QuizCram: A Question-Driven Video Studying Interface

Geza Kovacs
Department of Computer Science, Stanford University
geza@cs.stanford.edu

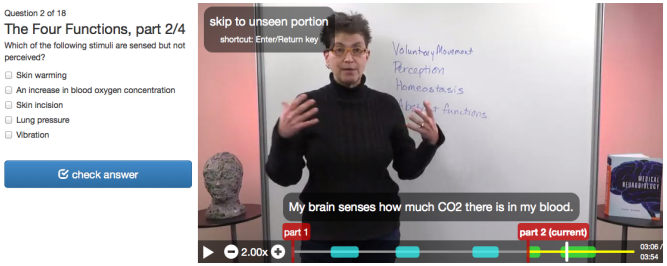

Figure 1: The QuizCram interface, showing the current video. The focus question is on left, and the associated video is on the right. The progress bar highlights the relevant portion of the video, and shows which segments have already been seen.

Abstract
QuizCram is a question-focused format for navigating and reviewing lecture videos. QuizCram shows users a question to answer, with an associated video segment. Users navigate through the video segments by answering questions. We also allow users to review using a timeline of previously answered questions and videos. To encourage users to review questions, QuizCram keeps track of their question-answering and video-watching history and recommends users to review questions they have not fully mastered. QuizCram-format courses can be generated automatically from lectures with in-video quizzes, though the format is flexible enough to accommodate multiple questions per video segment. Our user study comparing QuizCram to in-video quizzes finds that users practice answering and reviewing questions more when using QuizCram, and are better able to remember answers to questions they encountered.

Author Keywords
video flashcards, lecture reviewing, in-video questions

ACM Classification Keywords
H.5.2. [Information Interfaces and Presentation (e.g. HCI)]: Graphical User Interfaces

Introduction

Lectures on platforms such as Coursera use *in-video quizzes* to test learners on material while they watch videos. Although courses also have problem sets and exams, the majority of users engaging with MOOCs only watch lectures [1]. For these students, in-video quizzes are their only opportunity to test themselves on the material, which is critical for long-term retention [5].

While analyzing viewer logs of the Machine Learning course on Coursera, we observed that in-video quizzes play an important role in video navigation. Quizzes are the most common destination of seeks – users are 3.5 times more likely to seek to the 10 seconds before a quiz than to other segments. Users often skip forward to quizzes, or from one quiz to the next, as shown in Figure 2.

Users also rarely review lecture videos: only 11% of users who finished watching a lecture will ever open it again. Based on these observations, we wished to develop a video viewer that would better support quiz-centric navigation strategies and encourage reviewing.

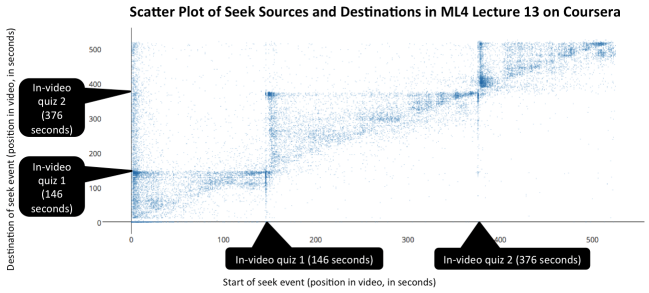

Figure 2: Seeks sources and destinations in a lecture with 2 in-video quizzes. Each point at (x,y) represents a seek from time x to y. There are many seeks to in-video quizzes from the start of the video, the previous section, and between quizzes.

Our system, Quiz-driven Video Cramming (QuizCram), uses quizzes to help users navigate the course and guide their review process. It includes the following features:

- QuizCram shows questions while users watch the video, to serve as a preview of the video content, and to guide their focus towards key concepts.
- To encourage people to review videos, our system keeps track of which video portions users need to review, and gives users suggestions of questions and video portions to review
- We facilitate adding questions to videos by allowing questions to depend on multiple video segments rather than just the immediately preceding one. This enables the presentation of a greater density of questions in the QuizCram format.

We used a within-subjects study to compare QuizCram to the in-video quiz format. We found that:

- Users remember answers to in-video questions significantly better when using the QuizCram interface
- Users practice answering and reviewing questions more often when using QuizCram
- We can improve the recall of particular facts from the video by adding extra questions in QuizCram.

Related Work

We designed QuizCram's features based on the following findings from the education literature:

Testing and Pre-Testing Effects

The *testing effect* shows that repeated testing combined with fast, informative feedback helps students remember material [5]. QuizCram's emphasis on answering and reviewing questions is designed to exploit this effect.

The *pre-testing effect* shows that asking users to try answering a question before they actually study the material enhances long-term retention [4]. QuizCram exploits the pre-testing effect by allowing users to preview the question before watching the associated video.

