Deliverable D3.1

Methods and Specification for Activity Capturing Tools V1

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1 Executive Summary

This document provides a preliminary set of methods and specifications for activity capturing for the first prototype of NEXT-TELL. Activity Capturing is the component that captures students' performance around learning and assessment activities as designed with the ECAAD methodology and tools. Since the details of the Learning Environment are not to be specified by and in NEXT-TELL, but are instead left to the schools and teachers to decide, the main challenge for Activity Capturing is to deal with the variety of learning tools available today to teachers and students.

Details on the data abstraction approach used in NEXT-TELL are given in this document along with information about the conceptual architecture of the system and the associated NEXT-TELL data processing stack. Methods and interfaces for capturing learning activities from different sources along with related solution paths are presented. Examples for visualising these captured learning activities are provided and methods from process visualisation appear to be a viable path in this direction. This document also provides information on the integration of ePortfolios in the NEXT-TELL system. Finally approaches for video capturing and annotation are presented as the system will be prepared to also accept video clips as a source for evidence on students' learning activities.
2 Introduction

2.1 Purpose of this Document

The purpose of this document is to provide a preliminary set of methods and specifications for activity capturing for the first prototype of NEXT-TELL. This includes a view on the data abstraction approach, methods and interfaces for capturing learning activities from different sources, visualising learning activities, ePortfolio integration as well as a scenario description for video capturing and annotation.

2.2 Scope of this Document

In the overall NEXT-TELL architecture, Activity Capturing occupies a central middle position: it is the component that captures students' performance around learning and assessment activities as designed with the ECAAD methodology and tools (further described in D2.1). Since the details of the Learning Environment are not to be specified by and in NEXT-TELL, but are instead left to the schools and teachers to decide, the main challenge for Activity Capturing is to deal with the variety of learning tools available today to teachers and students. (In the not too far future, the ICT components of the learning environment will be available as (web) services in the "Cloud", making the capturing less of a challenge as it is today.)

![Diagram of the NEXT-TELL architecture]

Hence, this report does not cover specific learning applications that make up the Learning Environment. (We will work with current "de facto standard" for LMS, Moodle, Google Docs for Cloud tools, and Second Live/OpenSim for immersive learning environments. In addition, specific applications that have an API and/or store all learning relevant data on a database server can in principle be considered, but their inclusion will need decisions on the level of individual participating schools.) This report does further not include details on how the learning activity sequences that are to be tracked, monitored and partially stored get designed (ECAAD layer, see D2.1) and how the data as captured get visualised (Open Learner Model layer, see D4.1). Details of the assessment process are also not covered in this report, because the assessment logic is captured in the assessment design (D2.1). What this report does cover is a general architecture for data capture, for visualising activity process data, the requirements for and integration of the e-portfolio component. The report also covers video recording and analysis as a way to capture learning activities that are not taking place (primarily) in digital devices, but in the physical world (e.g., excursions, museum visits, technology classes that work with paper, metal, wood, performing arts classes, physical education).

2.3 Status of this Document

This document is the final version.
2.4 Related Documents

Before, or in conjunction with, reading this document it is recommended to be familiar with the following documents:

D2.1, D4.1, D5.1

2.4.1 References to D2.1, D4.1, D5.1

This deliverable has strong relations in some aspects to D2.1 Specification of ECAAD methodology V1 and D5.1 Methods and Specifications for TISL Components V1.

![Diagram](image)

Figure 1: NEXT-TELL system - complete overview

In D 4.1 Methods and Specifications for Student Model V1 the Learner Models are described in more detail. Information that contributes to the learner model (LM) may originate from a varied number of sources and constitute a disparate variety of forms:

- e-portfolio (video, pictures, documents, weblogs etc.)
- data artefacts (non-portfolio) e.g. Google Docs
- self assessment / appraisal
- (adaptive) learning environment information / other learner models
- social platforms (e.g. Facebook)
3 Scenario and Specification of NEXT-TELL

In this section the scenario of NEXT-TELL is described for providing the background information for the NEXT-TELL system architecture.

3.1 Scenario

Possible interactions between teacher, student, the ECAAD tools and the learning environment that will be covered within the NEXT-TELL project are shown by the following activity diagram (see Figure 2) and described further in section 3.1.1.

Figure 2: Interactions covered in the NEXT-TELL scenarios
3.1.1 **Student-teacher interaction**

A learner engages in (potentially) learning-relevant activities, the outcomes (including intermediate outcomes) of which the student stores in a 2nd generation e-portfolio (LEPP). To the extent that the learning activities are conducted through a software tool (application) or a web service, the recording can take place automatically. For activities that take place in the "physical world" only, processes and product(s) are captured with video recordings, and text annotations as detailed as practically possible. If the tool/service is part of an assignment (i.e., planned in cooperation with a teacher) and takes place on a 'school-owned' system, the activities are logged and available to the teacher, too. Otherwise, the product and process log is stored in the student's private learning repository/e-portfolio and made available only under the student's control.

Once available to the teacher, learning activity logs and outcomes will be analysed and appraised by the teacher and others involved in the appraisal process (e.g., the student herself, peers, parents, software, external experts). The process of appraisal has been planned by the teacher in cooperation with students and perhaps other stakeholders, using the ECAAD Methodology and tools. This planning process involved a planning of the learning activities and environment, the specification of an evidence model as well as a student model.

