Instructors Desire Student Activity, Literacy, and Video Quality Analytics to Improve Video-based Blended Courses

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ABSTRACT

While video becomes increasingly prevalent in educational settings, current research has yet to investigate what feedback instructors need regarding their students' engagement and learning despite video technologies being equipped to provide viewing analytics and collect student feedback. In this paper we investigate instructors' requirements from video analytics. We used a Grounded Theory Approach and interviewed 16 instructors who teach using video to determine the advantages for using video in their teaching and the different requirements for analytics and feedback in their existing practice. Based on our analysis of the interviews, we found three categories of information that instructors want to inform their teaching. Instructors are looking to see if their students have watched their videos, how much they understood in those videos, and how useful the videos are to the students. These categories provide the foundations and design implications for instructor-centric educational video analytics interfaces.

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INTRODUCTION

The use of video as an education tool has a long history and with the advent of the Internet, sites like YouTube have made both discovery and distribution of instructional and educational videos ubiquitous. These technologies paved the way towards the introduction of online education tools, such as Coursera and edX, where instructional video is the centerpiece of self-paced courses. The introduction of Massive Open Online Courses (MOOCs) has led to an explosion of video use in structured educational courses on the Internet. In parallel, many mainstream video platforms began to pay more attention to educational videos, such as the growth of Khan Academy from YouTube [30]. Video's success in the online world has grabbed the attention of instructors who have begun appropriating video in their teaching. Instructors are starting to experiment with a blended learning approach [11], which mixes online material with traditional lectures, and more extremely, flipped classrooms [1], where learning is done at home and class time is reserved for exercises and problem solving.

Many instructors are still figuring out how to effectively teach their topics using video. These strategies include exploring the various types of video to use, such as talking heads, slides and demonstrations, how to use video to enhance engagement with the material, as well as the strength of using animation in video over text and static images. The increased use of digital media has opened up a new area for data mining and analytics which can be used to improve teaching by providing instructors and students feedback on learning objects. The Learning Analytics Cycle [4] is a framework that can provide instructors with the insights to improve their teaching. In teaching with video, there is a distinct gap in the technology for instructors to gather the information about student

behaviours around working with video that is necessary to make informed decisions about how to structure their classes around video. Our goal here is to identify the types of information instructors would like to see, as well as the strategies that they are currently using to work around the lack of visibility supported by software.

In this paper, we identify and describe the video-based strategies that instructors use when teaching in blended learning environments. The focus here is on instructors who have used video to teach in a face-to-face classroom, rather than online courses. Our participants' ranged from new instructors to experienced instructors who have taught for more than 30 years. They also have taught in a variety of disciplines. Participants' continued use of video has given them insights about strategies for increasing engagement with the course content in, and outside of the classroom. While they see many pedagogical advantages, there are still aspects about learning with video that they are missing, such as receiving feedback about student perceptions of video effectiveness and behavioural patterns in video, which they believe they could be used to improve their teaching. While instructors attempt to supplement these insufficiencies with tools like Personal Response Systems (PRSs), such as clickers, and end-of-term surveys, they still want to know more about how their students use videos. We interviewed 16 instructors who have used video in their teaching, and thematically analysed the types of student feedback and analytics instructors want to see.

This paper aims to answer the following research questions:

- What are the strategies that instructors employ to learn about how best to teach with video?
- What kind of information do instructors want about how their students are watching the video to improve their teaching?

The focus is to bring insight into the current practices of teaching with video at a post-secondary level, and the amount of visibility instructors are attempting to create to find out more about the students' learning. We conclude with a discussion the implications for designing a video learning analytics system for instructors that would satisfy those needs.

The qualitative data provide a rich understanding of the challenges *instructors* face in making sense of how their students learn with video. Furthermore, our work complements the research literature by triangulating findings using a methodological approach that has been identified as a promising yet under-represented in the Learning at Scale community [26].

RELATED WORK

We consider related work on investigations of current use of video in teaching, learning analytics used by instructors, existing video analytics systems, as well as mechanisms for garnering feedback, implicit or explicit, from students about the use and quality of videos being used to teach.

