Effects of In-Video Quizzes on MOOC Lecture Viewing

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ABSTRACT

Online courses on sites such as Coursera use quizzes embedded inside lecture videos (*in-video quizzes*) to help learners test their understanding of the video. This paper analyzes how users interact with in-video quizzes, and how in-video quizzes influence users' lecture viewing behavior. We analyze the viewing logs of users who took the Machine Learning course on Coursera. We find that in-video quizzes are a common source and destination of video seeks. These seeks may reflect behaviors such as searching for answers to quizzes within the video. We observe spikes in view counts in portions of the video surrounding in-video quizzes, as a result of reviewing and rewatching. Some users appear to use quiz-oriented video navigation strategies, such as seeking directly from the start of the video to in-video quizzes, or skipping from one in-video quiz to the next. We discuss implications that our findings have on the design of online courses and lecture-viewing platforms.

Author Keywords

in-video quizzes; lecture viewing; lecture navigation; seeking behaviors; MOOCs

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

INTRODUCTION

In-video quizzes are short, automatically-graded questions that are shown to users upon reaching a certain point in a lecture video, as shown in Figure 1. They are commonly found in MOOCs (Massive Open Online Courses) on platforms such as Coursera.

In-video quizzes are beneficial because they provide learners with a way to test themselves on the material, which helps long-term retention (a finding known as the *testing effect*) [10]. They are particularly valuable in the context of MOOCs, because many learners engage primarily with videos and do not complete assignments or assessments [8] [2].

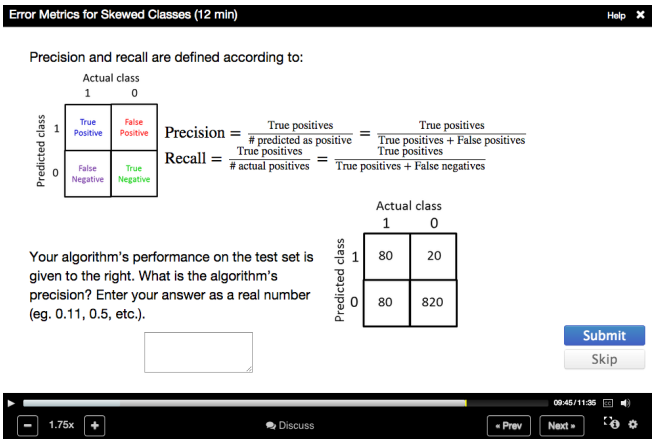

Figure 1. An in-video quiz on Coursera. In-video quizzes are short questions that are shown upon reaching certain points in the video.

In-video quizzes differ from other assessments in that they are displayed directly in the video viewer, so users can easily seek elsewhere upon encountering the quiz – seeking backward to find answers to the quiz, seeking forward to skip the quiz, etc. The presence of in-video quizzes inside videos can thus influence users' video viewing behaviors, potentially causing nonlinear navigation patterns such as seeking.

In this paper, we aim to learn more about how learners engage with in-video quizzes, and how video interaction patterns differ in the portions surrounding in-video quizzes. We do this by analyzing the video-viewing logs of the Machine Learning course on Coursera (ML4). We discovered the following interaction patterns associated with in-video quizzes:

- Users engage with in-video quizzes – a similar number attempt quizzes to those who finish watching lectures.
- Users commonly seek forward to the region preceding each in-video quiz.
- Users commonly seek backwards from in-video quizzes, which may indicate they are trying to find the answer.
- Users sometimes jump directly from the start of the video to in-video quizzes, or jump from one in-video quiz to the next, skipping the video segments.
- Users do not tend to skip over in-video quizzes, either in the forward or backward direction.

These behaviors suggest that viewers consider in-video quizzes to be a priority and frequently refer to them. These quiz-centric viewing behaviors can inform the design of future MOOC lecture-viewing interfaces, to make it easier for users to engage with in-video quizzes while viewing videos.

RELATED WORK

Kim et al performed an analysis of reasons for peaks in viewing and seeking while viewing lectures [7]. They found that users steadily leave videos over time, a phenomenon they refer to as *in-video dropout*, and that visual transitions (such as slide transitions) tend to result in *interaction peaks*, with peaks in events such as users seeking back to the previous slide. They also presented a video viewer that encourages video navigation to interaction peaks [6]. However, the courses that they perform their video log analysis on do not have in-video quizzes, hence they are unable to report on interaction peaks that result from in-video quizzes. We similarly found in our own analysis that there are many peaks in seeking behavior that can be accounted for by slide transitions, however in-video quizzes tend to also be a major factor in causing peaks in video seeking.

Guo and Kim analyzed the effects of video properties such as video length on viewer engagement [3]. They found that users become less engaged as videos grow longer, which is related to the problem of in-video dropout. However, they did not analyze the effects of in-video quizzes on viewer engagement, because the courses they analyzed do not have in-video quizzes. Our findings in this paper suggest that in-video quizzes encourage viewer engagement, as indicated by the increase in rewatching and seeking behavior in the regions of the video surrounding the in-video quiz.

