Effects of In-Video Quizzes on MOOC Lecture Viewing

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In-video quizzes

- Assessments which are integrated into videos
  - Short, automatically graded questions

Precision and recall are defined according to:

Precision = \frac{\text{True positives}}{\# \text{predicted as positive}}

Recall = \frac{\text{True positives}}{\# \text{actual positives}}

Your algorithm's performance on the test set is given to the right. What is the algorithm's precision? Enter your answer as a real number (e.g., 0.11, 0.5, etc.).
Why look at in-video quizzes?

- Lightweight, fast, integrated assessments
  - Lower barrier to engagement, vs external assessments
  - External assessments are often skipped – does the same apply to in-video quizzes?
- Allows us to observe interactions between assessments and viewing behaviors
  - Are there any viewing behaviors that appear to be optimized towards solving quizzes?
  - We often assume videos are watched linearly from start to end – is that still true in the presence of in-video quizzes, or do they influence navigation?
Related Work

• Many users only view videos, and don’t do any assignments or exams [1]
  – Is this because they just don’t want to do assessments, or because the assignments and exams are large and external to the video?
  – We’ll find that in-video quizzes, in contrast to external assessments, have high engagement

Related Work

- Peaks in video interaction events, such as seeking to different parts of the video, occur at points in the video such as slide transitions [2]
  - Are there also video interaction event peaks around in-video quizzes?
  - We’ll find that the largest peaks in video interaction events are at in-video quizzes

Related Work

• Certain key factors, such as video length, influence whether a user will stop watching a video before its end *(in-video dropout)* [2]
  – Does the presence of in-video quizzes influence in-video dropouts?
  – We’ll find that in videos containing in-video quizzes, users watch a larger portion of the video before leaving

Related Work

• Users sometimes navigate through the course materials in a non-linear fashion [3]
  – Does the presence of in-video quizzes influence how users navigate through the videos?
  – We’ll find that users often review the preceding section if they have not yet answered the in-video quiz, and often seek forward to in-video quizzes

Overview

• **Methodology: Dataset and event types**
• How do users interact with in-video quizzes?
  – What portion of viewers do in-video quizzes?
  – Do they answer quizzes correctly?
  – How long do they spend on in-video quizzes?
• How do in-video quizzes affect people’s viewing and navigation behaviors?
  – Are videos with quizzes watched more?
  – Seeking behaviors around in-video quizzes
  – Quiz-driven video navigation strategies
Methodology: Dataset

• Machine Learning course on Coursera, 4\textsuperscript{th} offering (from 2014), which we will call ML4
  – 96,195 users registered
  – 61,453 started viewing at least 1 lecture
  – 8,615 earned a certificate
Methodology: Event Types

• **Seek**: A jump from one point to another in the video, either forward in time or backward
Methodology: Event Types

• **Seek**: A jump from one point to another in the video, either forward in time or backward from 9:45 to 7:15.
Methodology: Event Types

- **Seek**: A jump from one point to another in the video, either forward in time or backward.
- **Seek chain**: To determine users’ actual seek targets, we group together seeks that occurred within 5 seconds of each other into a **seek chain**.
Methodology: Event Types

• *Seek*: A jump from one point to another in the video, either forward in time or backward.

• *Seek chain*: To determine users’ actual seek targets, we group together seeks that occurred within 5 seconds of each other into a *seek chain*.

Backward seek from 9:45 to 7:15
Methodology: Event Types

- **Seek**: A jump from one point to another in the video, either forward in time or backward.
- **Seek chain**: To determine users’ actual seek targets, we group together seeks that occurred within 5 seconds of each other into a seek chain.

Backward seek from 7:15 to 4:00 (immediately after)

Backward seek from 9:45 to 7:15
Methodology: Event Types

- **Seek**: A jump from one point to another in the video, either forward in time or backward.
- **Seek chain**: To determine users’ actual seek targets, we group together seeks that occurred within 5 seconds of each other into a *seek chain*.

Backward seek chain from 9:45 to 4:00
Methodology: Event Types

• *Viewed*: We can reconstruct whether a particular second of video has been viewed, by looking at the time elapsed between a play event and the following event.
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At 5:00pm, a play event occurs at point 2:00 in the video.
Methodology: Event Types

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- At 5:00pm, a play event occurs at point 2:00 in the video
- One minute later (at 5:01pm) there is a pause at point 3:00 in the video
Methodology: Event Types

• *Viewed*: We can reconstruct whether a particular second of video has been viewed, by looking at the time elapsed between a play event and the following event.

At 5:00pm, a play event occurs at point 2:00 in the video.

One minute later (at 5:01pm) there is a pause at point 3:00 in the video.

