and PM in 2020. In the other subjects, the videos selected are those that, depending on their variety in terms of styles, quality and topics, are viewed and assessed in the class by the rest of the classmates.

Once the classification has been obtained, it will be equally applied to teacher-generated videos to determine which style of production is used most often. All videos (50) generated for the presentations of an Ibero-American Workshop on University Computer Engineering Teaching held in July 2020 (JENUI, 2020) will be used. Each video presents methodologies, experiences or teaching resources related to university teaching in computer engineering. It is important to highlight that this is not a scientific research congress, but rather a collection of good practices in teaching innovation. The workshop was held virtually, and a completely free format was allowed for the exhibition of video. Only instructions for resolution and length were given (4 or 8 min depending on the type of contribution).

For the second aim of the article, differences between student and teacher video styles and videos from this workshop will be compared with those made by PM students during the first half of 2020 course. Since the video sets overlap in terms
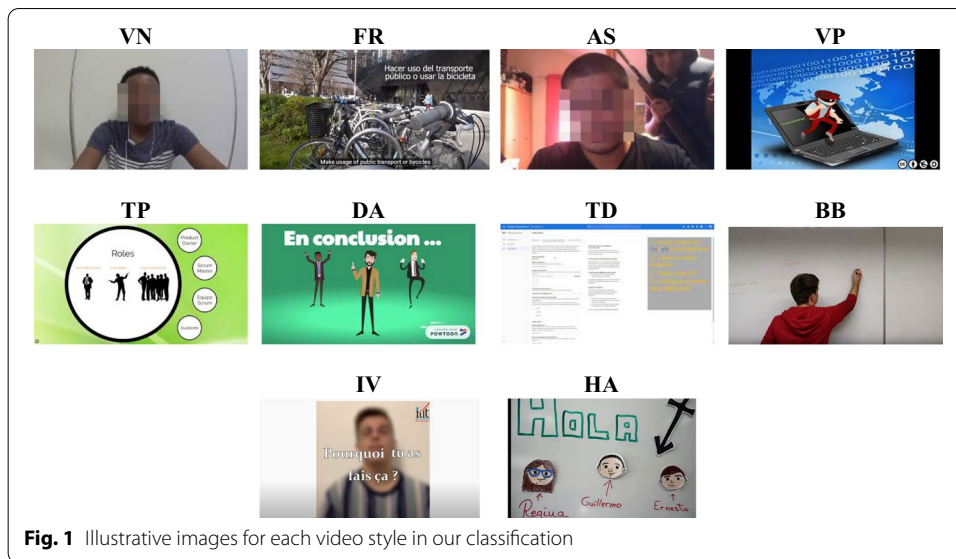
Fig. 1 Illustrative images for each video style in our classification

of date, we can consider them as having similar technologies and coming from the same area of knowledge. Usually, videos comprise the key points and problems of the topic, observable results or effects, and some conclusions in both situations (students and teachers). Although the objectives of the students' and teachers' videos are different, these common characteristics allow for comparison.

Results

The final taxonomy was required six rounds of successive refinements. Each round included 12 videos and involved four or five independent classifiers. Six styles were used as a starting point, although the final classification includes the ten styles explained below. Once the classification was obtained, it was applied to new videos, together with those that had not obtained unanimity (12 videos maximum per round). Eventually, it was applied to 33 videos made by students in 2020, and in this case, seven classifiers participated. Each video was included in as many rounds as necessary until it was rated by unanimity or a majority of six classifiers in the case of seven participants. In only two cases, five iterations were needed. In a single iteration, 69 videos were rated, 17 needed to be repeated twice, 8 needed three rounds, and 6 needed four rounds. In the end, only 3 videos had to be agreed upon. Teachers' videos were catalogued by the same seven classifiers applying the taxonomy obtained. Each classifier was assigned, on average, 21 videos. No further iterations were necessary to complete the classification of the teacher-generated videos.

Resulting classification

After the first iteration with the six starting styles, the description of some styles was adjusted to avoid ambiguities, clarifying further whether text is an important basis for communication support. Two more styles were added, one corresponding to Tutorial or Demo and one corresponding to Blackboard. In addition to adjusting the designation

and description of each style in successive iterations, new styles were added when needed. Thus, after the third iteration, Interview was introduced, and after the sixth iteration, Handmade Animation was added, leading to the 10 final styles. Only some designations were polished. The description of the resulting classification is given below, maintaining the order in which the categories were incorporated. Figure 1 shows a screenshot of each video style in our classification as an example.

