

# “Annotated Lectures”: Student-Instructor Interaction in Large-Scale Global Education

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## ABSTRACT

We describe an "Annotated Lectures" system, which will be used in a global virtual teaching and student collaboration event on embodied intelligence presented by the University of Zurich. The lectures will be broadcasted via video-conference to lecture halls of different universities around the globe. Among other collaboration features, an "Annotated Lectures" system will be implemented in a 3D collaborative virtual environment and used by the participating students to make annotations to the video-recorded lectures, which will be sent to and answered by their supervisors, and forwarded to the lecturers in an aggregated way. The "Annotated Lectures" system aims to overcome the issues of limited student-instructor interaction in large-scale education, and to foster an intercultural and multidisciplinary discourse among students who review the lectures in a group. After presenting the concept of the "Annotated Lectures" system, we discuss a prototype version including a description of the technical components and its expected benefit for large-scale global education.

**Keywords:** Global Large-Scale Classrooms, Intercultural Learning, Student-Instructor Interaction, Annotation Systems.

## 1. INTRODUCTION

### Challenges of large classrooms

Eliciting meaningful student participation in large classrooms, such as being able to ask questions, is difficult yet critical to learning. Anderson et al. [1] have identified three major challenges to student-instructor interaction in large classes: (a) *feedback lag*: questions are often suppressed due to the pace of the lecture as students may feel that they missed the right time to ask a question when the lecture moved on, (b) *student apprehension*: students may be afraid to ask questions due to the size or climate of the class, and (c) *single-speaker paradigm*: as only one person (student or instructor) can speak at a time, the amount of questions that can be asked and answered during a lecture is limited and whole-classroom discussions are not feasible. Furthermore, instructors rarely get *direct feedback from students* about the content of their lectures. Direct feedback from students, however, would be helpful for the lecturer for several reasons; for example, to better see the students' needs in order to explain the parts of the

lectures in more detail that have not been fully understood, and perhaps learn about the shortcomings of the lectures.

### Common technical solutions to foster interaction in large classrooms: Benefits and shortcomings

The challenges of facilitating student-instructor interactions in large classes have been discussed extensively by education scholars [2, 3]. Several technical solutions have been developed that intend to overcome the passive listening to the instructor in large classrooms, thus moving from teacher-centered lecture halls toward more interactive ways of actively involving students. Researchers have experimented with a variety of "clicker" systems, which enable students to respond to multiple-choice questions that are being asked in real-time by a lecturer [4, 5]. Means of quantitative student responses can be immediately calculated and displayed in a graphical way, for example, to check whether the majority of the students gets the questions right. Others have examined the use of mobile phone technologies to improve feedback and classroom interaction [6]. There are also technologies that enable students to post annotations on lecture slides in real-time [1]. However, these forms of student-instructor interaction are typically based on multiple-choice questions or predetermined annotations that students can select from (e.g., prompts for more information or alternative explanation to a particular slide). No technical solutions have been developed yet to simultaneously reply to a large number free text questions in large classrooms, which may be too time consuming to respond to in real-time.

### Using small group discussions in large-scale lectures: Benefits and shortcomings

Several teaching scenarios integrate small group discussions in which questions on the content of a lecture are formulated and discussed by students. Remaining open questions may then be sent to the instructor who can individually respond to the them or address general issues in the following lecture. Learning through discussion has been found to be essential to foster active learning and to construct conceptual understanding [7]. Small group discussions focus on thinking and reasoning instead of rote memorization and enable students to reflect on their own thinking, discuss issues, exchange ideas, question statements, and formulate questions for clarification. Thus, group discussions enable students to produce meaning through critical inquiry and deepen their understanding [8]. In this view, lectures are supposed to foster students' motivation to learn a specific topic and to awake their interest and curiosity

