Students' sense-making practices for video lectures

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Abstract

There has been increased interest in the use of videos for teaching techniques such as "flipped" classrooms. However, there is limited evidence that connects the use of these videos with actual learning. Thus, there is a need to study the ways students experience and learn from videos. In this paper, we use sense-making frames as a tool to analyze student's video-watching. We describe preliminary results from interviews with 12 students who watched short videos on introductory statistics and probability concepts and discuss implications for student learning.

Key words: Video Lecture, Statistics Education, Sense-Making

Introduction & Background

In the past decade, the ideas of "flipped" classrooms, "blended" classrooms, and massive open online courses ("MOOCs") have been increasingly hailed as effective teaching strategies and innovative ways to deliver content to students (e.g.,White House, 2013; USA Today, 2012). Most MOOCs and many flipped classrooms rely on video-recorded lectures to deliver their content. Despite the increasing interest in these pedagogical techniques, relatively little is known about how students watch and learn from these videos.

There have been numerous studies that have described the the positive influence of flipped classrooms—and, indirectly, video lectures—on student learning (e.g., Bergmann & Sams, 2008; Day, 2008; Demetry, 2010; Franciszkowicz, 2008; Frydenberg, 2012; Fulton, 2012; Gannod, Burge, & Helmick, 2008; Green, 2012; Lage, Plat, & Treglia, 2000; Lockwood & Esselstein, 2013; McGicney-Burelle, Jean, & Xue, 2013; Moravec, Williams, Aguilar-Roca, & O'Dowd, 2010; Seltzer, Gladding, Mestre, & Brookes, 2008; Toto & Nguyen, 2009; Warter-Perez & Dong, 2012; Wasserman, Norris, & Carr, 2013). However, there are few studies on flipped classrooms that provide empirical data to support their claims. Even those that do tend to suffer from several significant methodological issues. First, the data sources tend to consist of surveys in which students self-report their own engagement and learning; when studies use more objective measures of learning, these have tended to be very broad, such as students' scores on in-class exams and standardized state tests such as ACT scores. Second, many of the studies failed to use blinding or randomization when comparing groups of students in different types of classrooms, and did not account for variables such as instructor enthusiasm, instructor planning, and the effects of the novelty of the pedagogy. Third, most of the studies do not determine the degree to which the students are using out-of-class resources (in particular, watching videos).

In addition to these methodological issues, the studies generally do not attempt to separate learning that might occur in the classroom from learning that might occur from utilizing the out-of-class resources. Consequently, these studies have not established a connection between what the students do outside of class and what the students learn. Thus, it is essential for us to begin to investigate what students learn from watching video lectures, independently of class time.

The research questions we are attempting to answer are:

1. How do students make sense of video lectures?

2. What do students learn from video lectures, and how does this relate to their sense-making practices?

Theoretical Framework

We use the idea of sense-making frames (Weinberg, Wiesner, & Fukawa-Connelly, 2014) to describe the aspects of video lectures that students attend to and the ways students make sense of these aspects. A *conceptual frame* is "a mental structure that filters and structures and individual's perception of the world by causing aspects of a particular situation to be perceived and interpreted in a particular way" (Weinberg, Wiesner, & Fukawa-Connelly, 2014, p. 169). From this perspective, a student who is watching a video lecture experiences and seeks to organize a collection of phenomena; the student uses his or her prior knowledge and experience to create a conceptual frame, and this frame then determines which phenomena are noticed and how they are interpreted. While watching the video, students encounter *gaps*, which are "questions that must be answered in order for the student to engage in or construct meaning for the mathematical situation or activity" (Weinberg, Wiesner, & Fukawa-Connelly, 2014, p. 170). When the student answers the question, we say that she or he has constructed a *bridge*. There are four basic types of sense-making frames:

- *Content-oriented*: Students notice mathematical aspects of the situation (e.g., symbols, definitions, facts, and concepts) and encounter gaps about the meaning of the mathematical content or how to use it in an example that is being presented.
- *Communication-oriented*: Students notice the instructor's spoken, written, and gestural actions for organizing and presenting mathematical ideas and seek to understand the ways the instructor is categorizing or connecting ideas, the ideas communicated by board layout, and the instructor's organizational cues.
- *Situating-oriented, mathematical purpose*: Students notice mathematical aspects of the situation and seek to determine why the concept is useful or why it is mathematically significant.
- *Situating-oriented, pedagogical purpose*: Students notice communicational aspects of the situation and seek to understand how the instructor's pedagogical actions and decisions—such as choosing and ordering lecture content—are related to the meaning or significance of the mathematical ideas.