1) *Visible Narrator (VN)*: In these videos, the most frequent shot is of a person addressing the audience to explain a content, in some cases aided by a diagram or accessories in the background. Sometimes it is combined with other media (text, video or image) to reinforce key ideas of the narration, but these insertions represent a very small amount of video time. The narrator must appear; this is the outstanding feature of this style as, unlike teachers, students prefer to avoid appearing in academic videos.

2) *Filmed Reality (FR)*: Real scenes are filmed, not prepared, with a speech or a descriptive paragraph to explain something. In most cases, scenes are filmed around the campus. They are usually combined with some other style.

3) *Acted Scenes (AS)*: Students perform a play that illustrates a content and video record it. Unlike the previous style, they are not real scenes but prepared scenes. It requires preparing a previous script and adopting a specific role.

4) *Integration of Existing Videos and Pictures (VP)*: This type consists of a montage of videos, photographs and pictures obtained from the Internet or producers' own media, with very short fragments of text and with voiceover or sound. It is important to use images, integrated or not, with videos.

5) *Textual Presentation (TP)*: This type corresponds to a classic PowerPoint slide presentation. It necessarily prioritizes text and eventually includes the narrator's voice or narrator him/herself explaining the information. Although the narrator may appear, it is text that prevails in the video. We want to highlight this feature to distinguish it from presentations with many images and hardly any text, which fall into the previous category. This is our reason for avoiding the name Slides.

6) *Digital Animation (DA)*: An animation is used to visualize concepts, including image movements. This type is useful for showing relationships or abstract concepts. These animations are made using a computer tool such as PowToon, Explee, Animaker, or Moovly that includes templates and predesigned animations. Concrete tools vary over the years as tools appear.

7) *Tutorial or Demo (TD)*: This explains how an application, a tool, code writing or a similar process works. It is usually recorded as the user works on the computer with a specific application so that the audience can see the result or operation of what the user is doing. It includes simultaneous narration.

8) *Blackboard (BB)*: The presenter writes or draws by hand (which may or may not appear) on a blackboard, slate or tablet while explaining the content (such as mathematical formulas, diagrams or short text). They usually contain worked examples with step-by-step demonstrations of how to solve a problem or which elements constitute the explained content.

Table 2 Videos in each style made by students in different years and made by teachers

Video style	2016	2017	2018	2019	2020 (%)	Students (%)	Teachers (%)
Visible Narrator (VN)	1	3	3	1	3 (9.1)	11 (10.5)	20 (30.8)
Filmed Reality (FR)	0	0	0	0	0 (0)	0 (0)	0 (0)
Acted Scenes (AS)	2	3	4	7	3 (9.1)	19 (18.1)	1 (1.5)
Video and Pictures (VP)	3	3	4	6	17 (51.5)	33 (31.4)	7 (10.8)
Textual Presentation (TP)	2	0	4	1	4 (12.1)	11 (10.5)	35 (53.8)
Digital Animation (DA)	2	1	2	7	4 (12.1)	16 (15.2)	0 (0)
Tutorial or Demo (TD)	1	2	1	4	0 (0)	8 (7.8)	2 (3.1)
Blackboard (BB)	1	0	0	1	1 (3)	3 (2.9)	0 (0)
Interview (IV)	0	0	0	1	0 (0)	1 (1)	0 (0)
Handmade Animation (HA)	1	0	0	1	1 (3)	3 (2.9)	0 (0)
Total	13	12	18	29	33	105	65

9) *Interview (IV)*: One or more people answer questions about a topic. Interviewers may or may not appear in the video and may be conversational or more declarative in style. Interviewees do not address the audience directly, so there is no confusion with visible narrators.

10) *Handmade Animation (HA)*: This is the same idea as in the DA style, but in this case, the animation is based on materials created by hand, such as drawings or playdough figures or cut-outs, or using LEGOS. It requires considerable creativity and someone who is skilled, imaginative and a good drawer.

Differences between student and teachers in terms of video production style

Table 2 contains the types of videos made by students in the years we sampled, i.e., from 2016 to 2020, as well as a summary of the classification of all videos made by students over these years.

Although the Filmed Reality does not appear, it does not mean that students do not use it. In fact, in some video footage, this style appeared, and in some iterations, some classifiers used it. However, since the videos were only classified with a single type, the rest of those videos seemed to be more suited to another style. In addition, Filmed Reality is used in the learning context of Snowball and McKenna (2017). Additionally, the table contains the distribution of videos made by teachers in JENUI (2020).

