Applications

# 3is: Enhancing Learning and Teaching Activity through the Manipulation of Objects

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## Abstract

The 3is project at the University of Siena is devoted to the design of new artefacts for the support of learning activities. The key concepts that have inspired the design process are those of dialogical knowledge construction (DKC) and situated editing (SE) of content. DKC uses teacher/student and student/student dialogical interaction to facilitate the processes of exemplification of concepts, negotiation of meaning, and shared production of content. SE is the real-time manipulation of educational assets during an educational event. The current prototype digitizes events during a live presentation delivered with common presentation software, producing a package of multimedia resources and a viewing interface that allows navigation of captured video and screenshots. The 3is prototype system is comprised of an Open Source learning management system for the distribution of course content, and a client application, which records the event and resources presented during a presentation. The captured output presents the presentation by dividing it into timeline blocks that represent each multimedia resource used by the instructor. Timeline cross-sections can be referenced as individual objects for later manipulation. The main objective of the 3is project is to improve the effectiveness of a learning activity by facilitating the application of the conceptual frameworks, achieved through the application of technology to an otherwise traditional lecture setting.

## 1 Overview of 3is Project

The 3is (Trace) Project, in progress since 2002, began as an experimental collaboration to develop prototype tools for enhancing university classroom activity. The project follows a co-evolutionary model, allowing sub-processes to evolve in parallel and to converge for sharing, refining and developing integrated concept/activity scenarios. In divergence/convergence flow of the model, design and development activities occur simultaneously, each influencing the other. This process has produced a cycle of experimentation and prototyping that has resulted in the current prototype, 3is Learning Objects, an open-source software application for capturing lectures and manipulating multimedia objects.

The project objective is to design tools for supporting pedagogic activity according to two main concepts: Dialogical Knowledge Construction (DKC) and Situated Editing (SE) of educational content. These concepts are extended from the POGO project research, which designed and tested prototypes for children of elementary school level to support narrative storytelling through interaction with digital devices (Rizzo, et.al.). DKC facilitates teacher/student and student/student interaction allowing the exemplification of concepts, negotiation of meaning, and sharing of content. SE enables real-time manipulation of educational assets, permitting students and teachers to share the production of course content. The co-construction of content has been shown to improve the retention of new information and the transfer of that information to other tasks with respect to traditional educational practices. These concepts orient the design process of the 3is project and inspire the development of prototypes.

In current educational practices, the teacher produces educational assets (i.e. slides, textbooks, case study, exercises), while students are relegated to the consultation of those assets. In this way students are never given the possibility to produce educational assets, but according to well-established theory, proper understanding is achieved only by co-construction of knowledge (Fusai *et al.*, 2003). During the experimental phase of the project, however, it was discovered that facilitating a departure from the traditional model of information delivery and repetition is a task for which both students and professors create obstacles due to established habits and fears of "missing something important." Prototypes for student activity during class sessions found little success with students, who expect to receive content instead of participating in its dialogical creation, even in situations where professors tried to facilitate prototype use. Thus, the project group decided to attempt a gradual influx of support technologies that offer incremental steps toward the theoretic goals of the project, seeking to introduce technology into the traditional lecture format that produces the building blocks for later manipulation of content. The current prototype, 3is Learning Objects, is a portable version of an earlier classroom system and is planned to be the first of a suite of three applications for learning activity support.

## 2 Theoretical Framework

The project combines the socio-constructionist learning approach with Dialogical Knowledge Construction (DKC) and Situated Editing (SE) concepts, and attempts to bring them into the university classroom through the use of support technologies. The DKC and SE concepts derive from a previous research project (Fusai *et al*., 2003) and are inspired by Vygotsky's historical-cultural psychology and the works of Batchin, Bruner, Doise and Piaget (Rizzo, 2004).

### 2.1 Dialogical Knowledge Construction

DKC combines constructionist and collaborative viewpoints into a concept for collectively creating new content as a learning process, in order to support the differences of individuals in terms of abilities and aptitudes embodied in every classroom. Learning theories and tools that fail to take this diversity into account provide little help for teachers who, themselves, differ in similar ways (Wells, 1999).

