Video Development Methods for CDIO-Based Project Courses

VIDEO DEVELOPMENT METHODS FOR CDIO-BASED PROJECT COURSES

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ABSTRACT

Video utilization can be a powerful tool for teachers to stimulate students' interest and support flexible and adaptive learning. Successful video-based learning implementation cannot be assured without careful consideration regarding desired quality, learning outcomes and video development methods. The investigation and sharing of experiences considering video development is indispensable and will contribute to spreading a culture of easily made, peer-reviewed videos, which will enhance teaching and learning. For CDIO-based courses, it is required that the video development methods are agile and cost-effective in production as to support continuous update of videos relevant for the course and other course activities. In this paper, we identify and describe video development methods from different CDIO-based project courses. The methods are classified based on the content type, the production style, the required resources and the video characteristics. All presented video development methods follow our general framework of video development process which has been previously published and consists of four interwoven steps - topic selection, learning objectives mapping, content generation and video recording. Based on semi-structured interviews with the course teachers, we present their experiences with those different development methods to create content specific videos pertaining to various *Conceive-Design-Implement-Operate* topics. As outcome, we suggest our preferable video development method depending on video content category. We conclude that the choice of video development method must consider the audience's characteristics and needs while video content should be aligned with the course content, other learning activities and the literature. The video development methods suggested and described in this paper will assist educators to choose an appropriate video development method for their own courses and maximize the videos' contribution to student learning.

KEYWORDS

Video-based learning (VBL), Project-Based Learning (PBL), Design-build-test (DBT) project
Standards: 2, 5, 8, 10

INTRODUCTION

Due to the increased affordability of technology and the development of learning sciences in the past decade, a growing number of teachers in higher education use videos in their teaching to facilitate their students' learning in blended or virtual learning environments. Application of video-based learning (VBL) is an accumulated effort involving video-planning, content-development, video-usage, and monitoring aiming for continuous improvements. Merely video usage does not lead to better learning outcomes, but careful considerations regarding the quality, learning outcomes and video development methods are required. In CDIO-based project courses, VBL can assist to multiple course-activities such as to conduct workshops or assist in project assignments. Therefore, it is required that video development methods used

are agile and cost-effective in production to support continuous update and creation of new videos relevant to courses.

Preparation and recording of well-adapted videos can be time and cost intensive (Viksilä, 2013) and requires a sound pedagogic foundation. Therefore, studies have been conducted to provide guidelines or suggestions for video creation aiming to help teachers to produce their own videos (Plaisant & Shneiderman, 2005; van der Mei & van der Meij, 2013). Those guidelines are also applicable to videos developed for CDIO courses. However, to be more effective, the choice of the method should be based on the video content category, whether it refers to a Conceive, Design, Implement or Operate topic. Additionally, due to the inclusion of design-implement experiences in many CDIO courses, emphasis should be given on how to develop videos for this purpose. Currently, there are few references regarding the use of video-based learning in CDIO courses (Bhadani et al., 2017; Viksilä, 2013) and just one study considering video production in problem solving videos (Sellens, 2014). Therefore, there is a need to investigate the correlation between video content and production style in CDIO-based project courses. The purpose of this paper is to expand the research and systemize video development methods for CDIO-based project courses by answering the following research questions.

- What are the main components of a video development method?
- Which production styles are more suitable for different video content?
- What problems do teachers encounter while creating or using videos and how could those problems be mitigated?

The paper contains a brief description of the previous research followed by a description of our research methodology and data collection, which includes self-reflection and interviews with teachers. Our results consist of an overview regarding classification of video content, production styles, resources and video characteristics such as duration, narration, quality, presentation style. Further, a brief analysis of teachers' experience regarding video development is also presented followed by discussion. We conclude with suggestions to teachers on how to choose video development methods based on content characteristics aiming to produce their own adaptable and cost-effective videos.