Video teaching strategies

Video has been long used as a way to teach courses online, as a way of delivering a lecture without the physical presence of an instructor; they can also be prerecorded to supplement classroom lectures [2], recorded during lecture and posted online [29], or shown in the classroom to show simulations [9, 33]. Video's use in the classroom is often used as a centerpiece of the lecture, or as supplementary material, used to illustrate certain points. The pedagogical advantages of using video to teach have been explored exhaustively [36], however, there is little work about the advantages of using video to teach and instructor's perspective. Furthermore, the shortcomings of using video to teach, and the coping strategies for those shortcomings that instructors employ remain unexplored.

Learning Analytics

The Learning Analytics Cycle is the development of a feedback loop between student and instructor. In a classroom that is taught with the use of technology, it is at its core, a CSCW/CSCL problem [23] as there is coordination and a passing of information not only from the instructor, but students are also giving feedback to the instructor about the effectiveness of their teaching and the resources used in the course. There has been a lot of activity in creating tools that utilise learning analytics, with focus on activity within Learning Management Systems (LMSs) and educational technology [19], Massive Open Online Courses (MOOCs) [5, 35], discussion forums [8], and other media. Learning analytics has been used to inform intelligent tutoring systems [18, 31] and provide means for assessing students [17]. These systems deal with the students behaviours around LMSs, for example, completion rates of assignments and access frequencies of course materials. While the adoption of video in teaching is on the rise, these systems do not extend their analytics for video past how many times a video has been downloaded. Learning analytics, specifically working around video has been used to inform researchers, for example, to better understand interaction peaks in video, with a focus on, which would give instructors a more clear understanding of how their videos are being viewed [15, 21]. VisMOOC was a system that was created with the aid of two Coursera instructors, however, it focused on summarising data for MOOCs with thousands of users, rather than smaller class sizes [32].

Existing Video Analytics Systems

The purpose of video analytics is to allow interested parties in discovering how the video is being consumed by its viewers. Commercially available systems such as YouTube [1] and Facebook [2] analytics, for example, provide audience retention graphs, which would allow instructors to see at a very high level, where in the video viewers are watching. An instructor using these systems would be able to see the aggregate viewing of the video, however they would not be able to look at individual's viewing data. As stated before, the lack of transparency on what a "view" is makes the number of views a video has irrelevant.

[1] https://support.google.com/youtube/answer/1715160

[2] https://www.facebook.com/ facebookmedia/ best-practices /video-metrics

Table 1. Summary of the findings.

Categories	Analytics/Tools
Evaluation of Student Activity (Aggregate)	
How much time do I have to spend on each topic in the lecture, and where should my focus be?	
Did the students watch the video?	Show number of students who have watched the video
Where did students watch the video?	Show which parts of the video students watched most [21]
Did the students annotate confusing parts of the video?	Show which parts of the video were annotated most [6]
Evaluation of Student Activity (Individual)	
Does this student need extra help, and why are they having trouble?	
Is this student putting effort into the course?	Show if a student has watched videos, and how much
Are students having trouble with the material?	Show outliers and irregularities in watching behaviour per student
Evaluation of Student Literacy	
Do the students understand the material, and which topics are most confusing for students?	
Did the students learn the material?	Have in-video questions and quizzes
Which topics in the video were confusing?	Automatically summarize and interpret video viewing behaviour
Evaluation of Video Quality	
Are the videos appropriate for teaching these topics, and how can they be improved?	
Were the videos useful for students?	Show video watching behaviour across time [16]
What can be improved in the videos?	Have students submit feedback directly on the video [7, 14, 28]

There has been a lot of research on how to visualize video clickstream data [12, 21, 22]. These works are great for informing instructors about how to understand certain visualizations, and could provide the design basis for video analytics systems to suggest conclusions about the students viewing data. There are also education-based video visual analytics systems [3, 32] that attempt to showcase video data on MOOCs. The focus is on visualizing massive amounts of information on millions of students, and as such they offer no information on individual student behaviours. Additionally, because the focus is on MOOCs, the data is not intended for instructors to use as a way to alter the presentation of the material immediately, but rather to change the presentation for students of subsequent year. It would be useful for instructors to have more immediate feedback, especially in arrangements like blended courses, so that they can adapt quickly to their students.