The video type most frequently used by students is *VP* (31.4% of videos), followed by *AS* (18.1%) and *DA* (15.2%). These three video styles are hardly used by teachers. In fact, *DA* is not used at all, *TD* appears in only two videos, and *VP* is used in 10.8% of the cases. Most teachers make *TP* and *VN* videos, which together account for 84.6% of the videos. These two types of videos, although they are also used by students, appear less frequently, in 21% of cases. This relationship between video types also occurs in 2020, when teachers and students shared technology. In fact, in this year, students preferred to use *VP*, followed by *DA* and *TP*. *VN* and *AS* are also represented. After performing a comparative study of the frequency of video styles of all videos made by students with

Fig. 2 Evolution of student generated video styles over the years (from 2016 to 2020)
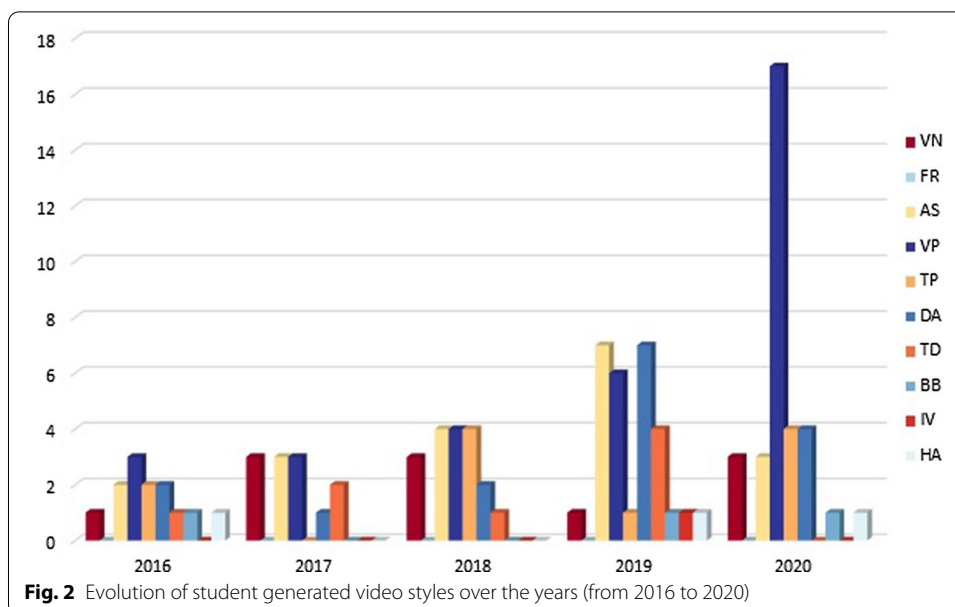
respect to videos made by teachers, significant differences are observed between the types of videos used: χ^2 test (8, N = 170) = 69.257, p < 0.001 (these differences are also obtained by applying Fisher's exact test, p < 0.001). Moreover, significant differences are observed between the types of videos used by students in 2020 and those used by teachers in 2020: χ^2 (7, N = 98) = 44.689, p < 0.001 (also with Fisher's exact test, p < 0.001). As the number of videos in some cases is very low, the study has been repeated with only the styles that have more than 5 videos of that type (i.e., with *VN*, *TP* and *VP*). Significant differences were also observed in this case: χ^2 (2, N = 86) = 30.546, p < 0.001 (also with Fisher's exact test, p < 0.001).

Figure 2 shows the evolution of video styles used by students over the years. There is no clear trend in the evolution of the typology, with different types appearing in different years. Thus, if we compare the distribution of the videos made during the last year studied (2020) with the videos made in the previous years (2016–2019), no significant differences are observed in this distribution: χ^2(8, N = 105) = 12.989, p = 0.098 (no differences are observed with Fisher's exact test, p = 0.077). It is only noteworthy that the *VP* rate has increased over the years.

Discussion

After analysing the videos generated by students, we obtained a classification with 10 styles. We consider it a valid classification because it includes a wide variety of styles and, above all, it covers the designs chosen by students to communicate themselves through video, which had not previously been taken into account. Since the study has been conducted over several years, we have included a variety of current production styles.