LITERATURE REVIEW

Research on video-based learning has increased over the last decade (Giannakos, 2013). A number of studies have thereby examined the effect of video usage on student performance (Means et al., 2010; Nikopoulou-Smyrni & Nikopoulos, 2010) and student satisfaction (Bhadani et al., 2017; Kay, 2012) in varying academic environments. The results tend to vary somewhat but studies indicate that - compared to traditional teaching - video-based learning has either positive or no effect on students' performance and that students tend to have a positive attitude towards videos. Similar findings were also presented for video-based learning in CDIO courses (Cheah, Lee, & Sale, 2016; Hugo, 2014). However, Basu Roy and McMahon (2012) supported that video usage could also have negative effects and lead to decreased deep thinking compared to text-based teaching if videos are not prepared according to their purpose. Therefore, video design should be considered carefully. Despite the growing trend of using video-based learning, there are only a few guidelines or methods on how to develop short videos, which is the suitable video-type for CDIO-based project courses (Bhadani et al., 2017; Sellens, 2014).

Documented video development methods focus mainly on content development and video characteristics, such as duration, narration, audio-image correlation and quality. They may

refer to a specific type of video content, for example tutorials (Blummer & Kritskaya, 2009), to a specific production style, for example screencasts (Oud, 2009), or to general guidelines (Guo, Kim, & Rubin, 2014). Their basis can be either practitioners sharing their experiences on how to develop video content in an effective and engaging way (Martin & Martin, 2015) or guidelines originating from an established theory, such as the cognitive theory of multimedia learning (Mayer, 2007) or the observational learning theory (van der Meij, 2017), aiming to reduce cognitive load imposed to students through videos (Koumi, 2013) or to address students' multiple learning styles (Mestre, 2012).

Video development methods can refer to videos either for purely web-based courses such as in distance education or Massive Open Online Courses (Hew & Cheung, 2014) or for blended courses that also include face-to-face interactions. This can, for example, be traditional courses where videos have an assisting role (Kay & Kletskin, 2012) or courses that apply a flipped classroom model (Karabulut-Ilgu, Jaramillo Cherrez, & Jahren, 2017; Svensson, Hammarstrand, & Stöhr, 2015). In both cases, videos developed use similar production styles but differ in the targeted audience and production budget. Videos in CDIO-based project courses are mainly used in a blended learning environment involving a relatively small number of students (up to 150) and the available resources for their development are usually low compared to those of Massive Open Online Courses. Therefore, although video development guidelines developed for Massive Open Online Courses or distance education are also applicable to CDIO courses, adaptation is needed to create videos tailored to project-based course format, where additional videos may be needed within a short notice for project assistance, and speed of delivery has priority over quality. As a result, emphasis should be given on how to develop short videos for varying contents quickly, using a reasonable amount of resources and maintaining a good enough quality to fulfil the educational purpose.

METHOD

The suggested video development methods were investigated in three steps. Firstly, an analysis of the developed videos was conducted to identify the components of the video development methods. Around 30 videos were analyzed resulting in the categorization of the video components. The videos were developed for three courses: Machine Elements (PPU210), Product Planning - Needs and Opportunities (PPU085) and Engineering Design and Optimization (PPU190) in the Mechanical Engineering program at Chalmers University of Technology. Secondly, semi-structured interview was chosen as a method to initiate a fruitful conversation with the faculty members and gather different perspectives on video development approaches. The interview's structure was decided after the initial identification of the video development components and aimed to cover all the sections of a video development method: Content, Production Style, Resources and Video Characteristics. Lastly, suggestions for video development methods were made based on our personal experience of video development during the past two years and on the four semi-structured interviews with faculty members who created the videos themselves.

RESULTS

The result section is divided into two sections: description of components in video development methods, comparison of the components based on teachers' experience. Further, an analysis of the interviews along with recommendations are presented.

Description of Components in Video Development Methods

The components of video development are broadly classified into four categories, namely, Content, Production Style, Resources and Video Characteristics which are described below.

Content

Content of a video refers broadly to the various aspects of the course topic to be presented in the video. Figure 1 presents the classification of the Content consisting of Category, Course Activity, Type, Purpose and Difficulty. Category refers to the classification of video in Conceive (C), Design (D), Implement (I) or Operate (O) according to CDIO syllabus and the learning outcomes. The videos are designed for various course activities which can vary from theoretical lectures to more practical assignments, lab exercises and workshops. Content type can be Methods & Examples (ME), where theory and applications are described, Software Demonstration (SD), where the software features with a problem are presented, Problem Solving (PS), where the solution to a specific problem is sequentially explained and Assignment Procedure (AP), where information regarding a specific assignment or project is included.