Guo and Reinicke investigated factors that contribute to nonlinear navigation through MOOCs [4]. They discuss examples of nonlinear navigation such as jumping back to previous lectures, rewatching videos, and going back from assessments to refer to lectures. Our present work is focused on navigation within videos as opposed to within MOOCs. However, we find that in-video quizzes, being a form of assessment that is embedded into the videos, trigger similar backjumps and reviews within a video that Guo and Reinicke discuss at the course-level in their paper.

Anderson et al found that learners differ in the ways they engage with online courses: some only watch videos ("viewers"), some only complete assignments ("solvers"), and some engage in both ("all-rounders") [2]. Kizilcec et al discover similar engagement patterns [8], and discuss how these engagement patterns may be a result of learners' motivations for taking the course [9]. These differences between learners' engagement patterns are relevant to our work analyzing in-video quizzes, as they help explain why we find that some users' viewing behaviors seem to be aimed towards solving in-video quizzes. Additionally, the large population of users who engage primarily with videos underscores the importance of in-video quizzes as a means to test users' knowledge, which helps them retain the material [10].

In-video quizzes are not new; there are many past systems that embed quizzes into multimedia [1]. In-video quizzes are believed to have positive effects on learning [5], as testing helps in long-term retention of material [10]. However, to our knowledge, our paper is the first analysis of the effects of in-video quizzes on learners' rewatching and seeking behavior in the context of MOOCs.

Type of event or data within the ML4 course on Coursera	Counts
Users who registered for the course	96,195
Users who visited the course page at least once	81,189
Users who started viewing at least 1 lecture	59,641
Users who finished viewing at least 1 lecture	41,643
Users who answered at least 1 in-video quiz	42,437
Users who visited the forums at least once	32,378
Users who submitted at least 1 review exercise	30,227
Number of lecture videos	113
Length of average video (in seconds)	621
Number of in-video quizzes	109
Number of slide transitions	339
Number of external multiple-choice assessment ("review exercises")	18
Number of distinct lectures started viewing, across all users	1,377,238
Number of distinct lectures watched until end, across all users	976,933
Number of distinct in-video quizzes answered, across all users	1,031,061
Number of distinct review exercises answered, across all users	229,556
Seek events total	6,442,590
Seek chains total	2,103,336
Average length of video skipped over by a seek event (in seconds)	31
Average length of video skipped over by a seek chain (in seconds)	96

Figure 2. Summary statistics for the ML4 course.

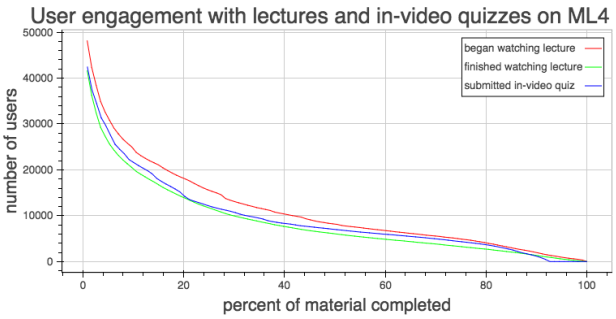

Figure 3. Response rates to the 109 in-video quizzes was similar to the viewing rates of the 113 lecture videos.

DATASET AND ENGAGEMENT LEVELS

The course we are analyzing in this work is the fourth iteration of the Machine Learning course on Coursera (ML4), which ran from October 2013 to January 2014. Our data dump was taken immediately after the course ended. It represents data from 96,195 users, of whom 59,641 watched at least one video. There are 113 lecture videos in the course, totalling 19.5 hours of video content, with an average length of 10 minutes per video. With 109 in-video quizzes over 19.5 hours of video, this averages out to one in-video quiz for every 11 minutes of video.

Of the 113 videos, 92 videos (81%) have 1 in-video quiz, 14 videos (12%) have no in-video quizzes, 6 videos (5%) have 2 in-video quizzes, and 1 video (1%) has 3 in-video quizzes. Videos with no in-video quizzes tend to be optional lectures covering interesting applications of machine learning, or are introductory videos that explain what will be covered next in the course.

Engagement with in-video quizzes was quite high: as shown in Figure 3, the answering rate of in-video quizzes closely mirrors the watching-completion rate for videos. This contrasts with the lower engagement rates that have typically been found for traditional assignments that are outside of the video [8] [2]. Other summary statistics are shown in Figure 2.