Existing Video Feedback Systems

Other work has been done to incorporate methods for students to either discuss the videos, or provide explicit feedback to the instructor about their learning. Monserrat *et al.* presented an education environment called L.IVE, which provided students with the ability to discuss parts of the video with temporal comments (marked at a single time in the video), along with assessments included with the video [28]. Kim *et al.* introduced RIMES, which explored the use of interactive multimedia exercises embedded within lecture videos, with student feedback recorded using video, audio and sketching for the instructor to review later [20]. Each video was self-contained with its exercises, with annotation available to the student to answer questions, but no mechanisms were present for later referral. Going deeper into the idea of student feedback about the videos, Glassman *et al.* introduced Mudslide, a tool that asked students to provide feedback at the end of a video detailing which slides in a video they found confusing. Using this system, instructors would then review the feedback provided by students and alter their lecture accordingly. Instructors were presented with confusion heatmaps which they found to be more helpful than a list of free-form comments for evaluation.

These systems demonstrate the wealth of information that can be extracted from video analytics. The aim of the current paper is to identify instructor needs from video analytics, in order to harness these possibilities to improve teaching and learning.

METHODS

In this paper, we used the Grounded Theory Approach [13] to develop an insight into instructors' need for visibility into the students' video viewing behaviour. We performed qualitative interviews with 16 instructors of varying disciplines. After transcribing these interviews, we analyzed the interviews through open, axial and selective coding [34] and looked for common themes throughout the interviews. We found that instructors had difficulty with transparency of student learning behaviours and had to utilize workarounds to ensure that they could get feedback about how the videos in their courses were being watched. Using these extra tools, instructors were able to gain some visibility of how students were able to learn the material from the videos and use that information to augment the class, for example, by focusing more on certain topics, and decreasing attention on others. However, these methods were not foolproof and were only interpretations of the instructor. There are some situations where it is imperative that students watch the videos provided, and the workarounds from the instructors are not sufficient for determining whether or not the videos were sufficiently viewed.

Data Analysis

Interviews were transcribed by the interviewer, which ensured a consistent interpretation of the data. The primary

investigator then, using a spreadsheet, selectively coded the interviews by participants' statements and by using thematic analysis, categorized into different themes. After each subsequent interview, prior interviews were revisited and reanalysed to extract common themes between multiple participants. We used the Constant Comparison method[13] to develop concepts that were common to the multiple interviews. Between interviews, another researcher was also debriefed on the interview, where themes and commonalities between interviews was also discussed.

Participants

We used a purposive sampling method of post-secondary instructors with a range of teaching experience in a large city who have used video in their teaching. These included instructors who taught various subject matters, such as chemistry and engineering, which enabled us to gain insight from a different video content types as well as instructor teaching styles. Since we wanted to investigate the experiences involved in teaching with video, we limited the pool to those who used video in their classroom as a method of delivering information to their students. Each participant is labeled P, which stands for Participant.

P1, P2, P3, and P4 all taught introductory chemistry at a local post-secondary institute, where class sizes ranged between 10 to 30 students. These courses had videos that consisted of as step-by-step directions on how to calculate significant figures, laboratory demonstrations, laboratory techniques, directions on how to write-up laboratory reports. In these classes, the instructors only encouraged the students to watch the laboratory report videos; the other videos were optional and treated as extra material. One of the instructors used three additional videos that students watched instead of attending a live lecture. The instructor assigned a worksheet to go along with the video that the students were to complete and hand in for participation marks. The videos themselves would go through example problems and suggest to the viewer that they pause the videos and work through the problem themselves. All the videos from the courses were created by the instructors themselves within the last two years.

P5, P7, and P13 taught an introductory programming course that was entirely *flipped* style, and class sizes were around 100 students each. Using the *flipped* classroom approach, instructors would assign a lecture video to be watched before class, and the class itself was devoted to exercises. In class, the instructors would use Personal Response Systems (PRS), or clickers, and ask students questions about the videos. They would then hand out exercises worksheets for the students to complete, which were collected for marks. During the exercises, the instructors and teaching assistants would walk around the class to gauge the class' understanding of the material.