Videos can have multiple purposes, especially in a project-based course. More specifically, they can be used to prepare students for course activities allowing more productive use of the allocated time or they can repeat something from a course activity for students who could not attend or for those who need a reminder. They can also be used as a direct action from the teacher by answering students' questions when many of them encounter difficulties in a specific part of the theory or a procedure. In this case, videos can save time from teachers and supervisors in assisting students to understand a trivial part and to continue their project assignments. Additionally, videos may contain extra material aiming to level the class, especially at Master's Level where students may have different studying background. The last aspect of content classification is the difficulty which may vary from an entry level to an advanced level.

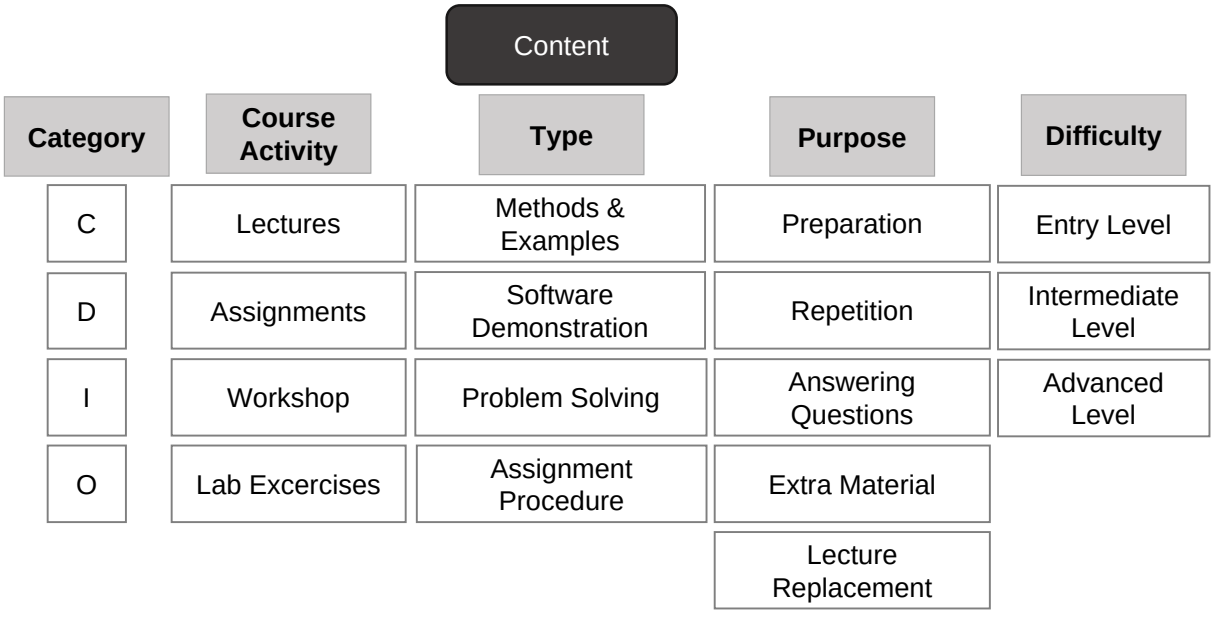


Figure 1. Content classification in a video development method

Production Style

Production style refers to the different electronic means that can be used to record the content of the videos (see Figure 2). It can be via PowerPoint slides recording, screencasting, camera recording, surface tablet recording or a hybrid method consisting of two or more production styles in the same video. Screencasting refers to recording of content presented on a computer screen and it may also include simultaneous recording of audio. Camera recording can be either recording of a person's hand while writing on a paper or recording of a person while performing a task on a board. Surface tablet recording describes the recording of the screen of a tablet device, where a person writes by hand or using stylus. The production style is closely associated with the available resources for developing video and user's choice.