Event type	Seek chains going forward		Seek chains going backward	
	% of all seek chains	# seek chains, normalized by the length of the seek target (seconds). Ratio to baseline in parentheses	% of all seek chains	# seek chains, normalized by the length of the seek target (seconds). Ratio to baseline in parentheses
All seek chains	56%	16.40 (baseline)	44%	12.86 (baseline)
Seek chains going to in-video quizzes (and their surroundings)				
Seeks to quiz (+/- 0.5 sec)	0.35%	**67.43 (4.1x)**	0.20%	38.21 (3.0x)
Seeks to 10 seconds preceding quiz	3.35%	**62.17 (3.8x)**	1.82%	34.58 (2.7x)
Seeks to 10 seconds following quiz	1.15%	21.89 (1.3x)	0.70%	13.33 (1.0x)
Seek chains going to slide transitions (and their surroundings)				
Seeks to slide transition (+/- 0.5 sec)	0.22%	13.60 (0.8x)	0.35%	20.89 (1.6x)
Seeks to 10 seconds preceding slide transition	2.49%	15.04 (0.9x)	3.41%	20.63 (1.6x)
Seeks to 10 seconds following slide transition	3.54%	21.42 (1.3x)	2.33%	14.11 (1.1x)
Seek chains coming from in-video quizzes (and their surroundings)				
Seeks from quiz (+/- 0.5 sec)	0.36%	**67.17 (4.1x)**	3.79%	**713.4 (55x)**
Seeks from 10 seconds preceding quiz	0.65%	12.30 (0.8x)	0.96%	17.99 (1.4x)
Seeks from 10 seconds following quiz	1.89%	35.95 (2.2x)	1.63%	30.76 (2.4x)
Seek chains coming from slide transitions (and their surroundings)				
Seeks from slide transition (+/- 0.5 sec)	0.30%	18.22 (1.1x)	0.27%	16.22 (1.3x)
Seeks from 10 seconds preceding slide transition	6.72%	40.68 (2.5x)	2.27%	13.73 (1.1x)
Seeks from 10 seconds following slide transition	2.78%	16.81 (1.0x)	3.98%	24.10 (1.9x)

Figure 4. Sources and destinations of seek chains. Users tend to seek backward from in-video quizzes (55x higher than baseline back-seek rate), and forward to in-video quizzes and the 10 seconds immediately preceding them (4x higher than baseline forward-seek rate)

Event type	value
Forward seek chains	
Total # of forward seek chains	1169873 (55.6% of seeks)
Average length of a forward seek chain, in seconds	129 seconds
Average # of times each second of video was seeked forward over	2153 (baseline forward seek rate)
# forward seek chains crossing slide transitions (339 slide transitions total)	909675 (43.2% of seeks)
# forward seek chains crossing each slide transition	2683 (1.25x baseline)
# forward seek chains crossing quizzes (109 quizzes total)	98613 (4.69% of seeks)
# forward seek chains crossing each quiz	905 **(0.42x baseline)**
Backward seek chains	
Total # of backward seek chains	933463 (44.4% of seeks)
Average length of a backward seek chain, in seconds	54 seconds
Average # of times each second of video was seeked backward over	719 (baseline backward seek rate)
# backward seek chains crossing slide transitions (339 slide transitions total)	301129 (14.3% of seeks)
# backward seek chains crossing each slide transition	888 (1.24x baseline)
# backward seek chains crossing quizzes (109 quizzes total)	47184 (2.24% of seeks)
# backward seek chains crossing each quiz	432 **(0.60x baseline)**

Figure 5. Length of seek chains, and portions of the video that they skip over. Users do not tend to seek forward or backward across in-video quizzes.

METHODOLOGY

Determining Portions of Video Seen

The Coursera logs we used for our analysis come with an action (such as play, pause, or seek) associated with a point in the video, and a timestamp. We use these logs to reconstruct the portions of the video that the user has seen, with a technique similar to the one described in [7] – if we observe a play event associated with video position p, followed by another event at video position p+i, we can assume that the user watched that segment of the video.

Reconstructing Seek Source Positions

The seek events in Coursera's logs specify only the destination of the seek and the timestamp at which it occurred, but not the origin (the logs tell us where in the video the user seeked to, but not where the user seeked from). However, we were able to reconstruct the seek source positions based on the previous event – for example, if the user started playing from video position p at timestamp t, and we observe a seek event at timestamp t+i, then we assume the seek originated from video position p+i (or p+2i if the user is playing back the video at 2x speed, etc).

Grouping Seek Events into Seek Chains

Additionally, we observed that many seek events tend to occur in rapid succession as the user narrows down on the actual target. For example, when users seek via the keyboard, if they are at the beginning of the video and their seek target is 3 minutes into the video, they will press the right-arrow repeatedly until they reach the destination, resulting in a large number of small, noisy seek events, rather than the user's intended seek from 0 to 3 minutes that we are interested in analyzing. Because we are primarily interested in where the user ends up seeking to, rather than the individual seek operations that got them to that point, if there are seek events that occur within 5 seconds of one each, we group them together into a single unit which we will call a *seek chain*. Using this approach, we reduced the 6,442,590 total seek events in our dataset into 2,103,336 seek chains. When we analyze seeking in this paper, as well as seek sources and destinations, we will be analyzing seek chains rather than raw seek events, to reduce noise from repeated seeks. That said, our main findings about peaks in seeking around in-video quizzes also hold if we analyze raw seek events instead of seek chains.

Limitations of Coursera's Dataset

A limitation of Coursera's dataset is that if the user closes their browser window or their network disconnects, this event does not show up in the log, and hence there is ambiguity as to what the user watched. For example, if a user starts playing a video at time t, and this play event is the last logged event, we know that the user must have closed their browser prior to the next in-video quiz or the end of the video (otherwise a pause event would have been logged), however we do not know exactly when the browser was closed. We address this ambiguity by treating it as though the user had immediately stopped watching after that last play event, so we do not include the last (unknown) segment that was watched after their final interaction with the video.