The part of the video that was viewed was 2:00 through 3:00.
Overview

• Methodology: Dataset and event types

• **How do users interact with in-video quizzes?**
  – What portion of viewers do in-video quizzes?
  – Do they answer quizzes correctly?
  – How long do they spend on in-video quizzes?

• **How do in-video quizzes affect people’s viewing and navigation behaviors?**
  – Are videos with quizzes watched more?
  – Seeking behaviors around in-video quizzes
  – Quiz-driven video navigation strategies
How much do users interact with in-video quizzes?

• In videos containing an in-video quiz, what portion of the users who start watching the video will submit an answer to the in-video quiz?
  – 74% of users who begin watching the lecture will submit an answer to its in-video quiz (averaged over all lectures in ML4)
How often do users answer quizzes correctly?

• 76.0% of users who attempt a quiz will answer it correctly on the first try
• Of those who answer incorrectly, 76.5% will submit a correct answer in the next 30 minutes
  – So 94.4% of users answer correctly within 30 minutes of an attempt
How often do users answer quizzes correctly?

<table>
<thead>
<tr>
<th>Type of interaction with in-video quiz</th>
<th>Percentage of users</th>
<th>Median time spent between initial and final answer (seconds)</th>
<th>Mean number of incorrect attempts</th>
</tr>
</thead>
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<tr>
<td>Answers in-video quiz correctly on first try</td>
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<td>13 (mean=29, σ=71)</td>
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<td>Does not seek before submitting answer</td>
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<td>11 (mean=23, σ=53)</td>
<td>1.28</td>
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<td>Makes a seek before submitting answer</td>
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<td>Backward seek</td>
<td>97.0% (1.6% of total)</td>
<td>116 (mean=217, $\sigma=275$)</td>
<td>1.51</td>
</tr>
<tr>
<td>Forward seek</td>
<td>3.0% (0.1% of total)</td>
<td>56 (mean=229, $\sigma=367$)</td>
<td>1.48</td>
</tr>
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Overview

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  – Do they answer quizzes correctly?
  – How long do they spend on in-video quizzes?
• How do in-video quizzes affect people’s viewing and navigation behaviors?
  – Are videos with quizzes watched more?
  – Seeking behaviors around in-video quizzes
  – Quiz-driven video navigation strategies
Are videos with more quizzes watched more?

• A larger percentage of the video is watched for videos that have an in-video quiz
  – 59.3% in videos with no in-video quizzes, vs 79.1% in videos with in-video quizzes

• More seeking occurs in videos that have an in-video quiz
  – 36.2% of viewers seek in videos with no in-video quizzes, vs 42.7% in videos with in-video quizzes
Seeking behaviors around in-video quizzes

• For illustration purposes our figures will look at Lecture 13 of ML4 (chosen because it has 2 in-video quizzes)
• In-video quizzes are a major source and destination for seek chains
• Seek chains rarely cross over in-video quizzes
Seek Sources and Destinations in ML4 Lecture 13

- In-video quiz 1 (146 seconds)
- In-video quiz 2 (376 seconds)
- Start of seek event (position in video, in seconds)
Seek Sources and Destinations in ML4 Lecture 13

- In-video quiz 1 (146 seconds)
- In-video quiz 2 (376 seconds)

Start of seek event (position in video, in seconds)

Destination of seek event (position in video, in seconds)
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In-video quiz 1
(position in video,
in seconds)

In-video quiz 2
(position in video,
in seconds)

Destination of seek event
(position in video, in seconds)
• Seeks tend to remain within sections delimited by the in-video quizzes
Seek chains do not tend to skip over in-video quizzes

Video portions seeked forward over in ML4 Lecture 13

Video portions seeked forward over: position in the video, in seconds
Seek chains do not tend to skip over
in-video quizzes

Video portions seeked forward over in ML4 Lecture 13

Video portions seeked forward over: position in the video, in seconds
In-video quizzes are a major source of seek chains

Seek chains in the backward direction come from in-video quizzes at 55x frequency compared to any other second of video

Seek Sources in ML4 Lecture 13 (to all destinations)
In-video quizzes are a major source of seek chains

Seek chains in the backward direction come from in-video quizzes at 55x frequency compared to any other second of video

Seek Sources in ML4 Lecture 13 (to all destinations)
Why are users seeking back from in-video quizzes?

• Most (60.5%) of seek chains occur after the user has seen the question, but before they attempt to answer it.

• Another 14.4% seek back to review the preceding section after submitting an incorrect response.

• Only 3.0% seek back after a correct response has already been submitted.