Resources

Resources refer to software and hardware used in each production style and location in which the video can be recorded (see Figure 2). In this study, the software used were PowerPoint Mix for slide recording with minimal editing, and Camtasia Recorder or Screencast-O-Matic for screencasting with more comprehensive editing. Both Camtasia Recorder and Screencast-O-Matic have a free basic version which is sufficient for short video recording in case there is not a purchased license. The advantage of PowerPoint Mix is that users can record the PowerPoint slides one by one which adds flexibility to the recording and modification of the video. However, it does not include advanced editing options which can be found in Camtasia Recorder. Hardware used included personal computers or laptops with built in or additional cameras and microphones for voice recording, a wolf camera for recording a person's hands, which can also be used to record a pen and paper style video, and surface tablets with pens which were used to add handwritten notes to slides or screen recordings. All videos analyzed in this study were recorded either in the person's office or at their home in case it was not possible to use their office or if they did the recordings at their spare time.

Video characteristics

Video characteristics refer to video-duration, narration, quality, and presentation style (see Figure 2). In this study video duration ranged from less than 1 until up to 18 minutes. When videos were larger than 20 minutes they were segmented into smaller duration creating a series of videos. Narration refers to the talking style, whether it is formal or conversational, the

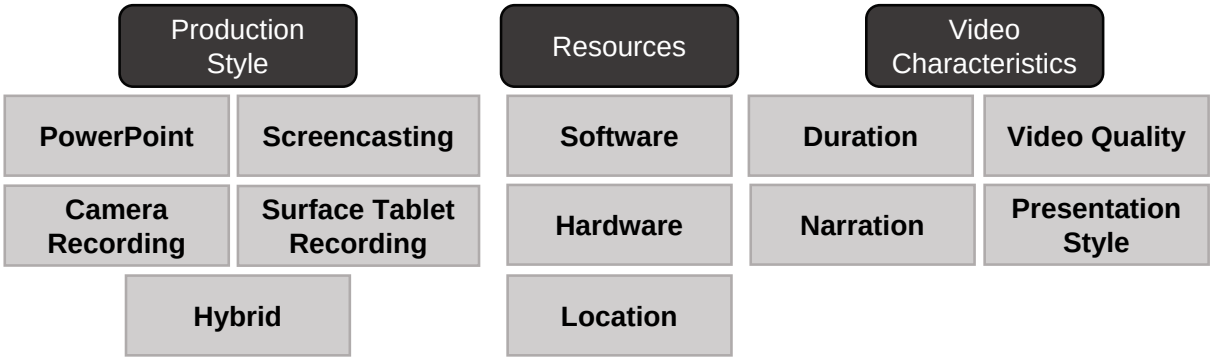


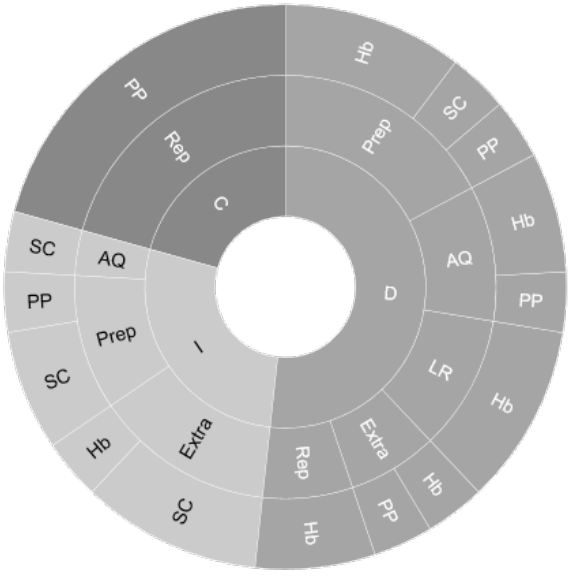
Figure 2. Production Style, Resources and Video Characteristics Classification in Video Development Methods

use of a script, and the relation between the person recording the video and students. Video quality refers to both sound and audio quality. In this study, the targeted video quality was reduced to facilitate quicker video creation. Presentation styles refer to the incorporation or not of annotating tools, zooming and instructor's face. In general, the videos had a casual conversational style and there was a personal contact with the students as the person recording was either the professor having the class lectures or teaching assistants acting as supervisors.

