

Enhancing Synote with Quizzes, Polls and Analytics

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Abstract— Videos combined with quizzes and polls are used for educational purposes in many settings, including Massive Open Online Courses (MOOCs) and university lectures. For the authors of these resources, this often involves splitting videos up into sections with a poll or quiz after each section to gauge understanding. This approach requires the author to have video editing skills, and can be time-consuming. It would be useful if quizzes could be created and included directly into videos without the need for video editing. The resulting media could be analysed to discover how best to present information for learning. This paper describes the development of three main tools to Enhance Synote, the web based video annotation System. The Quiz Authoring Tool allows users to specify: sets of questions and polls to appear in the video, the time at which question sets should appear, and actions to be taken when questions are answered (e.g. skip back in the video if the answer is incorrect). The Questions Overlay library to allow quizzes and polls to be overlaid on Web videos in any of the main video formats, playable in the major browsers on different platforms. The Video and Quiz Analytics records and displays metrics of user behavior.

Keywords—video; quiz; poll; analytics

I. INTRODUCTION

Videos combined with quizzes and polls are used for educational purposes in many settings, including Massive Open Online Courses (MOOCs) and university lectures. For the authors of these resources, this often involves splitting videos up into sections with a poll or quiz after each section to gauge understanding. This approach requires the author to have video editing skills, and can be time-consuming. It would be useful if quizzes could be created and included directly into videos without the need for video editing. The resulting media could be analysed to discover how best to present information for learning.

This paper reports on the development of three main tools:

The Quiz Authoring Tool allows users to specify: sets of questions and polls to appear in the video, the time at which question sets should appear, and actions to be taken when questions are answered (e.g. skip back in the video if the answer is incorrect).

The Questions Overlay library allows quizzes and polls to be overlaid on Web videos, playable in the major browsers (Mozilla Firefox, Microsoft Internet Explorer and Google Chrome) on different platforms (PC, Mac OS X and Android).

These videos could be any of the main video formats (MP4, WebM, OGG).

The Video and Quiz Analytics records and displays metrics of user behavior.

A. Assessment

In education, summative (or 'assessment of learning' [18]) and formative (or 'assessment for learning' [18]) assessments are often used to provide different types of feedback to students, and show their level of progression and competence. Summative assessment is used when achievement levels need to be reported against a set of published criteria, often as an end of course evaluation.

The enhanced Synote system has been developed to support student centred Formative assessment with the main aims being to get students to recognise the gap between the understanding level they have achieved and what is required, and for the students to take action to close this gap To identify the gap immediate feedback on how to improve is required [19] and the disclosure of concepts that are difficult needs to be encouraged [9] to be able to provide effective feedback.

An eAssessment (also known as Computer-Aided Assessment (CAA), Computer Assisted Assessment (CAA), or Computer Based Assessment (CBA)) is the process of making, viewing and scoring assessments using a computer. In this system these processes will be carried out by two tools: the "Authoring Tool" will be responsible for creating the questions and assembling, the test and the "Assessment Delivery System" will be responsible for displaying and scoring the assessments. These tools must be interoperable, meaning they must use data formats that are compatible with each other. This system focuses on the use of quizzes and polls within videos as a means of assessment.

In order to store and display the questions in an eAssessment, a schema for the questions must be defined. A formally defined standard is IMS Global's Question and Test Interoperability (QTI) specification, an industrial interoperability standard for eAssessments. The specification overview [8] splits the eAssessment system into five subsystems: authoring tool, item bank, test construction tool, assessment delivery system and learning system. It is a very complex specification with many ambiguous or optional elements. The complexity of the specification increases the likelihood for errors in the implementation as it opens up opportunities for developers to

interpret the specification in different ways [14]. QTI version 2.1 was finalised in 2012 [8] but up to this point the standard was not widely used [19] as there were several fundamental flaws in the standard which gave definitions in natural language which could often be long-winded and ambiguous, making the standard difficult to implement [14, 17].