while the actual learning takes place individually outside of the classroom and often in cooperation with peers. Nevertheless, feedback and interaction should be enabled between students and instructors – irrespective of the size of the class. In group discussion that takes place after a lecture, students typically do not have the possibility to review the lectures together. When a lecture is discussed based on its memorized content, it may be difficult to explain what one is exactly referring to, especially when that part of a lecture was not fully understood. Therefore, we claim that students should be given the possibility to jointly look at a sequence of a lecture or a particular slide of a lecturer's presentation and should be able to point to and direct the others' attention to the respective parts of a slide that one is commenting. Such shared visual representations in combination with synchronous communication can be expected to facilitate the establishment of common ground for the discussion of the content of a lecture. The reviewing of video-recorded lectures is supported by a current trend of podcast use for educational purpose [9].

### The “Annotated Lectures” system - An advanced technical solution to foster classroom interaction in large-scale lectures

We propose an “Annotated Lecture” system in order to overcome the challenges associated with traditional technical solutions to foster interaction in large classrooms. It is an extension of typical podcasts that integrates a free-text annotation feature into video-recorded lectures presented in a 3D collaborative virtual environment (3D CVE). We first describe the context in which the “Annotated Lectures” system will be used, followed by a description of the concept and technical components of the proposed system. A prototype version of the “Annotated Lectures” system has been developed by the co-authors of this paper from Lucerne University of Applied Sciences and Arts. The system will be further developed and evaluated in the context of a global virtual lecture series in 2010, a follow-up event of the “ShanghAI Lectures”<sup>1</sup>, which will be described in more detail in the following section.

## 2. THE “SHANGHAI LECTURES” - A GLOBAL VIRTUAL EDUCATION INITIATIVE

The “Annotated Lectures” system will be used in a follow-up event of the “ShanghAI Lectures”<sup>1</sup>, a mixed-reality global teaching and international student collaboration project, presented by the University of Zurich. Its core components are a lecture series on embodied – natural and artificial – intelligence presented by the second author [10, 11] and international task assignments for students. The lectures will be broadcasted from Jiao Tong University in Shanghai in fall term 2009 via video-conference to different universities around the globe to create a “global virtual lecture hall”. Approximately 300 students will collaborate in self-managed global virtual teams on project-based group assignments, view and annotate lectures, and meet with experts, embodied as avatars in a 3D CVE. The student teams will be assigned to a tutor (i.e., teaching assistant) who supervises their work, provides feedback to the deliverables of their projects, and can be contacted to discuss questions regarding the content of the lectures or conflicts that may emerge from working in interdisciplinary and multicultural teams.

1 <http://shanghailectures.org/>

The “ShanghAI Lectures” project is designed to make education and knowledge on cutting-edge topics accessible to a large audience and to establish a sustainable community of students and researchers who are approaching the topic of embodied intelligence from different perspectives. Moreover, the project aims to foster collaboration in a multicultural and interdisciplinary context and to bring global teaching and intercultural learning to a new level. In terms of educational goals, the project focuses on the following objectives:

- Creating a platform for the development of reflective thinking and for exchanging ideas among members of a multidisciplinary community in order to promote networking and to foster innovation.
- Supporting the development of intercultural communication competences in a global learning and collaboration context, and creating the conditions for practicing of the effective use of novel collaboration technologies in order to prepare students for an international work environment.

A 3D CVE (named “UniWorld”) is currently being developed at the University of Zurich using *Sun Microsystems' Project Wonderland* toolkit<sup>2</sup> in order to comply with the requirements of large-scale global collaboration (see Figure 1). This open-source toolkit enables the customized design of the virtual environment, the extension of communication tools, such as immersive audio and cameras into the real world [12], and collaboration features, such as virtual team rooms with shared applications, and the implementation of authentication schemes.