An analysis of the evaluated videos with respect to the components of the video development methods is shown in Figure 3. For course topics related to *Conceive* category, PowerPoint was mainly found suitable for the user whereas for videos related to *Design* category, the user preferred using a hybrid style of video, usually screencasting of software and PowerPoint or screencasting of PowerPoint and use of a surface tablet. This trend can be related to the need of switching between topic presentation and software demonstration to create a comprehensive video. The *Implementation* category mainly contained videos aiming to provide additional support to students in their assignments and screencasting was mostly used for this category.

Comparison of the components of video development based on teachers experience

Interviews were used to investigate how faculty members formulated their video content, what production styles they used, what resources they needed and what was their overall impression about the videos they produced. The summary of the interviews is presented in Table 1. The interviewees were categorized based on their teaching and video development experience. All of them were considered beginners in terms of experience in video development. However, their teaching experience was substantially varying. The analysis of the students' reactions to the videos is not part of this paper, but is presented by Bhadani et al. (2017).



Inner Circle- Content Category

C	Conceive
D	Design
I	Implement

Middle Circle- Purpose

Prep	Preparation
AQ	Answering Questions
LR	Lecture Replacement
Extra	Extra Material
Rep	Repetition

Outer Circle- Production Style

PP	PowerPoint
SC	Screencasting
Hb	Hybrid

Figure 3. Classification of analysed videos to components of video development

Table 1. Teachers' view on video development methods

	A	B	C	D
Teaching experience	Beginner (2 years)	Intermediate (8 years)	Experienced (25 years)	Experienced (25 years)
Video creation experience	Beginner (approx. 20 videos)	Beginner (approx. 15 videos)	Beginner (approx. 10 videos)	Beginner (approx. 10 videos)
Content Type	Methods & Examples, Software Demonstration, Problem Solving	Software Demonstration, Assignment	Methods & Examples	Problem Solving
Content Purpose	Preparation, Extra Material, Lecture Replacement	Extra Material, Repetition, Answer Questions	Extra Material	Extra Material
Production Style	PowerPoint, Screencasting, Hybrid	PowerPoint, Screencasting, Camera Recording, Hybrid	PowerPoint, Screencasting	PowerPoint, Screencasting
Resources	PowerPoint Mix, Camtasia Recorder, Surface Tab Pro, Extra microphone	PowerPoint, Screen-O-Matic, Wolf camera, Surface Tab Pro	PowerPoint Mix, Camtasia Recorder; Surface Tab Pro, Extra Microphone	PowerPoint, Screen-O-Matic
Recording Location & Time	Office, Up to 1 day/video	Home, Office, Up to 1 day/video	Home, Office, Up to 0.5 day/video	Office, Up to 1 hour/video
Video Characteristics	Up to 15 minutes, casual narration, use of script, use of annotation-red pointer, zoom feature, use of talking head for M&E topics	Up to 30 minutes, casual narration, use of script, use of annotation, use of talking head for M&E topics	Up to 10 minutes, casual narration, no script, use of talking head	Up to 10 minutes, casual narration, no script
Suggestions	Perform editing on same day of recording, get reviews for your content before recording, create interactive content and suggest literature during video	Keep same layout of the information between lectures and videos, make clear video purpose to students, extra microphone-set it correctly from the beginning	Use segmentation for long topics, invest time in preparation, use subtitles	Include follow up quiz, ensure students work themselves and not passively watch videos, not too compacted video content, fewer problems with more time for explanation

Motivation for video development varied between the interviewees. Two of them considered that videos could be a good tool to assist many students in solving their assignments, while the other two wanted to follow the trend of online teaching and observe students' response. None of them received formal training in video development and their approach was to just start trying recording and improve video quality through iterations. The equipment they used was provided by the university. Regarding the content development, most of the times they used existing lecture slides from course and sometimes, they created new content as well, especially when it referred to assignments. When they used existing content, they usually modified it to be more suitable for video recording by adding annotations or dividing the topic into smaller segments to make shorter videos. Three out of four interviewees preferred to spend more time on preparation of the content and the narrative to avoid time-consuming editing.