P6 taught a course on electromagnetics with class sizes of around 40 students. The class had a weekly video to watch at home, and they attended class where the instructor would go through example problems from the videos themselves. P6 would also use the PRS and ask students simple problem questions in order to get a first glance at their understanding of the concepts.

P8 taught a circuit analysis course with class sizes varying from 80 to 100 students. The instructor would have students watch his lecture style videos at home, and they would come to class and the instructor would go through the material again, giving students a second exposure. P8 would use an online PRS system to keep the class time interactive and as a way to gauge topics of confusion.

P9 taught an introductory philosophy course with 100 to 150 students. The instructor used video to describe philosophy problems, such as "The Trolley Problem", and the students would come into class and perform activities like writing an argument in favour of, or against a certain position. The videos were used mainly as an supplement to better explain the articles that are "*not that easy to read.*" P9 would also use a PRS system, along with slides to carry out classroom activities or lecture.

P10 taught introductory physics courses, with class sizes around 100 students. The videos were mostly example problem based and the students were expected to watch them before class. The lecture time was then structured with short introductory explanations, and the rest of the class would be structured around completing problems.

P11 taught biology courses with class sizes of around 120 students. The videos would be used in lieu of pre-reading material, where she used to use scientific articles found online. Instead, now she either looks for videos online that are suitable, or she makes them herself. She then makes extensive use of PRS systems, quizzes, and class discussion of problems during the lecture.

P12 taught in the nursing program, and videos were used to demonstrate techniques that students had to demonstrate competency of. Students were expected to watch them before class, but they were also allowed to watch them before performing the labs as a method of referencing the material.

P14 taught marketing courses with class sizes around 100 students. Students were assigned to watch one video and read two articles before class, which was then used for individual or group activities.

P15 taught political science courses, with up to 150 students. Students were expected to watch around an hour of video before class to prepare for activities that the instructor designed around the video. These activities would be application based. For example, students would be assigned to draft a speech as if they were a speech writing team for a prominent international actor, or they would do arms control negotiations.

P16 taught a linguistic course, with up to 200 students. The videos were used to introduce the material, and then instructor would moderate class discussion with some mini lecture and PRS questions.

Table 2. Summary of the participants' information.

ID	Age	Subject	Teaching Experience	Class size	Source of videos
P1	50–60	Chemistry	28 years	10-30	Self created
P2	50–60	Chemistry	15 years	10-30	Self created
P3	40–50	Chemistry	4 years	25–50	Online, self created
P4	40–50	Chemistry	18+ years	10–30	Self created
P5	30–35	Computer Science	1 year	80–100	Premade course videos
P6	40–50	Electromagnetics	20+ years	30–50	Self created
P7	40–50	Computer Science	10+ years	80–100	Self created
P8	50–60	Electrical Engineering	20 years	80–100	Self created
P9	40–50	Philosophy	20+ years	100–150	Self created
P10	40–50	Physics	16 years	80–100	Self created
P11	30–40	Biology	9 years	100–150	Online, Self created
P12	40–50	Nursing	30 years	100–150	Online, Self created
P13	50–60	Computer Science	33 years	220–325	Self created
P14	50–60	Marketing	18 years	100–125	Self created
P15	40–50	Political Science	25 years	100–150	Self created
P16	50–60	Linguistics	24 years	150–200	Self created