AGGREGATE SEEK CHAIN STATISTICS

Sources and Destinations of Seek Chains

The sources and destinations of seek chains are shown in Figure 4. We see that in-video quizzes are a popular destination of seeks, particularly in the forward direction – users seek forward to the in-video quiz at 4x the baseline rate of all seek chain destinations. Given the high answering rate for in-video quizzes we showed in Figure 3, this suggests that these seeks originate from users who want to answer the in-video quiz at that point. Note that Coursera's interface does not have any UI features for seeking to in-video quizzes apart from the progress bar, so the only way to reach the in-video quiz is to seek to a segment of video right before it. Hence, we consider seek chains which terminate at most 10 seconds before the in-video quiz to also represent users intending to do the in-video quiz.

Figure 6. Seek chains with sources near in-video quizzes, averaged across all 109 in-video quizzes in the ML class. There are many backward seeks originating at the in-video quiz, reflecting users wanting to review the preceding material.

Figure 7. Seek chains with destinations near in-video quizzes, averaged across all 109 in-video quizzes in the ML class. The portion immediately preceding the in-video quiz is a common destination of both forward and backward seeks, perhaps reflecting users who are seeking forward to preview the in-video quiz, or seeking back to find answers to the quiz.

Users also seek backward from in-video quizzes at 55x the baseline rate. As we will show, these represent users reviewing the preceding section, likely trying to find answers to the in-video quiz.

Lengths and Directions of Seek Chains

As shown in Figure 5, on average forward seek chains tend to be over longer distances, while backward seek chains tend to be of shorter duration. A potential explanation is that forward seeks aim to go to some salient part of the video – for example, an in-video quiz – whereas backward seeks aim to review a part of the video that was just missed. We also observe that users seek forwards more than backwards overall, including across slide boundaries; however, they tend not to seek forward over in-video quizzes. As we will see, this is because they are seeking to right before the in-video quizzes, either to view the quizzes, or to search for answers to quizzes.

Seek Sources and Destinations near In-Video Quizzes

As we saw in Figure 4, there are many seeks with sources and destinations near in-video quizzes. We will look at these seek chains near in-video quizzes in more depth in this section.

Seek Sources near In-Video Quizzes

Figure 6 illustrates the sources of seek chains near in-video quizzes, averaged across all 109 quizzes. As we can see, there are a large number of backward seeks originating from in-video quizzes. These reflect users who, having seen the in-video quiz, are reviewing the preceding section to find information to help them answer it. However, there are also many forward seeks originating from the in-video quiz as well as the portion that immediately follows it. These likely reflect users who, having looked at or completed the in-video quiz, are seeking forward to preview the next section.

Seek Destinations near In-Video Quizzes

Figure 7 illustrates where users seek to near in-video quizzes, averaged across all 109 quizzes. As we can see, the 10 seconds immediately preceding the in-video quiz are a popular destination of seeks, both in the forward and backward directions. Seek chains in the forward direction arriving just before the in-video quizzes may reflect users who intend to go to the in-video quiz – Coursera's interface does not provide a means of going to an in-video quiz, other than seeking to the immediately preceding portion and playing the video. Seek chains in the back direction arriving just before the in-video quizzes may reflect users who are reviewing the video to find answers to the in-video quiz. We observe a spike in back-seek destinations at exactly 10 seconds before the in-video quiz. This is likely users who are seeking backwards from the in-video quiz using the back arrow key on their keyboards, which causes a backward seek of exactly 10 seconds.

VIEWING BEHAVIOR IN INDIVIDUAL LECTURES

Visualization of Seeks and Watching

In order to explain why users are seeking to and from in-video quizzes, let us first visualize a representative video before moving on to videos in aggregate. This is Lecture 13 from ML4, titled "Matrices and Vectors". We chose it because it has 2 in-video quizzes, and neither is located at the very end of the video, so results should not be overly influenced by the position of the in-video quizzes.

Figure 8 presents the seek chain sources and destinations in this video as a scatter plot. It illustrates users seeking forward to in-video quizzes and going back to the preceding section to look for answers. It also show how seek chains do not tend to cross forward or backward across in-video quizzes. Thus, the in-video quizzes subdivide the video into smaller sections that users do not tend to skip between.

As shown in Figure 9, in-video quizzes are a popular destination of seeks. Many of these seeks originate from the preceding section, confirming the stats we saw in Figure 4. This suggests that users may have found the answer to the quiz, and are seeking forward to answer the in-video quiz. However, there are also many seeks to the in-video quiz from the start of the video and from the previous in-video quiz. This suggests some users might be following a quiz-centric navigation strategy of seeking directly to the quiz to preview it before they watch the video.