Fig. 1. Collaboration in 3D CVE: Virtual meeting rooms with application sharing facilities. Retrieved from: <http://research.sun.com/projects/mc/images/mpk20-kap-officeentry.png>

### Virtual presentations

By using a mixed-reality setting combining video streaming and virtual world technologies we intend to enable students from different countries not only to attend the lectures in their local lecture halls, which are connected to other universities via video-conference, but also to participate actively. For example, they can present their projects to other students around the

2 <https://lg3d-wonderland.dev.java.net/> (demo videos can be found at <https://lg3d.dev.java.net/WonderlandTechOv.html>)

world and comment on each others work. The students will be provided with the possibility to watch video-recorded lectures and expert talks (e.g., by experts from the robotics industry) in their team in a virtual room and comment a video-recorded presentation by posting annotations to it.

### In-world application sharing

In-world application sharing enables participants to share the same applications for the development of an activity, for example, text processor, presentation or spreadsheet programs (see Figure 1). Students from different countries can work together on their projects directly within the virtual world. The in-world shared applications enable them to create a mutual understanding by graphically depicting their ideas. Furthermore, avatar embodiment in a shared visual environment and synchronous communication is expected to create a sense of co-presence, that is a feeling of “being there together” [13]. A high level of perceived co-presence can be expected to improve virtual teamwork in both task-related and social relational ways.

The “Annotated Lectures” system will be used and evaluated in a similar educational and research setting in the context of a follow-up global virtual lecture series in 2010, which will be announced at <http://embodied-intelligence.org>.

## 3. THE “ANNOTATED LECTURES SYSTEM”

An extended application-sharing function is being developed in “UniWorld” that uses screens in a virtual room where recorded videos of the lectures can be reviewed. A menu lets the students select the lecture of their choice. Students (represented as avatars) standing in front of the lecture screen can view and control it using “stop” and “play” buttons. Next to the lecture screen an additional screen appears where they can make annotations or note questions while the video is stopped (see “annotation function”). The screens are coupled in a way that all annotations posted by the students are associated to the particular position in the lecture. Additionally, the video-recorded lecture can contain online questionnaires for self- or group-assessment or links to web resources for further information. The lectures will be divided into thematic segments in order to get collected annotations to a particular sequence of the lecture. Each annotation is marked with an identifier of the individual or the group who posted it and a link specifying the lecture, the chapter, and the exact time the annotation was made to the video. An initial GUI design of the “Annotated Lectures” system is depicted in Figure 2.

### Preparation of video-recorded lectures

The lecturer is recorded during his/her presentation in the global lecture hall and the video is post-processed using the SWITCHcast<sup>3</sup> software (see Figure 3). The SWITCHcast desktop application facilitates the local recording of audio and video data and slides. The recorded lectures are then uploaded to the SWITCHcast webserver where an authorized person can edit the video. It can be divided into chapters using a Web Cutting tool and enhanced with halts at slides showing questions or assignments. This information is stored in a metadata file (\*.json), which is automatically parsed and read into the application database. After these steps a lecture video is available in the “Annotated Lectures” system.

3 <https://cast.switch.ch/>

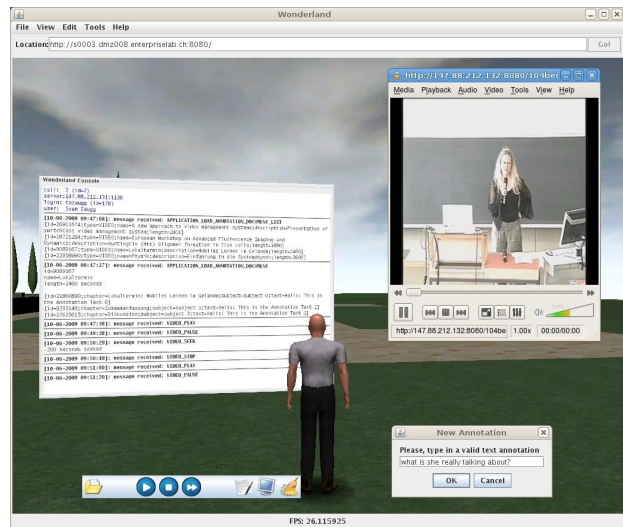


Fig. 2. Initial GUI design of the “Annotated Lectures” system integrated in “UniWorld”, a 3D collaborative virtual environment.