Data Collection Procedure

The instructors were emailed by the lead investigator, where they were asked to participate in an interview regarding their use of video in their teaching. The interviews were conducted in the instructors' office, as the settings were mostly quiet and the risk of interruptions was minimal and allowed for better audio recording. The interviews lasted between 25 and 60 minutes. The interview was semi-structured, with a set of questions that were generated by two researchers. One of the researchers generated the questions, by decomposing the research questions into more easily answerable components, which would be made easier to answer in an interview by an instructor. The questions asked the instructor about their use of learning materials (including video), and the strategies they employed to assess their students' understanding of the concepts via those materials. These questions formed the framework for the first two interviews (P1-P2). After the first two interviews, the questions were modified as per Grounded Theory, to adjust the scope and focus of the interviews, which then provided the framework and basis for the next six of the interviews (P2-P7). Many of these questions were fact and historical based questions, where the instructor was asked to describe their experience teaching with different learning materials such as slides. After gaining an understanding about the teaching tools that the instructors were familiar with, they were then asked about their experiences with teaching with video, including how video was used in the classroom, as well as the challenges and any success stories they experienced. With the focus on teaching and learning, we then asked the instructors about the type of data that they would like to see on their students' learning with the videos. The questions were then modified again for the last nine instructors (P8-P16) to focus more on the use of video in their teaching as well as well as the use of video analytics and feedback.

RESULTS AND DISCUSSION

Throughout our interviews with the instructors, several patterns and major themes emerged about why instructors taught with video, as well as how they evaluated how the students watched the videos and the quality of the videos themselves. While there is a mix of experience in using video to teach amongst the instructors interviewed, the reasons for using video and evaluation of video converge down to a couple points.

Why instructors teach with video

Pragmatically, there are several reasons instructors use video in their teaching over text-based alternatives. They believe that video is more engaging to students, and higher engagement levels lead to higher learning outcomes. They believe that the use of animations helps illustrate their content better. There are also accessibility advantages that come with video. Video can be more easily accessed while commuting to school. Videos are great for students who are learning English because they can replay hard to understand content, and video is great because of its permanence; P12 states "*the advantage of the video is its a permanent thing... you can watch that as many times as you want.*"

These are the most obvious advantages with teaching with video. From a learning perspective, particularly when combined in a blended learning format, video is also advantageous because instructors can have students perform activities that promote active learning. These activities force students to apply the basic knowledge learning that was accomplished outside of the classroom, onto the discussions, simulations, and scenarios that occur in-class; the experiential learning model popularized by David Kolb [24]. However, this model is met with resistance from the students. P16 states that they "*were really skeptical about it, because... they felt... 'I'm paying, and you're supposed to instruct me'. And they didn't see the benefit of learning by discussion. So they thought, well, we paid for this and now we have to do something outside of the classroom.*" Over the years, however, students have become more accepting of this style of teaching and video has become much more mainstream.

Effective use of classroom time

One of the more powerful things about video is that class time can be spent on activities that require an instructor's guidance. These activities vary for different disciplines, but the point is that class time is spent practicing and applying the knowledge learned. In chemistry courses, P2, P3, and P4 use videos to increase the amount of time that students could perform their laboratory activities by limiting the amount of time spent on pre-lab activities. P3 states that "*it would be most useful... preparing before they come to the lab, and so that they're not just looking at it cold [and] we'd rather the time that they're standing in the lab be time that they're actually hands-on working.*" The videos could then be used in lieu of giving a demonstration, which would not only allow each student a better view of the procedure, but allow students to backtrack and watch it over if they missed anything. Unfortunately, due to the difficulty in enforcing students to watch the videos attentively and the safety implications, live demonstrations are still being performed in front of the class.

In-class engagement

In addition to being able to spend limited classroom time more effectively, instructors also found that students tend to have a better understanding of the material. Several instructors found that students had more in-depth questions about the material. P15 says that "*it just takes their learning to a higher level, and then the instructors satisfaction to a higher-level because now I can speak with them, not to them, at a much higher-level. ... It's a conversation that, is much more sophisticated and developed because I'm not spending my time in the class giving them the basics.*" P8, who assigned videos to be watched at home and repeated his lecture in class, found that the students "*develop way deeper questions [and] are not asking basic understanding questions anymore. ... They are asking me questions about the topics that before I would get only from the very best students.*"

Personalisation and motivation

While the alternative to video is getting students to read articles, video seems to be a more motivating activity for students to do at home due to the humanizing aspect of being taught by an instructor in video that does not exist within text. "*This is the instructor and I'm learning from the instructor while I'm watching this video. There's something human about that, that you don't get if you read the book.*" A very important part of teaching is the element of trust between instructor and student. To do so, some instructors place a talking head in the corner of the video, giving the students a face to attach to the voice of the narrator. Once that trust has been established, the talking head can be removed.