Video is often used as a medium to convey educational material as it appeals to different learning styles. However, academics have found that when video is streamed there is a lack of interactivity and user control [2, 5]. To involve the user more, interactive elements must be added. Cherrett et al. [2] found that 75% of users agreed or strongly agreed that interactive video had enhanced their learning experience, but at the time of the paper (2009) they could find no evidence of interactive video being used as a learning tool. There are now some interactive videos being used as learning tools [10] but not widely in Managed Learning Environments.

Interactive videos have often been implemented in Flash [2, 13]. This is no longer supported on many devices in favour of HyperText Markup Language version 5 (HTML5) technologies. The interactivity in HTML5 video players is generally implemented using clickable areas or pop ups [15]. HTML5 video players do not require an external plugin to run and so will be browser independent [6, 15], however some standards are not implemented in all browsers.

Including polls and quizzes in interactive videos is one method that could be used to give a formative assessment. This would give immediate, meaningful feedback, a key feature of formative assessment [19]. Having the questions integrated into the video allows the appropriate sections to be automatically re-watched, encouraging immediate action on feedback.

B. Accessibility and Usability

Kolodyzhnaya [10] did a check for accessibility and other features on existing applications in the education industry that use video e-quizzes and found that none of them were accessible from a keyboard (Fig. 1). This means that they do not conform to the User Agent Accessibility Guidelines (UAAG) of the Web Accessibility Initiative (WAI) or the Web Content Accessibility Guidelines (WCAG) 2.0 Standards.

Criteria	Adobe Captivate	Camtasia Studio	Edpuzzle	Educannon	Hapyak
Version	Desktop	Desktop	Web	Web	Web
HTML5 support	✓	None	✓	✓	✓
Replay function	None	✓	None	None	None
Flash fallback	✓	✓	✓	✓	✓
Accessibility	None	None	None	None	None
Overlay support	None	✓	None	None	✓

Fig. 1. A comparison between existing systems with interactive video e-quizzes (from [17])

Keyboard-accessible and even clicker-accessible Web video players have been implemented by both Opera [4] and PayPal [11], using HTML5 which conforms to the WAI Accessible Rich Internet Applications (ARIA) specification. PayPal's implementation is even open source.

There are many ways of conveying content in a video and none of the methods alone will generally convey the whole message. Most video searches stay on a whole resource level as there is a lack of semantic interlinking [12]. Annotation systems such as Synote aim to make videos accessible by adding transcripts and other annotations to them. The videos being annotated may not be owned by the annotator.

C. Synote

Synote is a Web multimedia annotation system designed and built with accessibility in mind. The application aims to make multimedia content accessible by synchronising the multimedia

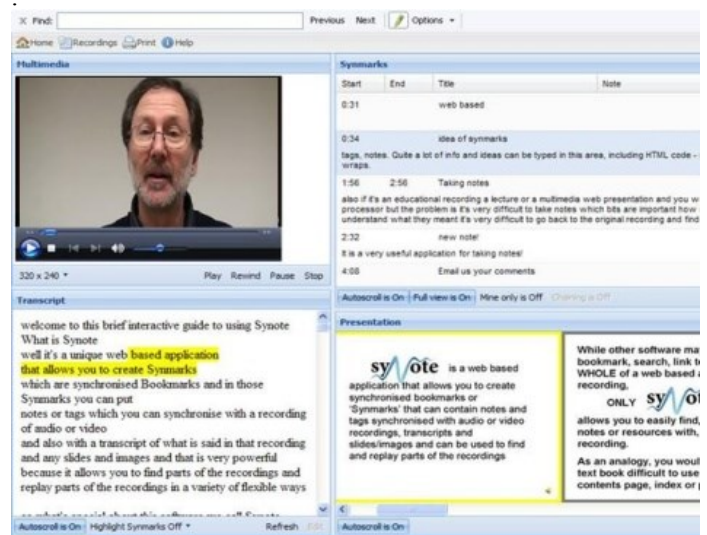


Fig. 2. Screenshot of Synote.

The synchronised interactive transcript of the video/audio makes the presentations searchable as well as more accessible, particularly for people with hearing impairments and cognitive difficulties. The time synchronised bookmarks (known as Synmarks) can be used to provide accessible summaries of the slide images as well as for making time notes on the recording. The transcripts, Synmarks, and images can be printed out.