The DKC concept aims to give focus to both teacher-student and peer-to-peer relationships. Asynchronous discussion forums are used toward this end in online environments, but there are doubts as to whether this activity constitutes dialogical knowledge construction (Knowlton 2005). Passivity and tendency toward monologue are problems frequently found in discussion forums, and reveal a lack of effectiveness in the medium for creating authentic dialogue and construction of new knowledge. Other kinds of dialogue common in educational situations are seldom shared among all class members and are almost never recorded.

The 3is project group hopes to overcome these difficulties through the use of audiovisual building blocks as elements for argument construction. It is thought that creating and editing audiovisual cells, a creative task requiring cognitive processes and analysis of individual elements, has the potential to diminish tendencies toward monologue, while providing a mode of expression that allows for participants' learning differences.

### 2.2 Situated Editing

SE is extended from the POGO project research, in which a children's story world was designed for construction of narrative content through interaction with digital devices (Rizzo, *et al.*). Through the co-construction of narrative structures, all phases of an abstraction-instantiation loop are experienced in the learning environment, whereas in the lecture model the student does not participate in the production of educational assets and therefore must perform the abstraction-instantiation tasks in an external environment without social feedback. The SE design concept aims to create an environment (physical and conceptual) where educational assets can be co-produced by the teachers and the students, localizing all phases of the learning process to the primary environment.

For adolescent/adult students, the cognitive process is much different than that of a child, and the need for reflection and theory-building must be taken into consideration (Inhelder *et al.*, 1958). Thus, the 3is project uses a model of SE that provides for presentation, reflection/editing phases, and social feedback. In this way the model seeks to allow the natural cycle required for construction of arguments at the cognitive level of a university student.

## 3 Conceptual Model of 3is System

Using the theoretical framework described, the 3is project group developed a conceptual model of a three-tiered system which would serve to support the activity as analysed in the experimental phase of the project. The system uses a cellular metaphor to represent the creation, growth, branching, and sharing of objects within the system, with the goal of supporting both the stream of ideas during an experience and the cognitive logic that comes from reflection upon an experience. In each tier, cell structures are created or used in different ways based on the type of activity.

### 3.1 Linear Capturing

The linear structure models a lecture activity as a live temporal flow. In this activity, objects are assembled by a single author for a unidirectional delivery of content. The result is a series of objects in temporal sequence with a single beginning point and a single endpoint.

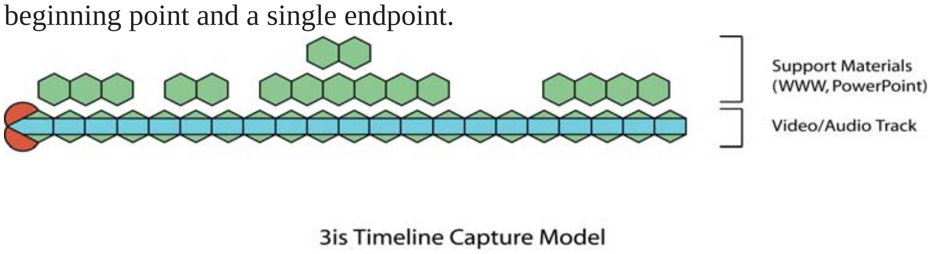


Fig. 1 3is Timeline Capture Model

The 3is cellular timeline model, as seen in Figure 1, demonstrates the results of a captured lecture subdivided into objects. Each object represents an element of content, and the cells depicted in the upper strata indicate support materials that reinforce the argument presented. While the base stratum may be considered a single object – a single audio or video file – the combination of strata allows for the subdivision of that single object into multi-layered cross-sections of the timeline, reusable as new individual media objects that combine verbal and visual content.