Methodology

The goal of sense-making research is to elicit the student's perspective and experience of watching a video lecture. Thus, the methodology focuses on providing students an opportunity to directly experience a situation (in this case, by watching a video lecture); to identify and discuss the gaps they encounter; and to investigate the ways they bridged the gaps. To do this, we used *message q/ing* and *abbreviated timeline* methods (Dervin, 1983; Glazier & Powell, 1992; Spirek, Dervin, Nilan, & Martin, 1999) as part of an interview protocol:

- In message q/ing, participants are asked to read a text and stop at places where they have a question to engage in an in-depth analysis. In order to generate stopping points, we asked students to take notes while they watched the video and to write a question mark in the margins of the paper when they felt that there was an aspect of the video that was unclear or confusing.

- In abbreviated timeline, the researchers select excerpts from the video and have students discuss these chronologically. We identified numerous points in each video that we thought included an interesting description of a mathematical concept, an interesting aspect of the way the concepts were presented or organized, or aspects of mathematical concepts that illuminated an aspect of a "big idea."

We wanted to know how the students' sense-making might be influenced by the mathematical content, conceptual focus (i.e., focusing on conceptual or procedural aspects), and presentation style of the video. For the mathematical foci of the videos, we selected two concepts from introductory statistics: the five-number summary and basic probability computations using counting, addition, multiplication, and complements. We selected these topics because they require relatively little background mathematical knowledge. Some research suggests the presentation style might influence students' engagement with the video lecture (e.g., Guo, Kim, & Rubin, 2014) and there is some evidence that explicitly addressing conceptual difficulties in videos might improve student understanding (e.g., Muller, Bewes, Sharma, & Reimann, 2007). Thus, for each content area and conceptual focus, we decided to use videos that had one of three presentation styles: A two-person discussion that explicitly addressed potential areas of confusion; a "talking head" video with an instructor drawing on a tablet or writing on a board; or a "Khan academy" style video with an instructor narrating a drawing or Powerpoint slides.

Methods

To recruit students, we visited all of the introductory mathematics classes at our institution (a mid-side, comprehensive Northeastern college) and invited all students who had not previously taken a statistics class to participate; students were offered a $20 gift certificate as compensation. Twelve students expressed interest in participating and all were interviewed.

In order to find videos that fit each of the twelve categories described above (i.e., two content areas, three presentation styles, and two conceptual foci), we searched various online sources (e.g., Coursera). We were unable to find any Discussion-style videos, so we created these ourselves, attempting to make the content and examples roughly equivalent to those presented in the other videos.

Each interview lasted approximately one hour, which was divided into a two half-hour blocks, the first one focusing on the measures of spread video and the second focusing on the probability video. In each block, the students were asked to describe their prior experience with the content area in order to gauge their background knowledge. Then, the students watched the video and took notes using the message q/ing method. The students then summarized the main ideas of the video and worked on several conceptual and procedural problems. After answering the questions, the students identified each place in the video where they had written a question mark, describing what was happening, what aspect they thought was unclear or confusing, and how they had eventually understood what was happening. If there was time remaining in the block, the interviewer "rewound" the video to several of the pre-selected excerpts and asked the students to describe the mathematical content, the significance of the content, and/or the instructor's reasons for including or explaining the concepts in a particular way.

The entire interview was audio-recorded; the student's note-taking was recorded with a Livescribe pen; the video was played on a tablet using Coach's Eye software (which allowed the student to draw on the video) and the student's playback of the video was recorded using Camtasia software. The audio recordings were transcribed and used as a basis for analysis.

The members of the research team initially worked independently to identify the sense-making frames that the students used. We each coded each student's questions and responses to each excerpt using the theoretical framework. We also categorized each question the interviewer asked as suggesting a particular frame; for example, when one video indicated that $0 \leq P(A) \leq 1$, the question "what does this mean?" suggests that the use of a content frame, whereas "why did the instructor introduce this notation?" suggests the use of a pedagogy frame. After applying the codes individually to one of the interview transcripts, the members of the research team compared codes and used differences in the coding to refine the coding manual. This process of refinement occurred until over 80% agreement was reached, and then we individually coded all of the transcripts.