Advance Organizers: Video Transcript Summaries
Advance organizers are information presented prior to learning, that help the learner process the material that is about to be presented [6]. Video Digests is a system that creates such summaries about videos, and uses them as an advance organizer and navigational guide for video lectures [3]. QuizCram similarly breaks videos into segments associated with an advance organizer, but we use existing in-video questions to summarize the clips.

Spaced repetition: Flashcards
Spaced repetition is a technique used by flashcards to help learners retain information by having them review items at regular intervals [2]. Similar to flashcards, our system also schedules questions for review based on our model of the user's mastery and recency of review.

System Design

QuizCram's interface displays a question and associated video segment, as shown in Figure 3. It also shows a timeline of previous questions below the current question. Once the user has made an initial pass through the questions, we suggest questions that they should review, based on past performance. We use the video progress bar to indicate the section of the video that is relevant to the current question, and portions that the user has previously seen. An existing course with in-video quizzes, such as MOOCs on Coursera, can be automatically transformed into the QuizCram format.

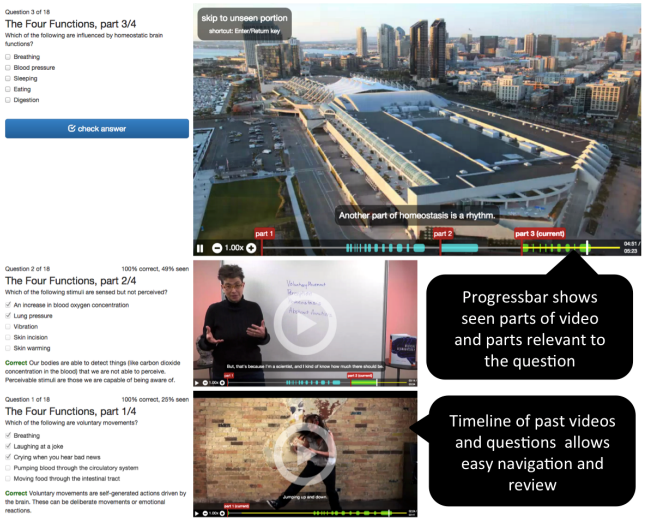

Figure 3: The scrollable timeline, shown below the current question, displays the past videos and associated questions, to help users review parts they had trouble with.

Question-Directed Video Viewing
Each section of the video in the course is displayed with an associated question, as shown in Figure 3. The question is designed to help users decide whether they should watch the video. If the user knows the answer, they can answer the question and move to the next section. For users who do not know the answer, reading the question summarizes the key points they will see in the video.

Timeline of Previous Questions and Videos
The *timeline* feature is designed to encourage review by making it easy to refer back to previously answered questions and video segments. Whenever a question is correctly answered, we insert the next question and associated video segment at the top of the interface, and

push the existing questions down. This results in a scrollable visual history of the previously answered questions, as shown in Figure 3. The timeline displays the question, its answer, and a miniaturized version of the video which can be clicked to enlarge it to full size and play it. The miniaturized video displays the frame the user left off at, so it serves both as a visual summary, and also allows users to easily resume watching previous videos.

By organizing the list of previous video segments according to the associated question that users answered, this allows users to scan video segments with a more salient summary than just the title. Question-based video navigation also allows users to search at a finer granularity, as questions refer to a specific subsection of the video, while the title refers only to the entire video contents.

Scheduling Questions and Video Sections for Review
We want users to spend their study time focusing on material that they have not yet mastered. Hence, we assign each question a *mastery score*, which represents how well the user currently knows the material, and show users questions from areas where their mastery scores are low. The mastery score is a weighted sum based on the user's past performance on the question, the fraction of the associated video segment they have watched, and the recency of review.

Once the user has seen all the questions in the unit, QuizCram encourages them to review questions and sections for which they have low mastery scores, by showing them at the top of the video timeline.

Directing Attention to Unseen Parts of Videos
To help users review videos, QuizCram keeps track of which parts have been watched. It highlights on the progress bar the portions that have already been seen. If the user is viewing a section they have already watched, they can skip to the unseen portion by clicking a button.

Evaluation

Our study used a within-subjects design to compare users' studying behavior with QuizCram against an in-video quiz interface that mimcs the format used on Coursera. We used the videos, in-video quizzes, and unit exam from the Neurobiology course on Coursera. We wished to answer the questions:

- Does QuizCram help users better remember answers to the original in-video questions?
- Does QuizCram help users score higher on exams?
- Can we improve recall of particular facts from the video by adding extra questions with QuizCram?
- Do users find QuizCram helpful for studying videos?

Participants
We recruited 18 students by posting on university mailing lists. 12 were female, 6 male. Their average age was 21.7 (σ=4.91, min=18, max=37). All had native-level English proficiency. None had prior exposure to neuroscience. They received $60 for participating.