## 3.2 Cellular Structuring

The cellular structuring model demonstrates the use of objects both captured during presentations and created within the editing application interface for presenting and developing ideas as progressive audiovisual content. Structures depart from a central argument and branch out as possible argument outcomes diverge. As shown in Figure 2, a time-based series of objects determines the progression and branching of the argument structure, while additional cells are attached in strata to the temporal flow objects as supporting materials. New arguments can be linked from the cell structure as questions or topics develop that require a new logical structure.

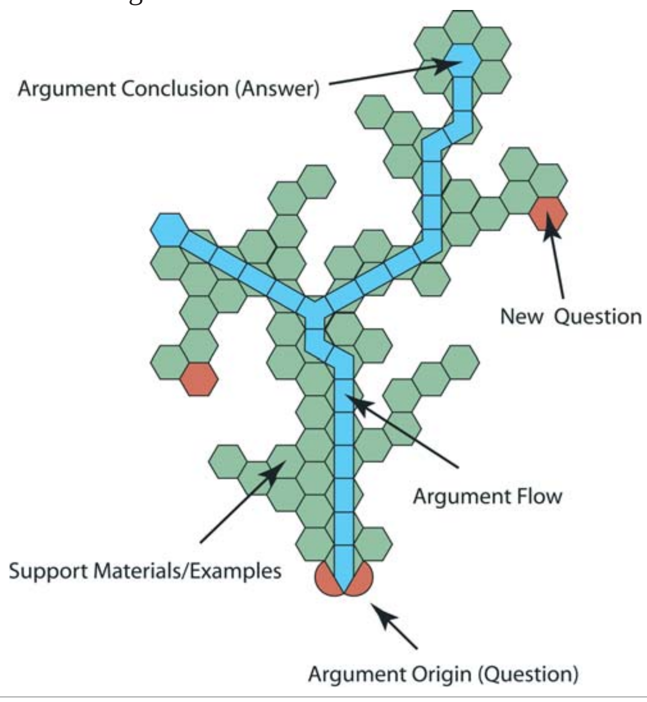


Fig. 2 3is Argument Construction Model

Once the traditional lecture has been objectified into a series of subdivided elements, it is no longer a fixed, one-time experience of which remain only the notes taken by individual students, but it becomes a malleable collection of objects to be used and reused in the development of new narrative structures. These structures, to be generated by groups working together or collectively through asynchronous editing, are modelled to be a dialogical construction in which disagreements become new structural branches and alternative perspectives can develop from a common root.

## 3.3 Management System

The management system, as conceptualized in Figure 3, combines a local cache of structures and timelines on individual file systems with a centralized library of distribution and organization. The structures created locally are synchronised to the centralised library upon completion, using LMS or CMS systems for direct distribution of new structures. An additional object-oriented or associative database is also conceived in the model for providing search services and associations among objects.