Increased Rewatching near In-Video Quizzes

We hypothesized that if users try to find answers in the preceding video upon encountering an in-video quiz, this should be reflected in the viewing logs. Namely, we would expect to see increased re-watching of the portion prior to the in-video

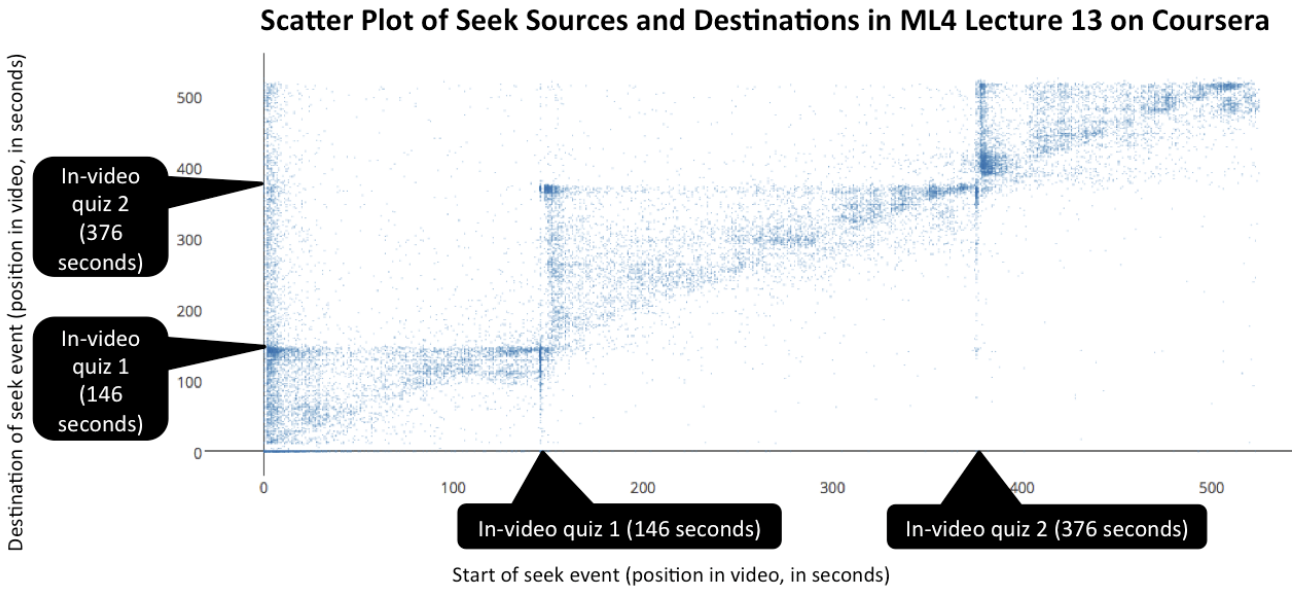

Figure 8. Seek sources and destinations in a lecture with 2 in-video quizzes. Each point at (x,y) represents a seek from time x to y. There are many seeks to in-video quizzes from the start of the video, the previous section, and between quizzes.