D. Analytics

Meaningful analysis of video data is difficult as you need to know the content of the video to understand why the sections may have been of interest to the user [16]. Ronchetti [16] proposed that extra features can be added to the video to aid automatic analysis, including: multiple (parallel) cognitive channels, semantic marking, transcripts, and annotations. Video viewing styles have been researched for non-interactive

videos (streaming) and in general four main styles were identified [5]:

- Linear { A student watches a video in one pass (without interruptions) from the beginning to the end
- Elaboration { A student watches a video again after finishing the first time in one pass
- Maintenance rehearsal { A student watches parts of a video repeatedly
- Zapping { A student skips through the instructional video at intervals of relatively short viewing times

With the growing popularity of Massive Open Online Courses (MOOCs) analysis of video tutorials has been important to the educational industry to increase their usage. Guo et al. [7] made several findings such as:

- Shorter videos are much more engaging
- Tablet drawing tutorials (like those on Khan Academy) are more engaging than PowerPoint slides or code screencasting
- Students engage differently with lecture and tutorial videos

These findings would also apply to video quizzes but as the quizzes add a new element to the material the interactions will be different and there will be many more things that could be learned from studying their usage patterns.

Currently there is little research into viewing styles of interactive videos with quizzes and polls in them as there are few tools to capture the necessary data. Chorianopoulos and Giannakos [3] created an analytics tool that showed the quizzes separately to the video to create graphs of video usage patterns. They used the YouTube player to collect the usage data and Google Drive to include quizzes. They chose to display this information in graphs of video time vs frequency.

II. IMPLEMENTATION

A. Videogular Player

Videogular has the option to display HTML controls for the video player, replacing the browser's built-in controls. However there was no way for the user to access these controls without a mouse. The main problem was that the controls did not identify themselves as interactive elements, and so could not be 'focused' (selected with the tab key). This also prevented them from being picked up by a screen reader. Modifications to the code were made so that the controls were made individually focusable by using semantic markup where possible, and Accessible Rich Internet Applications (ARIA) attributes otherwise. When a control is in focus, a visual indicator is displayed to highlight it. Buttons can then be pressed using the space bar; the scrub bar can be moved using the left and right arrow keys; and the volume can be adjusted using the up and down arrow keys when the mute button is focused. All changes made have been adopted by the Videogular project.

Videogular Cuepoints is a Videogular plugin for displaying 'cuepoints', marks on the scrub bar which can be positioned at different times. For example, cuepoints could indicate the start of a section in the video, or (in this case) a time when a pop up will appear.

Videogular Heatmap is a Videogular plugin for giving areas of the scrub bar different colours. This is used to give a visual representation of the number of times each section of the video has been watched.

B. Videogular Questions

A Videogular plugin was written to provide the core functionality of the project. It allows for questions to be overlaid on top of the video and handles user interaction. This plugin is called Videogular Questions. It also provides utility functions for the Definition File messaging passing interface, making it easy to create content.

The implementation of the questions overlay was split into three sections: first, representing the question sets internally; next, displaying the questions within the user interface; and finally, implementing the back-end communication between the question representations and the video. One of the main issues to address early on was how to represent the questions. The Question and Test Interoperability (QTI) specification was investigated, but was found to be complicated and made implementing accessibility features difficult.

It was decided to design a new format for representing the data and logic that is used for a particular application of Videogular Questions. This new format separates the front end of the library (responsible for interacting with the Document Object Model (DOM)) from the data and logic describing the questions, by means of a message passing interface. This is achieved in a rigorous way in the browser by using a WebWorker, a sandboxed thread that runs independently of other scripts, and without access to the DOM or JavaScript functions which could compromise security.

An early decision was to define the difference between a poll and a quiz question. The decision made was that a poll is a type of quiz question that does not have a correct answer.