Figure 3 includes a comparison of the classifications we have obtained of videos made by students with respect to others made by other authors. In particular,

Our taxonomy	Correspondence with		
	Snowball and McKenna, (2017)	Santos-Espino et al. (2016)	Hansch et al. (2015)
Visible Narrator	Talking Heads	Talking Head	Talking Head
			Webcam Capture
			Text-Overlay
			Actual Paper/Whiteboard
			Green Screen
Filmed Reality	Filmed Reality	Documentary	On-location
Acted Scenes	Acted Scenes	Others	Demonstration
Integration of Existing Videos and Pictures	Montages of Existing Videos and Photographs		Not included
Textual Presentation	Not included	Slides	Presentation Slides with Voice-Over
			Picture-in-Picture
Digital Animation		Others	Animation
Handmade Animation			
Tutorial or Demo		Screencast	Screencast
Blackboard		*Virtual* Whiteboard	Khan-Style Tablet Capture
			Udacity-Style Tablet Capture
Interviews		Interview	Interview
			Conversation
			Recorded Seminar
Not included		Live Lecture	Classroom Lecture
			Live Video

Fig. 3 Mapping between styles in authors' taxonomy and others by extending the Santos-Espino et al. (2016) mapping

the authors we highlight are Snowball and McKenna (2017) (because it is the only attempt with students), Hansch et al. (2015) and Santos-Espino et al. (2016). Table 3 in the appendix includes a complete list of video type classifications used in education found in the reviewed literature.

Our classification is a more compact categorization than others that have appeared in the literature, and therefore, it causes less ambiguity when classifying videos. It is simpler than Hansch's with 18 styles and more complete than Santos-Espino's with 7 styles and Snowball's with just 4 styles. It avoids subtle differences that appear in some classifications. Thus, we maintain the grouping of Hansch's styles that Santos-Espino makes, and we avoid considering very slight differences, such as those in Crook and Schofield (2017), who distinguish in their categories whether the presence of narrators in relation to the slides is mobile, fixed, overlapping, etc. These subtleties, in our view, do not enrich any of the styles described by Santos-Espino et al. (2016).

Here are some considerations about our styles and designations compared to previous classifications:

- The Visible Narrator (VN) style coincides with the so-called Talking Head style of Santos-Espino, Hansch, Snowball and others. In the case of Hansch, the narrator also appears in the webcam capture styles but in a more informal way, or in the Green Screen styles, with different backgrounds, Text-Overlay or Actual Paper/Whiteboard where the text is secondary. Our denomination allows us to consider more forms of appearance of the narrator, including half-body or full-body or others.
- The Filmed Reality (FR) style is included with the same designation as Snowball's, and it can be similar to Santos-Espino's Documentary style, which they define as the standard film genre, a narrative about footage of a topic. They relate it to Hansch's Demonstration style, which is used to address a concept, see a process in action or show experiments rather than hearing someone talking about them.
- The Acted Scenes (AS) style, which again corresponds to Snowball's Acted Scenes style, could be similar to a subtype of Hansch's Demonstration style, already men-

tioned, though in this case students adopt a more dramatic style as if it were a scripted film. It therefore implies a specialisation that is seen in videos made by students and is not detected in videos made by teachers. Santos-Espino found no examples of this style and did not include it in their classification.

- The Integration of Existing Videos and Pictures (VP) style detected by Snowball and named Montages of existing Videos and Photographs does not appear in any categorisation, but this is the only one that takes into account videos made by students. It is the Internet and quick-search generation style, and they apply the idea of cut and paste to videos as well.
- The Textual Presentation (TP) style, despite not being a style detected by Snowball, appears in all the other categorisations, though with the name Slides (as in the case of Santos-Espino), or is distinguished as Presentation Slides with Voice-Over or Picture-in-Picture in Hansch according to the way the instructor appears.
- The Digital Animation (DA) style coincides with Hansch's Animation style, and, as they indicate, it can be very simple or very sophisticated. Currently, there are tools that ease its realisation. For these reasons, we distinguish how the animation has been made, and we consider digital animation when the video is made using a tool such as Powtoon, Xplee, Animaker or Moovly. Students keep themselves informed about new technological developments, such as new tools for editing, production, broadcasting, etc., and quickly incorporate them into their daily lives.
- The Handmade Animation (HA) style is novel in this work. This distinction does not appear in other classifications. It is clear that the production work and creativity involved are very different from those in the case of Digital Animation, which is why it is considered a different style.
- The Tutorial or Demo (TD) style coincides with what Hansch and Santos-Espino call Screencast, commonly used for technical training, software or a step-by-step tutorial. It is useful in many academic contexts, even though in the Snowball context it did not seem necessary.
- The Blackboard (BB) style is similar to the Virtual Whiteboard style by Santos-Espino and corresponds to the style that became popular as Khan-Style Tablet Capture. It is also similar to Hansch's Udacity-Style Tablet Capture. In the case of students, they do not often have technology to replicate exactly this style in a sophisticated way; hence, the final product is more handmade, or they use a posterboard, paper or a device that is not necessarily virtual. Therefore, we do not use the Santos-Espino nomenclature. This style would coincide with the Paper style of Shoufan, but we prefer the term Blackboard, Whiteboard or Slate, which is more in line with most classifications.
- The Interview (IV) style is listed under the same name in Santos-Espino's classification and in Hansch's classification. In Hansch's classification, Interview variants such as Conversation and Recorded Seminar are distinguished.