Instructors also believe that video that is personable motivates students to watch video. P16 stated: "*But I found actually, that students like the grittiness. It's more authentic. They kind of get, oh okay, there's no production values here. This isn't slick, it's just the professor at home or in the office and they're shooting a video for me.*" There seems to be a charm for the students in knowing that the videos were created by the instructor. P15 describes that the videos that were created professionally are less authentic, and students tend to "connect" more to a video that was purposely created for the student themselves. "*[The professionally-created videos are] just not as approachable. It's not as informal, it's not like this is my professor, this is like someone shooting a video it could be for anybody. Right? But the other videos, no, it's clearly for me. He's shot this for me. And they're right, I have. And I think that's something the students picked up on.*" The finding that personable, self-made videos are more engaging, complements existing work on how video production affects students' interaction with instructional video [15].

How instructors evaluate students and video quality

For the instructor, the motivations for teaching with video are clear, but it is often difficult for them to articulate how their students are watching the videos. The types of questions that instructors have about the video use in their classrooms can be separated into three categories: have the students have watched the video, how much they understood in those videos, and how useful the videos. There are various ways that instructors have attempted to answer these questions, however, a majority of these can be answered by way of some form of analytics dashboard for video. A summary of these findings can be found in Table 1.

Evaluation of student activity

One of the most common questions instructors have in regards to their students is "Did my students watch the videos I assigned?" The answer to this question serves as a rudimentary way for instructors to gauge student engagement levels, which instructors can then use as a measurement of their own teaching. Viewing student activity can be divided into level of detail: aggregating all student activity and summarising it, or looking at students at an individual level.

Summarising and aggregating student activity can be a very useful tool, and would allow instructors to quickly gauge how their students are performing in the class, and what the instructor needs to focus on during the lecture. Instructors currently employ three different methods for finding out if the students watched the videos assigned before class: simply asking the students as a class, assigning worksheets for students to complete in conjunction with watching the video, or polling the class and testing their knowledge using PRS. The first method typically results in a small percentage of the students responding, and has generally not been a good indicator for whether students watched the video or not.

Assigning students an assignment gave instructors not only an indicator of how many students watched the video, but also gives insight into how the video was consumed by students and answers the questions "Where did the students have trouble?" and "Where do I need to focus more on the lecture?" The answers to these questions are indicators of troubling areas in the video, which almost all of the instructors interviewed expressed interest in. For instructors who have been teaching the material for a long time, this only serves as affirmation of topics in their courses that are often troubling, but for newer instructors, such information would be invaluable.

However, in the spirit of a quick summary, an interface aiming to provide instructors with an at-a-glance look at the sta-

tus of their videos would be invaluable. Such an interface should aim to provide instructors with an overview of how many students watched the videos ("Are my students watching the videos?"), and which sections of the videos did they watched, which may indicate students' interest or confusion ("Where are my students getting stuck?"). While such an interface would allow for a quick overview of how the entire class is doing, there are times where instructors would like to look at individual performance.

Instructors may want to look at individual student activity for a couple reasons. For one, an instructor may be interested in the amount of effort that a student is putting into the course. Similar to where instructors may provide leniency on marking examinations by looking at the amount of effort a student has put forth in their prior assignments, an instructor can add an additional criteria to further evaluate a student. P6 states that when students come to her for help, for "*if you get a student who is having some problems and so on or is, there's academic concession request or there's something like that, I look to see, 'Has the student been active in the course?'*" For a instructor who is limited in time, this serves as an invaluable resource in deciding how much effort they should put into helping a student. A possible way to help enable this would be an automated system to identify outliers in student activity, similar to the work identified by Roll *et al.* [10].

Similarly, there are instructors who are more proactive in their teaching and are interested in whether individual students are having trouble with the material. P2 mentions the use of an analytic dashboard for online assignments that he used to evaluate individual student performance. Using this system, they were able to look at individual questions on each assignment to see which questions were did well and which did not. P2 then found that sometimes questions were not written well and contributed to poor performance by the students. By interpreting data like this, instructors can draw conclusions about their own teaching and find ways to improve. Similarly, analytics on how students are viewing a video can be interpreted by instructors to improve their videos or notify less experience instructors about trouble spots in the course.