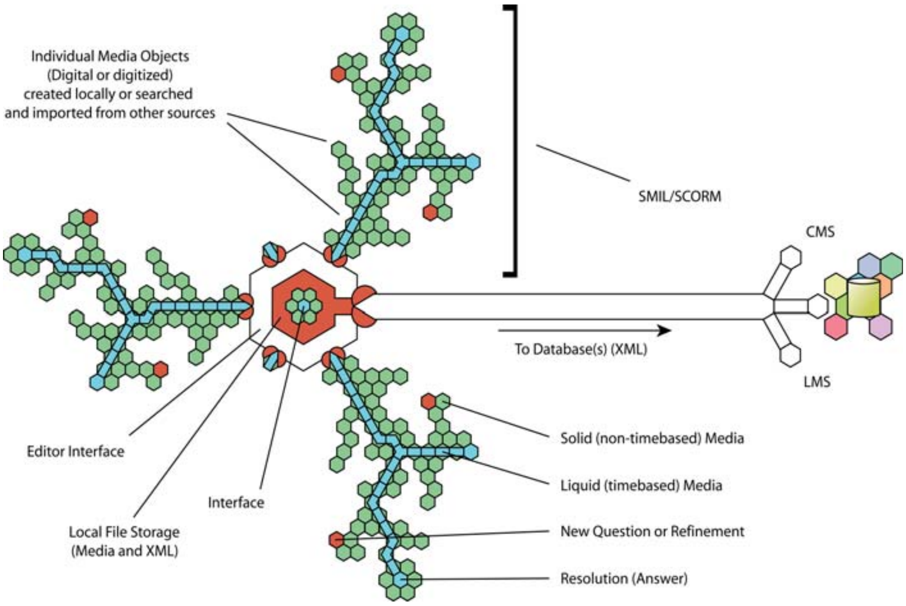


Fig. 3 3is Management System Model

## 4 Current Prototype

The current prototype is the first of three development phases that will constitute the entire 3is instructional support package. The three phases consist of a recorder to capture object-oriented learning objects, an editor for viewing and manual editing of presentations and arguments, and a file manager for associative management and network sharing. While the entire system will be required to support the theoretical framework, the 3is Recorder forms the bridge between the traditional lecture instructional model and the situated, dialogical construction model. The 3is Recorder converts the traditional lecture into a series of reconfigurable and reusable objects, organized and made portable through the use standardized XML syntax and metadata.

The tactic of building from the lecture format resulted in the development of the 3is Recorder. Professors of courses involved in testing the prototype use presentation software or web-based media to present lecture materials, and 3is Recorder captures the audio and video of the lecture while recording timestamps, screenshots and metadata that describe the professor's use of the computer as s/he presents materials. The audio-visual track is reunited with the recorded data in an interface that allows students to review the lecture content by navigating on the timeline. (Fig. 5)

### 4.1 3is Recorder Output

3is Recorder uses XML output to provide various usage options for the material it records. The XML files created by the software during the recording process, allow recorded material to be immediately usable when recording is stopped. The two primary XML standards employed in 3is recordings are the Shareable Content Object Reference Model (SCORM) and Synchronised Multimedia Integration Language (SMIL).

### 4.2 SCORM

The prototype records structural data in SCORM 2004 format, standardized by the Advanced Distributed Learning initiative of the U.S. Department of Defense and adopted as a common feature in many Learning Management Systems. (ADL 2005) SCORM provides a format for describing instructional modules, and the 3is prototype incorporates this standard by storing all textual and multimedia elements in an assets directory with an external SCORM manifest that structurally represents the lecture in XML.

An XML entry is recorded in the manifest for each element used as the lecture progresses, storing a structured reference and metadata. Use of the SCORM standard increases the reusability of these captured presentations, allowing them to be used with SCORM compatible software. Additionally, SCORM provides a structure which lends itself not only to the description of learning materials, but also to the objectification and subsequent reorganization of individual elements.

```
<!-- begin sco list -->
 <resource identifier="SCO1" adlcp:scormtype="sco" type="webcontent" href="assets/audio_20050302161048.mp3">
      <file href="assets/audio_20050302161048.mp3" />
 </resource>
 <resource identifier="SCO2" adlcp:scormtype="sco" type="webcontent" href="assets/multimediadesign.ppt">
       <file href="assets/multimediadesign.ppt" />
      <dependency identifierref="Slide_1" />
      <dependency identifierref="Slide_2" />
      <dependency identifierref="Slide_3" />
 </resource>
<!-- begin this_is_my_presentation.ppt slides -->
 <resource identifier="Slide_1" type="webcontent" adlcp:scormtype="asset" href="assets/Slide_1_20050302161220.jpg">
      <metadata> <!- Slide_1 meta-data-->
...
 </resource>
<!- Internet resources -->
 <resource identifier="www_google_com" adlcp:scormtype="sco" type="webcontent" href="http://www.google.com/">
      <file href="http:// www.google.com/" time="20050302161616" />
 </resource>
 <resource identifier="www_unisi_it" adlcp:scormtype="sco" type="webcontent" href="http://www.unisi.it/">
      <file href="http://www.unisi.it/" time="20050302161653" />
 </resource>
<!-- end Internet resources -->
```

Fig. 4 Sample Section of 3is SCORM

## 4.3 SMIL


Figure 5. SMIL Interface

SMIL, a developing World Wide Web Consortium standard for XML-based definition of multimedia presentations (Michel 2005), allows the 3is prototype to construct a viewing interface during runtime. XML entries are made automatically by the software as actions occur on the presentation computer, progressively building the viewing interface during recording. The XML is structured in standard SMIL format, which can be read by compatible media players. The SMIL file serves to reunite captured media, allowing for the review of a presentation in a navigable context immediately following its occurrence.