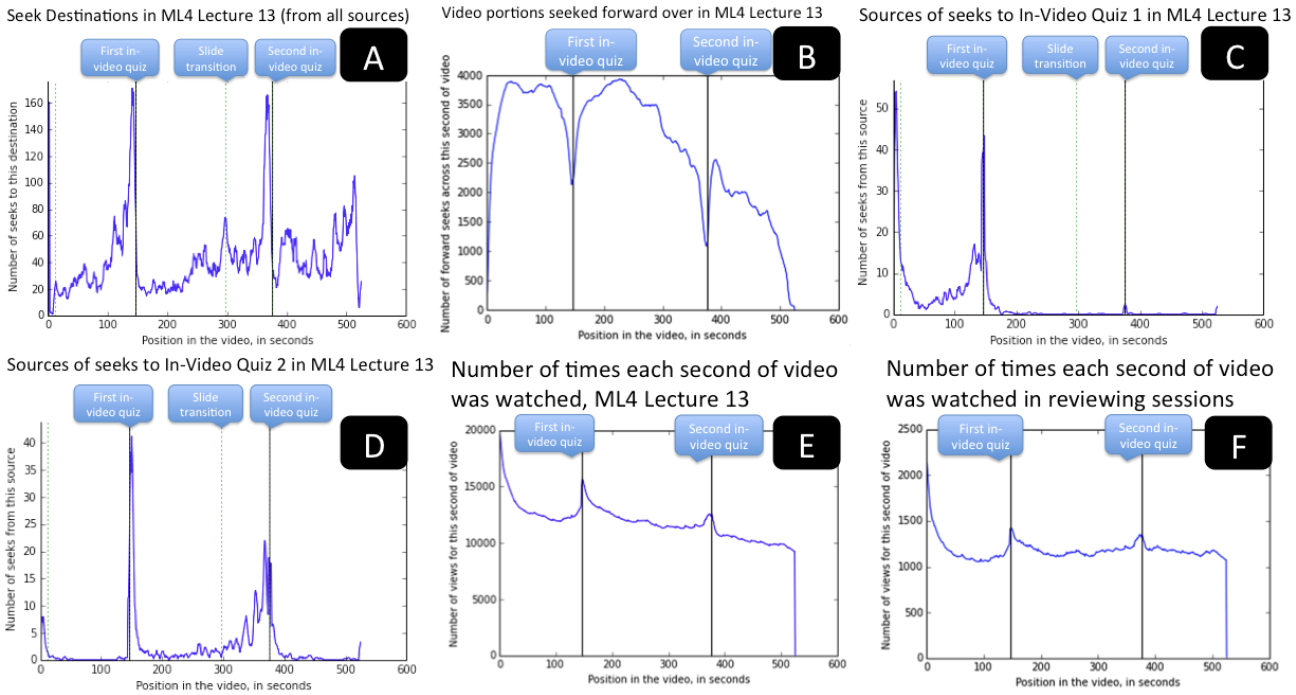

Figure 9. A) in-video quizzes are a popular destination of seeks. B) users do not tend to skip forward over in-video quizzes. C) seeks to in-video quizzes tend to be from the preceding section. D) some users are seeking directly from one in-video quiz to the next. E+F) local peaks in viewing occur around in-video quizzes.

quiz where the answer is located. Therefore, we anticipate seeks that originate from the in-video quiz and go backwards to the point where the answer is located. We show examples of these phenomenon in this section.

We see in Figure 9 E) that the portion of the video surrounding the in-video quiz tends to receive more views. We also observe a trend of fewer views for portions of the video that occur later, which can be explained by in-video dropout, which occurs as a consequence of users' tendency to watch videos linearly [7].

We believe the increase in number of views surrounding the in-video quiz is due to users rewatching the portion preceding the in-video quiz, perhaps hoping to find an answer to the quiz. Indeed, if we exclude each user's first-time watch, and look only at what users are rewatching in aggregate, we still observe this peak in number of rewatches around the first in-video quiz, as shown in Figure 9 F).

Because Coursera does not require users to take in-video quizzes, we wondered whether users explicitly skip across in-video quizzes to avoid taking them. As illustrated in Figure 9 B), we found that this does not tend to be the case. On the contrary, there is actually a dip in the number of forward seeks that cross over the in-video quiz, so users are explicitly trying not to skip the in-video quizzes. This low number of forward seeks crossing over the last in-video quiz in this example might be attributed to the fact that it is located towards the end of the video, so the user may be aware that there is no new content to find towards the end. However, if we look at the first in-video quiz in the example, we also observe a dip in the number of forward-seeks over the in-video quiz, even though there is important content in the video after it.

Now, we will look at the seek chains across all 113 videos and 109 in-video quizzes in the course.

VISUALIZING SEEKING OVER ALL VIDEOS

Forward Seeking to In-Video Quizzes

Figure 10 shows where users seek forward to in each of the 113 videos in the course. Each horizontal line represents a video, where darker shades indicate more seek chains going to a particular segment of the video. We label the locations of in-video quizzes (red) and slide transitions (green).

In-video quizzes are a popular destination of seeks, as indicated by the black streaks immediately preceding the in-video circles (recall that Coursera doesn't let users seek directly to in-video quizzes, but requires them to seek to the segment right before the quiz if they want to take it, which is why we're seeing that the seek destinations are at the preceding segment as opposed to just at the quiz itself). As we showed in Figure 4, forward seek rates to the in-video quizzes are 4 times higher than the baseline rate.

If we look at lectures 25-30 in Figure 10, they don't visually match the pattern we see in the other lectures. This is because they're optional videos discussing applications of Machine Learning, which don't have in-video quizzes.

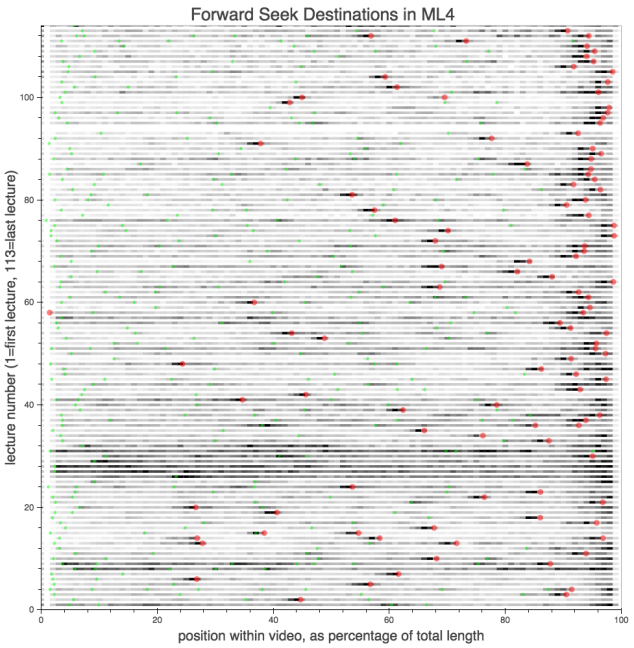

Figure 10. Destinations of forward seek chains in all videos. Each horizontal line represents a video; darkness of a segment indicates the number of seek chains going to that part of the video. Red dots indicate in-video quizzes, and green diamonds indicate slide transitions. Users tend to seek forward to in-video quizzes.