An accessible Authoring Tool was required to allow users to create their own question sets. Within the authoring tool users can create polls and quizzes and overlay them at chosen locations in a video. Within the authoring tool users have the ability to create questions sets within a video. There could be any number of questions in a set and these could be of many different types. A range of options are given to modify the functionality of each question to allow the user to create exactly what they need. At any point the user can preview their creation on the inbuilt video player. Once they are satisfied with the quiz they can export it for use with Videogular Questions externally from the tool. Fig. 3 shows a single choice question example and Fig. 4 shows the Question Authoring Tool interface. An early prototype was evaluated by 6 undergraduate and 2 postgraduate students with a mean age of 20 and from three universities and their feedback via a focus group and questionnaire was used to help inform the requirements.

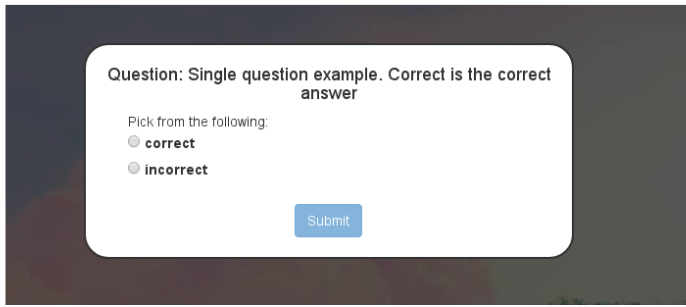


Fig. 3. Single Choice Question Example.

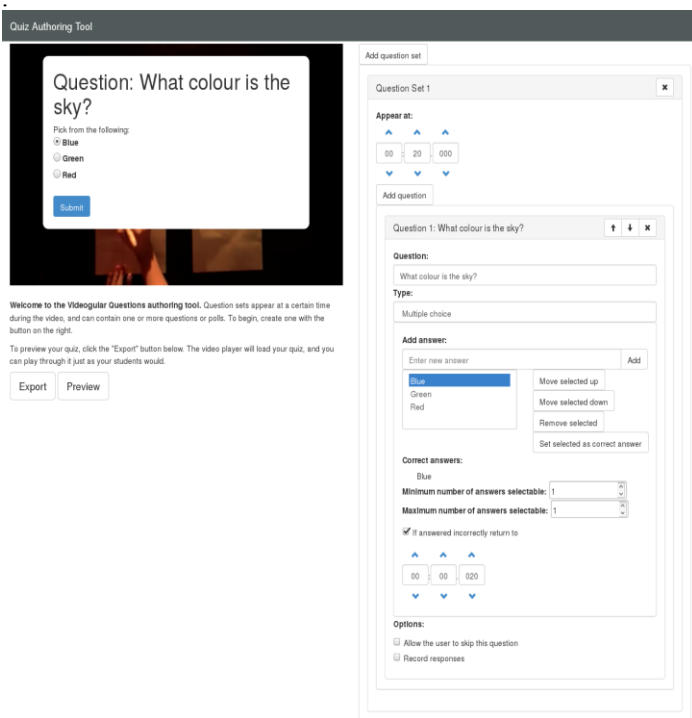


Fig. 4. Question Authoring Tool Interface.

C. Analytics

One of the main requirements was that video and question events should be emitted from the Videogular player and so it was decided to make a new plugin to handle analytics rather than putting analytics events directly into the Videogular Questions plugin. This plugin will monitor how the user uses the Videogular video player and the Videogular Questions plugin and store events related to this. If a server is configured this will send the users data to a server where it can be aggregated and processed.

The reason for designing the plugin to be separate from the main Videogular Questions plugin is that not all users of the core functionality will also want to perform analytics. This

means that the overhead of collecting the data is removed for users who are not interested. This can be important on mobile devices that have less processing power available. In addition, implementing this as a separate plugin means that it is not dependent on any of the other plugins. To test integration with Videogular Questions a set of dynamic graphs were included that update as events about question results are sent. Fig. 5 shows an example of the results of questions that have been sent from the plugin.

Results of questions

Question: The Caesar Cipher is a type of...