As shown in Figure 5, the interface consists of the video/audio recording of the professor, screenshots from the presentation computer timed to the visual elements used during the lecture, and an object-oriented timeline that permits internal linking to individual elements. Upon linking to a particular timeline element, the interface synchronises playback to the element selected.

### 4.4 Presentation Package

Following a recording, the presentation computer contains a portable version of the lecture with an object-oriented interface, structured description, and all presentation materials, including presentation files in their original formats. The package consists of a directory with the SCORM manifest and html file for viewing the SMIL interface at the root. All audiovisual materials are contained within an *assets* subdirectory, alongside the SCORM format files that contain metadata recorded for each element.

The benefit of recording the presentation in this way is twofold. First, the review of the recorded materials becomes a targeted interaction, providing immediate access to specific portions of the lecture without need to review the entire recording. Second, as further progress is made in subsequent development phases, individual blocks will be treatable as separate elements to be reused and recombined in new collaboratively or individually constructed arguments. Each element of a lecture thus will become an object to be reused in student-generated content.

## 5 LMS Modules

The 3is group uses an installation of Moodle as its Learning Management System, and recorded packages can be uploaded to Moodle as SCORM modules, which Moodle breaks down into individual elements. In keeping with the goals of distributing and reusing individual objects, Moodle separates and lists the objects as structured by the SCORM file, making them browseable and downloadable as seen in Figure 6.