Materials
The videos, in-video quizzes, and unit exams were from Unit 1 of the Neurobiology course on Coursera. There were 9 questions and 5 videos for each 25-minute segment. We generated the initial QuizCram materials directly from the course. To see whether we could improve the recall of particular facts by adding questions, we added extra questions to the QuizCram condition to double the total number of questions. The extra questions were in the same multiple-checkbox format as the original questions. We made sure that they did not depend on the same facts as the unit exam or in-video questions.

We also wrote a set of free-response questions, with one corresponding to each of the extra questions. We used these free-response questions to test whether users had learned the material tested by in-video questions well enough to recall it (rather than recognizing it).

Procedure

The study was conducted online over 2 days. On day 1, users studied the first section with one tool for 40 minutes. Then, they studied the second section with the other tool for 40 minutes, and took surveys. The order of tools was randomized. On day 2, users took the following exams:

1. Extra free-response questions
2. Original in-video questions from Coursera
3. Original unit exam from Coursera
4. Extra multiple-checkbox questions

Parts 2-4 were automatically graded, and free-response questions were graded blindly.

Results

Exam Results

Exam results are shown in Figure 4. QuizCram users performed significantly better on the original in-video questions. We attribute this improvement to QuizCram's increased focus on questions. They also performed better at both types of extra questions. This suggests that we can use added questions in QuizCram to improve retention of particular facts from the video.

Exam	QuizCram	In-Video	Statistically significant?
Original in-video questions	**85.4%**	**81.3%**	**Yes (t=2.24, p=0.039)**
Original unit exam	65.1%	63.4%	No (t=0.44, p=0.669)
Extra multiple-checkbox questions	**85.5%**	**76.0%**	**Yes (t=2.44, p=0.026)**
Extra free-response questions	**67.6%**	**49.0%**	**Yes (t=3.95, p=0.001)**

Figure 4: Average exam scores for each condition

Survey Results

When asked to rate their overall satisfaction with the tool a scale of 1 to 7, the average was 5.28 for QuizCram, and 5.17 for the in-video quiz format. 61% indicated they would prefer using QuizCram if they wanted to remember material long-term or were preparing for an exam.

Users liked QuizCram's question-based timeline of videos, and thought it was helpful for reviewing. However, some users thought that the interface's emphasis on questions distracted them from watching the video.

Analysis of Viewing Logs

To compare how users interacted with the two systems, we collected usage logs from each tool, as shown in Figure 5. We found that users answered each question more times when using QuizCram. Users also reviewed previously-answered questions more often when using QuizCram. This increase in practice and reviewing helps explain the increased exam scores on the original in-video questions.

Users seeked less on average when using QuizCram, which may be because they did not have to seek to and from in-video quizzes. However, this difference was not statistically significant.

Event	QuizCram	In-Video	Statistically significant?
Original in-video questions answered	**22.3**	**13.5**	**Yes (t=3.22, p=0.008)**
Original in-video questions answered correctly	**13.8 (62%)**	**5.3 (40%)**	**Yes (t=4.62, p=0.0007)**
Original in-video questions re-answered (after at least 1 minute)	**9**	**0.17**	**Yes (t=5.00, p=0.0004)**
Extra questions answered	18.3		
Extra questions answered correctly	14.4 (79%)		
Extra questions re-answered (after at least 1 minute)	8		
Number of seek events	7.2	11.9	No (t=-0.82, p=0.43)

Figure 5: Average number of events per user in each condition

Conclusion

We have presented QuizCram, a system that guides users' video viewing using questions. QuizCram aims to:

1. Encourage users to answer and review questions while they watch videos
2. Enable users to easily follow question-driven video navigation strategies (which we currently observe some users already using on Coursera)

QuizCram breaks the video into segments associated with questions, and always shows a focus question alongside the video. The focus question serves as an advance organizer that guides the user's attention towards the key points in the video. QuizCram also encourages reviewing based on questions: it displays a timeline of questions previously answered and their associated videos. It keeps track of users' progress through questions and videos, and suggests questions for users to review. Courses in the QuizCram format can be generated automatically from existing videos with in-video quizzes, though it also has the flexibility to accommodate additional questions.

Our user study finds that QuizCram increases focus on questions – when the in-video questions were tested again a day later, users using QuizCram remembered them better than if they were presented as in-video quizzes. Users practiced answering and reviewing questions more often when using QuizCram.

Current online courses rely on external problem sets and exams to test understanding of content in more depth than the in-video quizzes. However, the majority of MOOC particpants interact primarily with videos and do not take exams or do problem sets. [1]. Thus, moving more of the course content out of problem sets and making the video more interactive and question-oriented provides a way to benefit these viewers without removing them from the scaffolding of videos. We believe that QuizCram is a logical step from in-video quizzes towards more interactive, question-driven study experiences.

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