By focusing on student videos, we do not include the Classroom Lecture style or Live Lecture style (Hansch et al., 2015; Santos-Espino et al., 2016), which are typical styles employed by instructors in a face-to-face class. This style may appear at some point, but

depending on how the recording is made, it may eventually be classified as a visible narrator or some other style. Additionally, adaptations of our styles may appear that are not currently included. For example, interviews could be conducted online so that the video generated would be the equivalent of a video call. In this case, it would be a feature that in some contexts might seem important and distinguish itself as another style.

Whilst in our case we have only classified each video with one style, it is clear that the styles can be merged, and we believe that the production of heterogeneous videos or videos that integrate several styles is a trend. In this work, we have decided to select the predominant style because they are short videos. This multiple classification might be necessary with longer videos.

Taking this into account, as seen in Table 2, the video style most frequently used by students is Integration of Existing Videos and Pictures. This type of video is not documented as being used in MOOCs (Hansch et al., 2015; Santos-Espino et al., 2016). The videos used in MOOCs have a style closer to a conventional lecture style, while those made by students make little use of this pattern and are more likely to redistribute existing content, with or without adjustments, usually after a quick Internet search. Furthermore, the styles most widely used in MOOCs include the instructor's image (Santos-Espino et al., 2016), while for students, the use of this style is infrequent. Students tend not to appear in the video, and if they do, it is in theatrical mode, the second most used by students, who probably use this style to make the videos more engaging and eye-catching. The textual presentation, also widely used by instructors (Santos-Espino et al., 2016), when used by students, is often replaced by a digital animation that may include text but in a more attractive way. In this regard, a new category appears in the taxonomy for students, in which they use handmade animation. This style does not appear among videos produced by instructors.

If we compare the videos made by students at PM (2020) and those made by instructors at the JENUI Workshop, we see that students use more variety: seven types of video compared to five by instructors. Students are likely more creative since they have more examples, as they have access to more videos, while teachers may tend to transfer their experience to this context and make more formal videos. Students in this year preferably use VP (which require searching for videos and images on the Internet in order to generate the video), AS and DA videos (in which student creativity predominates). The use of these types of videos corresponds, to a certain extent, with those used by students in previous years, while teachers in the same year prefer TP and VN. These styles are also the video types most commonly used in MOOCs according to previous results (Hansch et al., 2015; Santos-Espino et al., 2016).

A number of limitations must also be taken into consideration in this work. First, although the number of videos we have used seems sufficient to create the taxonomy (at least when compared to the number of videos used in works with wide taxonomies) and we have not limited our study to a single year or subject, the number of videos in some styles is scarce. Second, we used videos from three universities in an attempt to make the results generalizable to students from different communities. Third, although students' and teachers' videos analysed in this study coincide in some aspects such as freedom

of format and length of the video, their target audience is different. However, finding a context where both groups have the same demands and motivations is complex. In our case, the workshop and the students' activity follow the same script of presenting a problem with some alternative solutions and conclusions, which allows for comparison. Finally, the study was carried out with computer engineering students. We believe that the results obtained are generalizable to students from other universities and degrees. Nevertheless, it may be necessary to replicate the study with larger samples from other universities and degrees to confirm the results obtained in this work. In the same way that teachers from different disciplines show differences in their video preferences (Santos-Espino et al., 2020), the same can be expected to be true for students' video creation.