Table 2. Pitfalls and suggestions to avoid them

What can go wrong?	How to avoid pitfalls?
Video preparation and recording lasts longer than expected and videos are not ready on time.	Emphasize over fast delivery and content quality against video recording quality.
Videos do not convey the desired message.	Consider learning objectives in the design of the videos.
Video creates more problems to the students than it solves.	Maintain same layout between lectures and videos, avoid distractions and misunderstandings.
Students are not interested in the videos.	Choose the appropriate production style based on the content classification. Develop short (2-15 minutes) videos with good enough quality.
Students watch passively and do not practise, their performance deteriorates.	Include interactive elements to involve students.

Regarding flexibility of re-using the videos, one of the teachers indicated that the videos may seem aged after a while, because lecture notes were changed but not the videos since it is time consuming to renew them. One of the interviewee pointed that the use of camera recording is an important tool especially for the problem-solving topics and it can be used to create a presentation by hand at the time of recording and replicate students' way of working while providing intuition to the solution. This can serve as a reminder to students that not everything can be done on a computer and that they should perform hand calculations as well. Another interviewee suggested that video content for problem solving should not provide the solutions to the students in a straightforward way but it should challenge them to think. Additionally, it should be complimented with hands-on exercises to engage the students actively. Table 2 includes a summary of the main issues during video production and how to avoid them based on the authors' self-reflection and the interviews with the faculty members, where they identified problems they encountered during video production and use.

DISCUSSION

The paper identifies the main components of a video development method and which production styles are more suitable for different video contents. This is the first approach to identify suitable methods for video development in CDIO-based project courses. The interviews with the teachers tried to identify the problems they faced and their suggestions for more efficient and effective video development. There were mainly two categories of problems, the first concerned the teachers themselves and the fact that they may lacked time to produce videos or they delayed their delivery. The second category referred to the students and how they interacted with the videos based on the teachers' observations. Typical problems in the second category were that the video could create more confusion to the students than understanding, students may not be interested or they watched passively without really understanding the concepts presented.

As measures to the above problems it is recommended that the videos have clear objectives and are aligned with course's learning outcomes, while students' engagement and their evaluation during and after watching the video should also be considered, which is in-line with the recommendations by Blummer and Kritskaya (2009). It is also advised not to use outdated videos in tutorials if the content has changed considerably and segment the videos to lower the duration which is also supported by Martin and Martin (2015). It is also suggested the use of conversational and friendly narration style to imitate classroom environment which was also recommended by Mayer (2007) and Koumi (2013). Additionally, the creation of short videos and the minimum post-editing to ensure good enough quality are also proposed to maintain students' attention and save time during video production. Those are partially in-line with

suggestions by Guo et al. (2014) who recommended an informal setting with casual narration and post-production editing. The difference between the two approaches regarding post editing could be explain by the different targeted audience and the context of the videos in terms of size and purpose between Massive Online Open Courses and CDIO courses.

CONCLUSION

This paper identified four central components in video development methods, namely, Content, Production Style, Resources and Video Characteristics and it describes the different alternatives in each case. The analysis can assist teachers to choose the most appropriate production style for their video based on the content category and the purpose of the video and get an overview of good and bad practices for the different components. For videos in the *conceive* category, PowerPoint is suggested as a production style and for *design* videos a hybrid method may be more suitable to produce comprehensive videos. *Implement* videos usually refer to software demonstrations and therefore screencasting or a hybrid approach is proposed for production style. While differing in terms of production style, the video development methods are adaptable and cost-effective in terms of the required technologies. This study is limited by the content of the courses that videos were created for and the relatively small number of videos examined. However, this approach of video development could be potentially implemented in video development for project-based courses with similar content. The main implication of the study is the preservation of the knowledge acquired during those two years regarding video development and the creation of a video component classification method which can act as a basis for further investigations in more courses.

ACKNOWLEDGEMENTS

This work is based on the research supported by CDIO, project number 15013 and CDIO2, project number 17165, funded by EIT Raw Material. This support is gratefully acknowledged.

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