Preliminary Results and Discussion

Although we are still in the early stages of analysis, we have already noticed four interesting aspects of the data related to identifying gaps and constructing bridges.

First, no two students identified the same gaps while watching the videos. This suggests that it is not possible to design a video that all students would experience in the same way or that would be an equally effective learning tool for all students.

Second, students identified relatively few gaps while watching the videos. Out of the twelve students, only three wrote more than one question mark in the margins of their notes; most of the students felt that they had constructed bridges for the gaps as they watched. However, all of the students had difficulty responding to many of the interviewer's questions. Student 4 summarized this at the end of his interview:

> I think, well until, like I said like before just watching the videos, that was all fine. And then when you actually broke down the video and then asked me like why do you think, like motives behind certain things that he did I kinda was like, kind of stumped I mean because I don't really know, I don't really know his teaching methods or his styles so I didn't know if it was something mathematical based like you were saying or if that's just the way he teaches to kind of give us a further understanding.

In addition to not recognizing when parts of the video didn't make sense, this student's description suggests that this may be, in part, a consequence of not attending to, at various points, the mathematical content, the instructor's way of presenting the content, or the big picture ideas. One way to interpret this is that productively interpreting the video requires the student to use and switch between multiple sense-making frames.

Third, all of the students encountered the issue of only recognizing aspects that they didn't understand when the interviewer asked them specific questions. For example, Student 1 did not make any question marks in the margins of her notes, and stated that the video made sense while watching it. When she was later asked what is meant by a "random variable," after a long pause she responded that she "definitely didn't" understand the term. There are two ways we might interpret this result. First, the student might experience a gap, but various constraints—such as the need to quickly attend to subsequent parts of the video—might prohibit the student from consciously recognizing the gap and constructing a bridge. Second, the gap might not exist until the researcher helps the student notice particular aspects of the video and choose an appropriate sense-making frame.

Fourth, in addition to not recognizing aspects of the video that they didn't understand, most students also experienced gaps and constructed bridges that, when questioned by the interviewer, appeared to have flaws. For example, Student 12 described how he was able to interpret the symbol string $P(Y)=2$ while taking notes, but subsequently was unable to understand what it meant:

> *Interviewer*: So here he says Y is the total number of heads, P Y equals two. What does that mean when he says P Y equals two?
> *Student 12*: Your guess is as good as mine. I think it's the possi... let's pretend that P equals two and I don't know what two would mean. Yeah I have no idea. I wrote it down and it made sense when I was writing it down here, but I have absolutely no—I can't fathom what it is.

There are several ways we might interpret this result. First, the constraints described above might prohibit the student from fully examining his bridge and recognizing its limitations. Second, the student might have been using a sense-making frame that did not enable him to construct a "robust" bridge. Third, the student might not match the *implied reader* (Weinberg & Wiesner, 2011) of the video and does not possess the necessary background knowledge or ways of interpreting aspects of the video that are required to construct an accurate bridge.

These last two results have important implications for students' opportunities to learn from watching videos. If one of the benefits of video use is that students are able to pause and rewatch sections that are confusing or aren't making sense, then an implicit assumption is being made that students are able to recognize when this is happening and either identify concepts with which they need help or construct a correct understanding of the concepts. Our data suggest that students may have difficulty recognizing these moments and, when students do recognize such moments, they might not realize when their understanding is insufficient. Consequently, students may not be able to take full advantage of the potential benefits that video use may provide.

As indicated above, we have not yet completed the analysis of our data. In the future, we plan on identifying patterns in the students' use of various sense-making frames; the role that background and cross-disciplinary knowledge play in sense-making; what the students learned from watching the videos; and how the students' sense-making practices are connected to their learning. We hope to use these results to make recommendations for structuring students' video-watching practices to help them use videos effectively as learning tools.

Discussion Questions

- What aspects of videos might influence the ways students make sense of the videos?
- How might we structure students' video-watching to support their learning?
- What are the limitations of sense-making frames as a theoretical tool?
- What additional tools might be useful for analyzing this data?

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