Conclusions

We have established a novel taxonomy of types of videos made from students' points of view by analysing the videos generated in a set of computer engineering subjects over five years. This classification completes the existing video classifications, incorporating the typology of videos developed by students. These types of videos reflect the tastes of students when making a video, which do not necessarily coincide with those of teachers. Students are becoming generators of content to be used in the learning process. It is therefore important to take into account the way students themselves make these videos. Additionally, it is also suggested that instructors who generate videos bear this in mind when trying to reach students. Furthermore, it is evident that technology is rapidly changing; in our study, however, it seems that this taxonomy is valid for a range of years. Thus, the ways students disseminate content do not advance as fast as the technology itself does.

Having a taxonomy that also captures the types of videos generated by students can benefit those involved in the research, design and production of educational videos, for example, to carry out studies to better understand the preferences of students according to their fields of knowledge, level of studies, effectiveness for learning, etc. Moreover, the type of video may be conditioned or limited by its didactic use. Instructors can decide to guide or not on the type of video to be made or used in their teaching practice, since the production of each type of video has associated resources and a life cycle with associated characteristics and time costs. Knowing the limitations or available resources allows for a better orientation of the planning and execution of video activities by the students.

Based on the classification defined, a comparative analysis was performed between the types of videos developed by instructors in a virtual workshop and videos developed by students. Significant differences were found. The integration of multiple expressive resources and the reuse of content obtained from repositories and the Internet is more frequent among students. Students know tools that allow them to create videos that are more engaging for their peers (such as animation) and they use more variety of styles. On the other hand, teachers tend to transfer their expertise to the online video context and make more formal videos, in most cases, similar to the presentation slides, with or without their image. The type of videos that students prefer can inspire teachers to design more engaging, different and effective pedagogical videos for active learning.

Appendix: Previous taxonomies of academic videos and the styles identified

Table 3 Classification of video type used in education published in the literature; only Snowball and McKenna (2017) considers student-generated videos

References	Video typologies	Video sources
Hansch et al. (2015)	Talking Head Text-Overlay Actual Paper/Whiteboard Webcam Capture Green Screen Classroom Lecture Live Video Recorded Seminar Interview Conversation Presentation Slides with Voiceover Picture-in-Picture Screencast Khan-Style Tablet Capture Udacity-Style Tablet Capture On-Location Animation Demonstration	Coursera EdX FutureLearn Khan Academy Iversity Udacity
Santos-Espino et al. (2016)	Talking Head Live Lecture Interview Slides Screencast Virtual Whiteboard Documentary	Cousera and EdX (USA) FUN (France) FutureLearn (UK) MiriadaX (Spain)
Guo et al. (2014)	Slides Code Khan-style Classroom Studio Office desk	EdX (MIT, Harvard, UC Berkeley)
Shoufan (2019)	Khan Slides Head style Paper Anim Class	YouTube
Crook and Schofield (2017)	A1 Voice over slides A2 Voice over screencast A3 Writing over slides A4 Kahn whiteboard B1 Fixed frame B2 Mobile frame outside B3 Fixed but B4 Mobile frame and overlapping C1 Presence in split screen C2 Presence in picture C3 Presence overlapped by content D1 Presence active on whiteboard D2 Presence in lecture D3 Presence in full screen E1 Presence in interview E2 Presence in discourse	Class Central: Coursera EdX FutureLearn, etc

Table 3 (continued)

References	Video typologies	Video sources
Rahim and Shamsudin (2019)	Voice over animation Voice over video Voice over slides Animation Voice over screencast Kahn whiteboard Animation + active whiteboard Slides Presence active on whiteboard Presence overlapped by content Writing over video Writing over slides Voice over video and screencast Screencast Mobile frame outside	MOOCs by Malaysian Polytechnics
Chorianopoulos (2018)	*Human embodiment:* Hand Talking head Full body *Instructional media:* Instruments Board Slides Animation Digital board Simulation	*Instructional video repositories:* iTunesU MIT Open Courseware TEDed VideoLectures.net YoutubeEdu *Organizations:* Coursera EdX FutureLearn Iversity Khan Academy Udacity
Díaz Velasco et al. (2016)	Khan Academy Chroma effect Talking Head Video tutorial Master class	Telescopio EdX Coursera MiriadaX Udacity Khan Academy
Snowball and McKenna (2017)	Talking Heads Filmed Reality Acted Scenes Montages of existing videos and photographs	Students from first-year Economics (South African University)

Only the last row considers student-generated videos

Availability of data and materials
The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Competing interests
The authors declare that they have no competing interests.

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