The ability to peer into students' individual viewing patterns and behaviours opens the door to a whole host of privacy issues. While instructors are privy to student behaviours within a classroom, or student performance on assignments and examinations, being able to "spy" on students working at home may cross some boundaries. There would be a compromise between protecting students' privacy to their own behaviour, and instructors being able to find behavioural patterns. For example, one possibility would be a permissions system, where students would be able to control the visibility of their own behavioural patterns, or an anonymizing system that allows instructors to see behaviours but not be able to pinpoint which student is responsible.

Evaluation of Student Literacy

In a flipped classroom, students are supposed to have come to class having completed the pre-class activities. In order to make the most of the time spent in the classroom, students are expected to have some previous literacy in the topics at hand, in order to participate in further more in-depth discussion of the topic. Furthermore, by measuring literacy of topics, instructors can structure the class time more efficiently, by focusing more on topics that are more difficult. Current practices instructors use include the use of worksheets accompanied with the video, clicker systems, discussions, as well as in-class assignments.

The most common method for gauging understanding and literacy is through the use of PRSs which allow instructors to pose questions to the class, and each individual student is tasked with both discussing a solution to the problem with a neighbouring student, and then providing their answers. This served not only as a way to increase visibility about where students were having trouble, but also increases engagement with the material [27]. For example, P5, P13, and P16 used the system to assess how well they've actually grasped that pre-lecture material. They would then look at the results of the question and decides whether or not to go over the material in more detail to the class. A solution that is more integrated would be to have embedded quizzes within the video [25]. This would allow instructors to offset the evaluation of student literacy to pre-lecture, thus creating more time for lecture activities.

Other instructors used worksheets as a way to gauge understanding of the semantics in the videos. P1 paired the videos with worksheets that the students were to complete while viewing the videos. The videos were designed to guide students through the worksheet on a step-by-step basis. The worksheets themselves were not counted towards their grade, but were handed in and the instructor marked them and to give the students feedback about their understanding. The instructor in turn, was also able to which students actually watched the video and applied the knowledge, as well as pinpoint topics that needed further reinforcement. Often times, instructors will also stage discussions. Students are asked to break off into groups to discuss a problem posted by the instructor, and as they did that, the instructors and teaching assistants would walk around the classroom and answer questions or encourage students who were having trouble with the problems.

With these practices, instructors must pay close attention to the students' activities during the class, and must devote class time evaluating students' literacy of the material. Although instructors are teaching with video, they are not utilizing the medium to the extent in terms of understanding how their students are consuming the material and whether or not they understood it.

The behaviour in which students exhibit while watching behaviour can be summarized, which will provide insight into the semantics of the video. For example, parts of the video that are rewound and re-watched a lot indicate topics of confusion or interest. Areas of the video that students pause a lot may be portions of video that are difficult to understand, and require students to spend more time processing. In any case, simple counts of how often a section of video has been viewed can tell an instructor which topics to focus on during the face-to-face time.

While these would require some interpretation of the viewing data, the instructor could also facilitate discussion of the video material online. Doing so would allow the instructor to gauge literacy of the students who are asking questions, as well as those who are answering those questions.

Evaluation of Video Quality

Most instructors are interested the students' opinions of the videos, more so if the instructor made the videos themselves. As video is being used more and more as a medium for teaching, instructors are fairly interested in the comparison of video to textual mediums, especially in their students' perceived effectiveness of video as a learning tool.

Instructors often have a difficult time eliciting feedback from their students about different aspects of the course. Currently, there are two methods that instructors employ: end-of-semester surveys distributed by the institution, and informal conversations with the students. The completion rates for the surveys are described as insufficient, and depending on the age range of the students in the class, it is difficult to get informal conversations with the students. Furthermore, there are times where students give feedback that is not constructive. For example, P8 had students complain about the voice in his videos. P14 receives feedback about the shirt that he was wearing, or about his accent. Nonconstructive feedback that the instructor cannot use to improve upon was disregarded.