The correct answer was Substitution Cipher

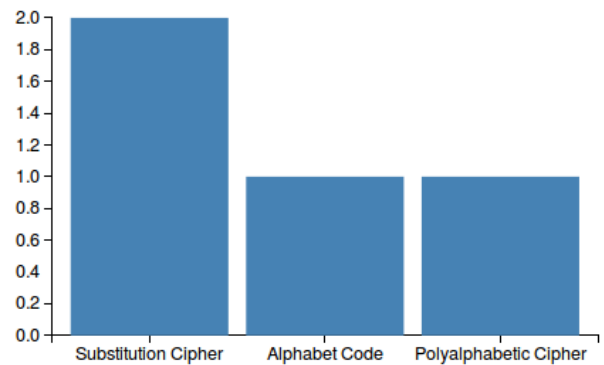


Fig. 5. Results from Question Answers.

One of the analytics used in the example site is the Videogular Heatmap. When running an instance of Videogular Questions Example this can be used to dynamically update the heat map in the example analytics page (Fig. 6). This is used to test that the Videogular Analytics plugin is able to properly export the timing data. The processing on the client side matches up start and end marks. These marks shown in Fig. 6 are then further processed to produce the data that the analytics can use.



Fig. 6. Video Analytics Overlay Heatmap

The added feature of displaying the frequencies was also tested (Fig. 7). These displayed well and matched the frequencies represented by the colours used in the heat map. A screen reader could still access the data as it was declared in hidden text.

Start time	End time	Frequency
0.00 seconds	18.19 seconds	1
18.19 seconds	18.19 seconds	2
18.19 seconds	18.24 seconds	3
18.24 seconds	2.94 seconds	6
2.94 seconds	50.03 seconds	0

Fig. 7. Times and Frequencies Video Sectors Viewed.

III. CONCLUSIONS AND FUTURE WORK

The plugin (Videogular Questions) central to this project involved overlaying quizzes and polls onto videos. From the review of previous work it was found that instantaneous feedback is key to learning, therefore this was an important feature of the Videogular Questions plugin. Another important client requirement was that all plugins should be extensible. Using AngularJS for the user interface of the Videogular Questions plugin, gives the required extensibility with the additional benefits of efficient reuse of code and high levels of customisability.

In order for a dynamic set of questions to be displayed to the user, WebWorkers (JavaScript sandboxed threads) have been utilised. This allowed for the use of a programmatic Definition File, rather than using an exhaustive data format. This was a very different approach to using the Question and Test Interoperability (QTI) definition standard; making accessibility considerations easier to implement without restricting the options available to authors. The creation of the Definition File is a non-trivial task. Thus, an authoring tool was produced to reduce the barrier to entry, enabling non-technical users to use the system. Accessibility considerations were a key factor in the development of the authoring tool.

It was important to ensure that the system is able to be easily integrated into Synote. To ensure this all, all services use an open standard to communicate using either Representational State Transfer (ReST) calls, or protocols such as Web sockets. These services can be run as small Web servers which will allow Synote to communicate with them easily. In addition, since these are standalone, the best language for the associated service could be chosen. This has decreased the complexity which should reduce the time needed to learn how the software

works in order to continue from this work. The core of the project uses AngularJS and the Videogular player as the latest version of Synote will be written in Angular. All of the plugins were written for the Videogular player and therefore will be able to be easily integrated into the primary Synote codebase. The plugins are the only part that will be integrated into Synote directly and therefore were best suited to be written in Angular. The other services will communicate with Synote and therefore did not need to be written in Angular.

At the 2014 ng-europe conference during a talk about the future development of Angular details about the 2.0 release were given. It is set for an early 2016 release, with Angular 1.x receiving bug fixes for another 2 years. Currently it seems that Angular 2.0 is a complete rewrite of the Angular ecosystem and is only related to Angular 1.x by name. Upon its release applications wishing to stay up to date will need to be rewritten from scratch. As this project is currently built around Videogular, it would first need to be updated and rewritten. The framework's main client, Synote, is currently in development and as such is using Angular 1.x. As such there is potential future work for investigating Angular 2.0 upon its final release. At that time much more information regarding potential upgrade paths would exist.

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