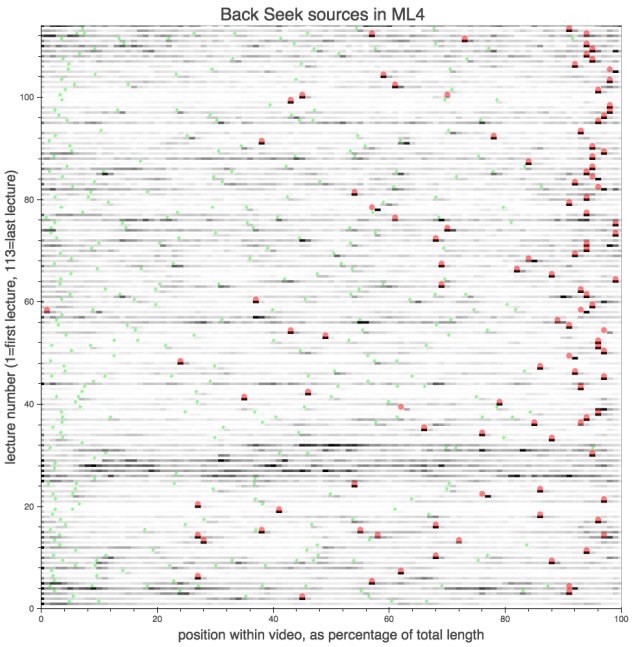

Figure 11. Sources of backward seeks. Red dots indicate in-video quizzes. In-video quizzes are a major source of backward seeks, due to users going back to the previous section to review the video.

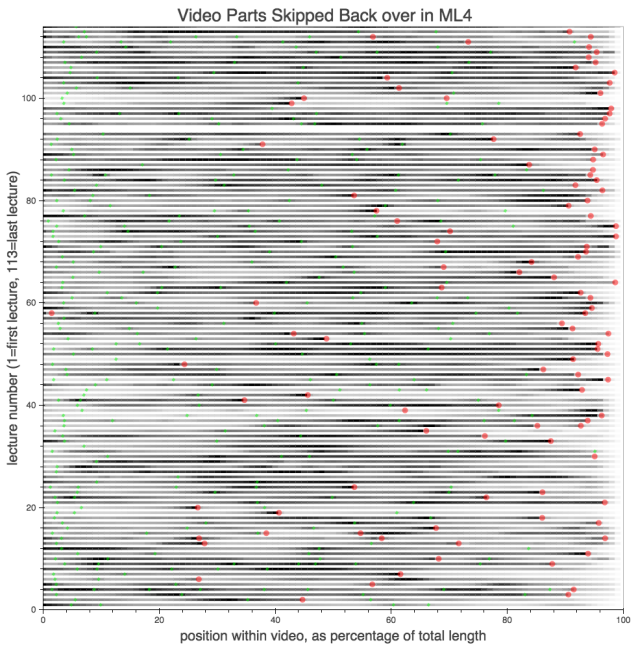

Figure 12. Parts of the video skipped back over. They tend to be the portions preceding the in-video quizzes, reflecting that users are reviewing the video in response to seeing the in-video quiz

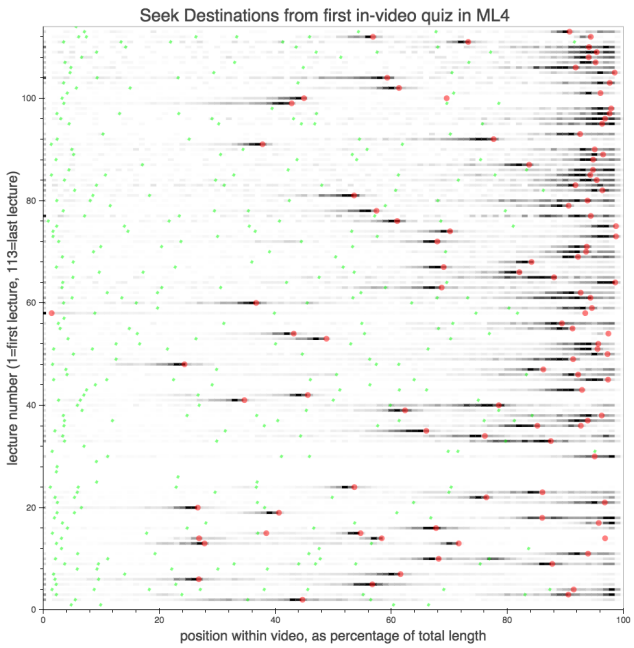

Figure 13. Seek destinations from the first in-video quiz in each lecture. The portion preceding the in-video quiz is a major seek destination, which is often where the answer to the quiz can be found.

In-Video Quizzes are a Major Source of Backward Seeks

As we can see in Figure 11, there are many seeks in the backward direction that start from the in-video quizzes (red circles). Specifically, as shown in Figure 4, the rate of backward seek chains from in-video quizzes is 55 times higher than the baseline rate. We also see peaks in backward seeks after slide boundaries (green diamonds), which confirms prior findings of interaction peaks at slide boundaries in EdX videos which lack in-video quizzes [7].