The end goal of the feedback for the instructors is typically about what works well in the video and what needs more attention.This breaks down into several things: clarity, student comprehension of difficult topics, comparison between video and text, whether or not students take it as seriously as lecture, whether they sparked curiosity, and ideas about making the video more interesting and more engaging. In order for video to be useful in teaching, the students need to find value in watching it. P14 describes that "*there is a level of edutainment in here. We're trying to engage and excite people in a way which means that it's not purely about knowledge transmission*". By creating a video that is entertaining and engaging, students are going to be more intrinsically interested in the topic at hand. P10 found that by creating videos that students could apply their own interests to, students would be more interested in the content. For example, a biology student studying physics "*would be turned off if a problem [doesn't] deal with humans or animals ... and she only cared about living things.*"

Every instructor stated that they would take the feedback into consideration when doing subsequent teachings of the course. The level of action that they would take varies from editing the video, completely remaking the video, changing the activities associated with the video, and completely replacing the video with other learning materials if they found that using video was not appropriate. While every instructor also emphasized that creating the videos was not a trivial task, they all stated that should the need arise, reworking the video would be something that would be worth the effort.

From an analytics perspective, being able to see when students were watching the videos would allow instructors better interpret whether the videos were useful. Videos that are watched twice, for example, when the video is released, and just before the final exam, can be seen as more useful than a video that has been seen once and never again. Conversely, a video that is only watched once throughout the term by the majority of students could mean that students were able to learn the information at a deeper level. Similarly, a video that shows continuous watching can be seen as more engaging than a video where the majority of students are seen skipping around. The ability to view this kind of data can be used as a guide to deciding when to use video, as well as a guide for what makes a video useful to the students.

LIMITATIONS OF THE STUDY

The instructors we interviewed are from two Canadian post-secondary institutes who have used video, mostly out of self interest in improving their teaching. As such, these observations are strictly from the views of instructors in the educational sector. They are also experienced in teaching at a post secondary level, and the observations and conclusions may not apply to elementary or secondary school teaching.

The majority of the videos used in the classrooms were overwhelmingly self-created as well. Most instructors found the information on the internet to be insufficient and inadequate for their own classrooms, and opted to create their own videos instead. Due to budget restraints, with the exception of P14 and P15 (who were able to have the university studio aid in creating one or two videos), the videos were largely created by screen-capture of a slide-presentation and recording their voices over it. However, it is also to be noted that P15 preferred the non-studio quality approach, citing that the students "connected" more with the videos that were produced more impromptu.

Finally, with the exception of P9, P14 and P16 who taught philosophy, marketing, and linguistics, respectively, the majority of the instructors interviewed taught science based subject matter that was practical and much of the video content was based in procedure (i.e. problem solving examples, scientific experiment procedures). Further work would include instructors from more varying disciplines where the videos are more information based.

This work summarises the only the perceptions that instructors have regarding their needs on teaching with video in the classroom. Further work should be done to associate these perceptions with observed the practices and effects of teaching with video.

CONCLUSION AND FUTURE WORK

In this paper, we studied and articulated several advantages instructors have using video to teach, and the methods that they employ to understand how their students are using the videos in their classrooms. The use of video is advantageous because instructors are able to take a hands-off approach to introducing material and offset it to the students' own time. The extra time spent in class can then be spent performing activities that demonstrate deeper learning. Instructors who teach with video are also looking for information about the students' use and perceptions of video, which

we split into three categories: student activity, student literacy, and video quality. Instructors are interested in each of these to create strategies about how best to teach the topics at hand. If instructors were able to gain an in-depth analysis of student video watching behaviour through an analytics dashboard, and accompanied with some careful interpretation, they would be able to answer many of the questions about the status of their students' grasp of the material.

The task of increasing visibility of student learning behaviours using video and simplifying the data down to "Did the student understand the concepts in the video?" does not have an easy solution. More work needs to be done to investigate how instructors are currently evaluating understanding and learning in traditional printed media, and seeing how this can be transferred over to video.

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