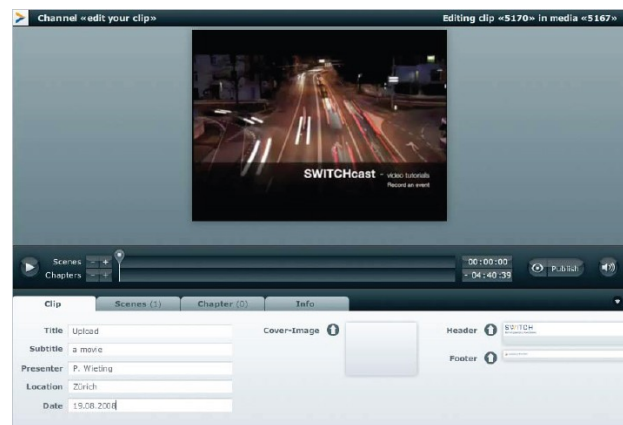


Fig. 3. SWITCHcast software used for video editing to prepare the lectures to be used in the “Annotated Lectures” system. Retrieved from: [https://cast.switch.ch/resources/SWITCHcast\\_manual.pdf](https://cast.switch.ch/resources/SWITCHcast_manual.pdf)

### In-world movie-player

The lecture screen in “UniWorld” runs a Java player, which is linked to an annotation board placed next to it. A student chooses a particular lecture video from a menu. This selection sends a request to the server module instance, which is responsible for steering the VLC streaming server using Telnet. The VLC streaming server provides the requested video as a video-on-demand HTTP broadcast, which is transmitted to the client. This streaming service behaves like a TV sender. As soon as the video plays, all connected clients can synchronously see the same video. In contrast to watching TV, users stand in front of the screen in the virtual environment embodied as avatars and can synchronously control the lecture video (e.g., play, pause, stop, or jump to predetermined positions within the lecture). In addition, existing annotations (with identifiers, see below) can be displayed while the movie is in a playing state. A tutor who views a lecture has the option of displaying only the annotations that have been posted by a particular group that he/she has been assigned to.

### Annotation function

Students can post annotations to a video-recorded lecture at any point in time. After clicking a symbol in the player a window opens where students can type in an annotation to the current position of the lecture. Annotations are tagged with an identifier containing the chapter of the current lecture, the exact time reference of the annotated picture frame and an identification of the sender. Clicking a “send” button transmits the message to the assigned tutor and makes the annotation visible for other students. The tutor who has been assigned to the team of the student who posted the annotation receives the tagged annotations and can respond to them by clicking a “reply” button. Students will be notified immediately about replies to their annotations. They are also provided with the possibility to view the lectures with or without annotations made by others. If the option with annotations is chosen, the annotations are displayed in an aggregated way to each chapter, which enables students to respond to annotations posted by other groups. The same aggregated display function can be used by the lecturer in order to read and comment on the annotations that are displayed for each chapter of his/her lectures.

## 4. TECHNICAL COMPONENTS

The "Annotated Lectures" system is an *Embedded Swing GUI* application running in *Project Wonderland v0.5*. The system makes use of an application database where it checks for available lecture video metadata. This information is shown in a shared application in “UniWorld”, the 3D virtual environment. As soon as an avatar chooses a particular lecture he/she registers with the particular video stream, which is served by a dedicated streaming server to all connected clients. The videos in “UniWorld” are streamed in a way that each user who stands in front of the screen sees the same images and hears the same narration at the same time. In order to avoid bottlenecks an out-of-band approach for the video stream is used. The “Annotated Lectures” system is in charge for achieving synchronized audio and video playback among these clients. It handles the key feature for video annotations: adding and showing text annotations coupled with lecture videos.