Video Parts Skipped Back Over

As we saw in Figure 12 and Figure 4, in-video quizzes are a major source of backward seek chains. As we can see in Figure 12, if we look at all portions of the video that are skipped backwards over by seek chains, it is primarily the segments preceding the in-video quizzes. This can be explained by users searching in the preceding segment for the answer to the in-video quiz. We suspect that the portion of the video that is seeked backwards over may reflect where the portion of the video relevant to answering the in-video quiz can be found.

Interestingly, we observe that when the last in-video quiz occurs at the midpoint of a video, as is the case with Lecture 19 in Figure 12, there is little back-seeking which occurs after the quiz. This suggests that the back-seeking phenomenon which occurs directly before a quiz is indeed a result of the in-video quiz causing users to seek backwards more, as opposed to being a side-effect of in-video quizzes tending to occur near the end of the video.

Seek Destinations from In-Video Quizzes

As we can see in Figure 13, the seek destinations from in-video quizzes are primarily backwards, towards the immediately preceding portion. This is confirmed in Figure 4, which shows that there are over 10x more seeks in the backward direction from in-video quizzes than in the forward direction. These can be explained by users who decide to go back and review the preceding segment in response to having seen the in-video quiz.

Seek Destinations from the Start of the video

As we can see in Figure 14, many users jump directly from the start of the video to in-video quizzes. This suggests that these users might be previewing the quizzes before they watch the video, or they are using the quizzes as a navigational tool to help them decide which parts of the video they need to see and review.

DISCUSSION AND CONCLUSION

In this paper we sought to characterize the ways in which users engage with in-video quizzes, and how they effect users' video viewing behavior. We did so by analyzing the viewing logs of videos in the Machine Learning course on Coursera.

We found that unlike external assignments, users engage heavily with in-video quizzes, with a similar fraction of learners answering in-video quizzes as those who finish watching videos, as shown in Figure 3. We also found certain video viewing patterns emerge in regions surrounding in-video quizzes, specifically:

- There are peaks in rewatching behavior in the regions surrounding the in-video quiz. In particular, we see a large

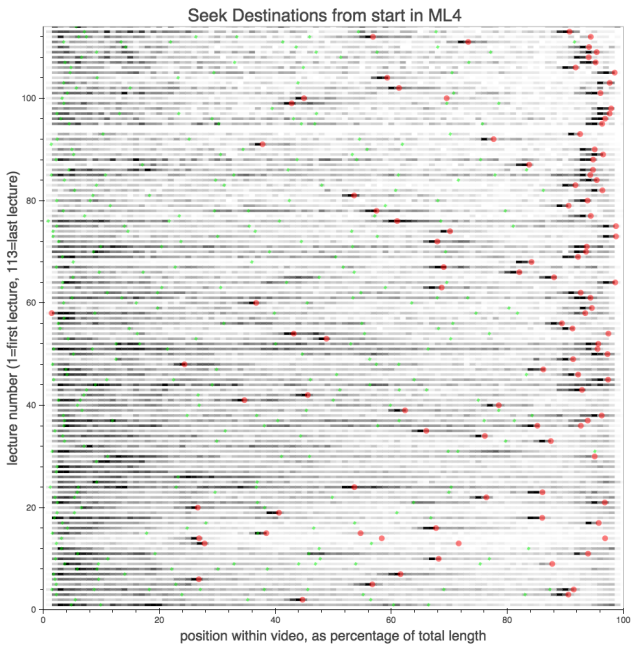

Figure 14. Seek destinations from the start of the video. Many users seek directly from the start of the video to the in-video quizzes.

amount of back-seeking from in-video quizzes to the immediately preceding video section. This is likely due to users seeking answers to in-video quizzes.

- Users do not tend to skip forwards or backwards over in-video quizzes. They thus segment the video into isolated subsections that users rarely seek between.
- In-video quizzes are a common source of seek chains within videos. Users tend to seek backward to find answers, or forward to the next in-video quiz.
- In-video quizzes are a common destination of seek chains within videos. Users most commonly seek from the preceding video segment where the answer can be found.
- Some users follow quiz-oriented navigation strategies, jumping straight to the quiz from the beginning of the video, or jumping from one in-video quiz to the next.

Our results suggest future work investigating the effects of in-video quizzes on in-video engagement rates. Previous work (on videos lacking in-video quizzes) has shown that there is a steady dropoff in users watching lectures, particularly in longer lecture videos [7]. However, as we saw in Figure 9 E, this dropoff in number of views appears to temporarily stop in the area surrounding the in-video quizzes. Additionally, because we found that users tend to answer in-video quizzes and not skip over them, and we found peaks in seeking activity around in-video quizzes, this leads us to speculate that in-video quizzes may potentially be helpful in counteracting the disengagement patterns that occur in longer lecture videos. However, A/B tests would be required to actually verify the effects of in-video quizzes on engagement rates.

The peaks in seeking towards in-video quizzes suggest a number of possible interface improvements that could be experimented with. Coursera currently does not allow users to easily skip directly to in-video quizzes, instead requiring them to go to the preceding few seconds of videos. Since in-video quizzes were one of the most common destinations for seek chains, particularly in the forward direction, skipping to in-video quizzes should be made easier, perhaps via improved scrubbing techniques.

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