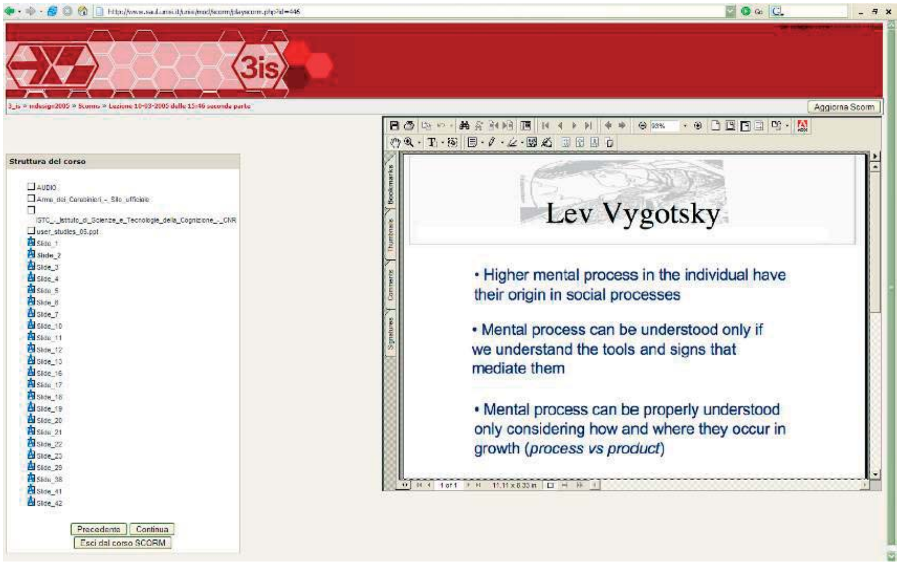


Fig. 6 Results of Moodle Standard SCORM Parsing

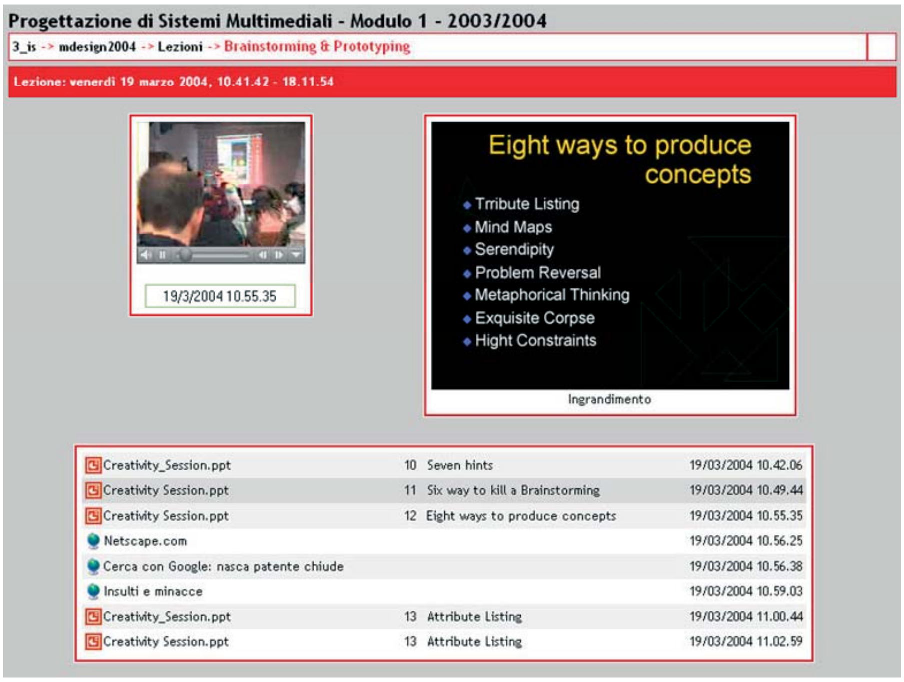


Fig. 7 Results of 3is Parsing Module for Moodle

Figure 7 shows an alternate SCORM parsing created by the 3is Group as a module for Moodle. With the parsing module installed, a reunified interface is created after uploading the SCORM package. The interface, similar to that in SMIL, synchronises audio, video, and screenshots for the navigation of the lecture objects.

## 6 Testing Experiences

With both the original 3is classroom system and the 3is Recorder portable system, little of the resistance seen in the experimental phases occurred, as the software does not request drastic changes in the habits of professors and students. At times, some discomfort was expressed about the lecture being recorded, but after seeing the results, all participants were positive about the outcome. In one case, in which multiple sections of the same lecture were delivered, professors reported to have used the 3is output to review the content in order to improve the lecture for later sections.

## 7 Conclusion

The 3is Recorder provides the first step toward a restructuring of teaching and learning methods. The fact that use of the prototype was well-accepted by both teachers and students indicates the strong possibility for its use and integration into the lecture environment. 3is experimentation allows us to test the heuristics of the two main concepts that were instrumental not only for the design of the physical tools but also for understanding other issues such as the organization of the class and the temporal flow during lectures. Endless projects have attempted to provide technology for collaborative learning, but few have seen significant distribution or created real change in the methods used for university-level pedagogy. We believe that this is largely due to the resistance created by professors and students who do not want to abandon the system to which they are accustomed. It is hoped that by supporting the lecture method in a way that provides new experiences of course content by professors and students, and subsequently providing new functions that edge these experiences toward DKC and SE, the methodology used in the classroom can be opened to these more effective theoretical frameworks.

The next step is to open the software code to the open-source community. With support from additional developers we hope to accomplish the realization of the entire gamut of ideas, creating ultimately an entry point for DKC and SE into the university community.

Experimentation is also an important aspect of refining prototypes. A recent version of the 3is prototype is available at www.saul.unisi.it/3is, and participation by professors and instructors is encouraged. Feedback is welcome and needed as we continue the development of the entire 3is suite of open-source applications for teaching and learning through manipulation of objects.

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