The technical components of the “Annotated Lectures” system are depicted in Figure 4.

### Client-side requirements

The following technical components are required on the client side:

- *Wonderland* version 0.5 Dev3 (via Webstart)
- Java Runtime Environment 1.6 update 13
- VLC client 1.0.0-rc1 Goldeneye
- Java Monkey engine compatible graphic adapter (3D rendering with OpenGL)
- Internet access and headsets

### Server-side requirements

The following components are required on the server side:

- *Wonderland* version 0.5 Dev3 Server
- Java Runtime Environment 1.6 update 13

- VLC streaming server, 1.0.0-rc1 Goldeneye, with access rights to the archive of the annotation documents (lecture videos, PDFs, slides etc.)
- Application database: Annotation, metadata of lecture videos (path of the videos, document type, publisher, chapter etc.), user and group data

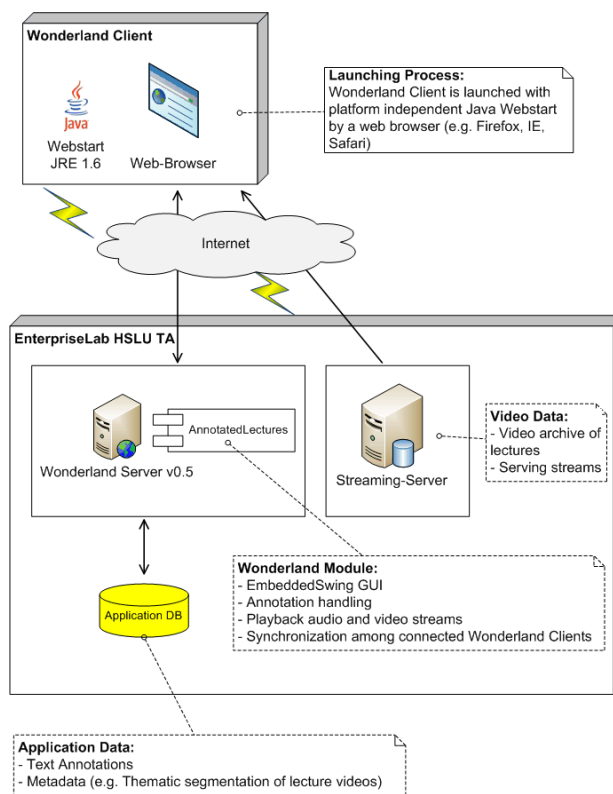


Fig. 4. Technical components of the “Annotated Lectures” system.

## 5. FURTHER DEVELOPMENT

There are several extensions to the “Annotated Lectures” system that can be implemented at a later point in time due to its modular setup, for example, the integration of selectable audio channels. This would make it possible for users to individually choose the language of the narration while watching the same pictures simultaneously with others, which may be a solution to overcome possible language barriers in synchronous cooperation in an intercultural learning environment. Other types of documents, such as PowerPoint files or PDF may be used for making annotations instead of video-recorded lectures. In *Wonderland*, the communication between avatars is supported by the open-source Darkstar game engine. This layer can be replaced by another communication channel in order to use the “Annotated Lectures” system outside of *Wonderland*.

## 6. CONCLUSIONS

We expect that the “Annotated Lectures” system helps to overcome the issues of large-scale global education, which have been described in the introduction (i.e., feedback lag,

student apprehension, single-speaker paradigm, and direct feedback from students). Data will be collected during global virtual lecture series on the usage and acceptance of the “Annotated Lectures” system in order to improve and extend the proposed system according to users' needs. In addition, the conversation of the students will be recorded while they work with the “Annotated Lectures” system in the 3D collaborative virtual world. This enables us to gain insights into the intercultural and multidisciplinary discourse and what comments or questions these discussions result in. The recorded communication may also contain additional valuable information on the usability of the “Annotated Lecture” system and will be analyzed in a systematic way.

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