• Suggests that they may be reviewing the video to help them answer the question.
In-video quizzes are a major destination of seek chains

Seek chains in the forward direction go to the immediately following in-video quiz at 4x frequency compared to any other second of video

Seek Destinations in ML4 Lecture 13 (from all sources)
In-video quizzes are a major destination of seek chains

Seek chains in the forward direction go to the immediately following in-video quiz at 4x frequency compared to any other second of video

Seek Destinations in ML4 Lecture 13 (from all sources)
Why might users be seeking forward to in-video quizzes?

• To preview the in-video quiz prior to watching the section (quiz-driven viewing strategy)
• Returning to answer the in-video quiz after they have seeked back to the preceding section
Seeks to in-video quizzes occur primarily from the preceding section and start

Sources of seeks to In-Video Quiz 1 in ML4 Lecture 13
Seeks to in-video quizzes occur primarily from the preceding section and start.

Sources of seeks to In-Video Quiz 1 in ML4 Lecture 13.
Users sometimes skip from one in-video quiz to the next.

Sources of seeks to In-Video Quiz 2 in ML4 Lecture 13.
Users sometimes skip from one in-video quiz to the next

Sources of seeks to In-Video Quiz 2 in ML4 Lecture 13
Conclusion

• In-video quizzes have high engagement
  – 74% of users who start watching a video will attempt the quiz, and 94% of those will answer correctly within 30 minutes

• A larger percentage of the video is watched for videos that have an in-video quiz

• Users often seek to in-video quizzes from the preceding section, and from in-video quizzes to the preceding section
  – May reflect quiz-driven navigation strategies, or looking for information to help answer the quiz
Are videos with more quizzes watched more?

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<td>534.8</td>
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How much do people interact with in-video quizzes?

User engagement with lectures and in-video quizzes on ML4

- Began watching lecture
- Finished watching lecture
- Submitted in-video quiz

Percent of material completed vs. number of users
Seek chains do not tend to skip over in-video quizzes

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

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<td>% of all seek chains</td>
<td># seek chains, normalized by the length of the seek target (seconds). Ratio to baseline in parentheses</td>
</tr>
<tr>
<td>All seek chains</td>
<td>56%</td>
<td>16.40 (baseline)</td>
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<tr>
<td><strong>Seek chains going to in-video quizzes (and their surroundings)</strong></td>
<td></td>
<td></td>
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<tr>
<td>Seeks to quiz (+/- 0.5 sec)</td>
<td>0.35%</td>
<td>67.43 (4.1x)</td>
</tr>
<tr>
<td>Seeks to 10 seconds preceding quiz</td>
<td>3.35%</td>
<td>62.17 (3.8x)</td>
</tr>
<tr>
<td>Seeks to 10 seconds following quiz</td>
<td>1.15%</td>
<td>21.89 (1.3x)</td>
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<td></td>
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<td>2.49%</td>
<td>15.04 (0.9x)</td>
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<td>21.42 (1.3x)</td>
</tr>
<tr>
<td><strong>Seek chains coming from in-video quizzes (and their surroundings)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seeks from quiz (+/- 0.5 sec)</td>
<td>0.36%</td>
<td>67.17 (4.1x)</td>
</tr>
<tr>
<td>Seeks from 10 seconds preceding quiz</td>
<td>0.65%</td>
<td>12.30 (0.8x)</td>
</tr>
<tr>
<td>Seeks from 10 seconds following quiz</td>
<td>1.89%</td>
<td>35.95 (2.2x)</td>
</tr>
<tr>
<td><strong>Seek chains coming from slide transitions (and their surroundings)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seeks from slide transition (+/- 0.5 sec)</td>
<td>0.30%</td>
<td>18.22 (1.1x)</td>
</tr>
<tr>
<td>Seeks from 10 seconds preceding slide transition</td>
<td>6.72%</td>
<td>40.68 (2.5x)</td>
</tr>
<tr>
<td>Seeks from 10 seconds following slide transition</td>
<td>2.78%</td>
<td>16.81 (1.0x)</td>
</tr>
</tbody>
</table>
Seek Destinations from first in-video quiz in ML4

- Chart showing lecture number (1=first lecture, 113=last lecture) against position within video, as percentage of total length.
Video Parts Skipped Forward over in ML4

lecture number (1 = first lecture, 113 = last lecture)

position within video, as percentage of total length
Seek sources and destinations

- Seeks tend to remain within sections delimited by the in-video quizzes

Scatter Plot of Seek Sources and Destinations in ML4 Lecture 13 on Coursera

In-video quiz 2 (376 seconds)
In-video quiz 1 (146 seconds)
In-video quiz 1 (146 seconds)
In-video quiz 2 (376 seconds)

Start of seek event (position in video, in seconds)