The outcomes of the analysis/appraisal process are used to update the OLM (Open Learner Model), and in the case of formal assessment to update relevant school records. The OLM together with the e-Portfolio are important elements for the communication process between student, teachers, peers, parents, and other stakeholders, and of course for the planning of further learning. In particular, the teacher will need to communicate (perhaps rapidly) with individual students and groups of students in and outside of the classroom.

Part of the communication will be on meta-assessment answering how to make sense of the various pieces of evidence that were considered in the appraisal, and planning for elements and processes that will go into the next appraisal cycle.

A similar kind of dialogue is conducted with parents, but less frequently. Parents in general will have access in a managed way ("active reports") to data on their children's learning by means of access to LEPP, the OLM, and school records.

3.2 **Bringing the scenario to life**

3.2.1 **Design and Negotiation**

During the Design and Negotiating Phase the NEXT-TELL system needs to support teachers in modelling learning paths for a specified learning goal and negotiating them with their student. Students can see in the NEXT-TELL system their current courses and associated learning goals and proposed learning paths. The NEXT-TELL System supports students in organizing their learning activities and negotiating learning paths with their teacher.

3.2.2 **Learning**

During the Learning Phase the NEXT-TELL system records students' activities. The teachers should be able to decide what they want to record by configuring the NEXT-TELL system. For example some teacher may want to see how long it takes a student to select a book from a literature list, while other teachers don't care. The NEXT-TELL system can propose, in the activity design phase, activities which a teacher might want to record during a certain learning path.
3.2.3 Evaluation and Assessment

During the Evaluation and Assessment Phase the NEXT-TELL system should support teachers in assessing their students by visualizing student’s performance while working on a concrete learning path. This visualisation and suggestion of assessment for their final results supports teachers during the assessment phase the NEXT TELL system. Therefore the system needs to know which activities are pedagogical relevant for a certain learning goal and a certain solution path. This knowledge is created using the NEXT-TELL ECAAD Toolset described in detail in D2.1. The outcome of using the Toolset will be a set of models, used for execution the ECAAD process. As shown in the figure above, there are two types of monitoring that NEXT-TELL needs to support: (a) the monitoring of learning activities, answering the question: Where are my students now in the set learning activity or learning activity sequence? And (b) the monitoring of knowledge development, answering the question: Are my students learning from the activities what I expect them to learn? The later question (b) will be addressed in the Open Learner Model, while supporting the monitoring of learning activities and of the production intermediate as well as final activity products (artefacts in the ePortfolio) is part of the functionality described in this deliverable.
4 NEXT-TELL Execution System

4.1 System Design

According to the described scenarios the system architecture has to provide the backend environment to support the automatic and manual execution of the models. The following figure gives an overview of the components and relations which have been identified. The graphical representation is enhanced by a detailed view on the components and relations identified and propose communication means as well as exchange formats between components.

Figure 4: Conceptual Architecture of the NEXT-TELL system
The main components and relations are described in the following table:

<table>
<thead>
<tr>
<th>ID</th>
<th>Component Name</th>
<th>Description of Component</th>
<th>Implementation Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Assessment Method Calculation Engine</td>
<td>Combine the models with log data and compile a learner model out of it following the defined stack.</td>
<td>The calculation engine interprets the models designed and provides mechanisms to discover bind and queries web-services on a technical level. Technical basis: Service Oriented Workflow Orchestration such as available by BPEL and corresponding engines.</td>
</tr>
<tr>
<td>C2</td>
<td>Activity Sequence Execution Engine</td>
<td>The module which executes the learning activity sequence model designed with the help of the ECAAD Toolset (D2.1)</td>
<td>The activity sequence execution engines uses a model designed in the activity planner (D2.1) as input and executes the model as a stepping mechanism. This is regarded as guidance system also triggering the activity tracking for specific modules attached in the model.</td>
</tr>
<tr>
<td>C3</td>
<td>Domain Model Repository</td>
<td>Repository for storing Domain Model modelled with the ECAAD tools (D2.1)¹</td>
<td>This component is part of the ECAAD environment and is described in detail in D2.1</td>
</tr>
<tr>
<td>C4</td>
<td>Learner Model Repository</td>
<td>Repository for storing Learner Models which are arising during the execution of activities and assessments</td>
<td>This component is initially filled by the ECAAD planner and designer. Enrichment happens in execution time.</td>
</tr>
<tr>
<td>C5</td>
<td>Learning Environment Database(s)</td>
<td>As the main capturing database stores low level log files, activity sequences and other system relevant data</td>
<td>Database of the learning environment holding low level log files for analysis.</td>
</tr>
<tr>
<td>C6</td>
<td>ePortfolio Database</td>
<td>This database stores compiled data used to present the ePortfolio</td>
<td>Database to support the ePortfolio view.</td>
</tr>
<tr>
<td>C7</td>
<td>Activity Model Combination</td>
<td>Combination of assessment and activity model for the ECAAD process</td>
<td>As a semantic component, this service takes care in combining the domain model with the learning data perceived.</td>
</tr>
<tr>
<td>C8</td>
<td>Domain Model</td>
<td>Running (in system memory) Representation of the domain model</td>
<td>The domain model is not a component by itself but mechanisms for persistence and contextualisation are provided in this module (versioning, time-stamping, etc.)</td>
</tr>
</tbody>
</table>

¹ Note that the Domain Model is not an 'operational' component of NEXT-TELL: it is not used to drive assessment and pedagogical decisions. It needs to be represented in the operational architecture nevertheless because of its function in providing support for the assessment negotiation phase.
### Table 1 NEXT-TELL Execution System Components Overview

In the following table the relation between components are identified. Relations represent interfaces needed by the system to exchange data, resulting in an incoming and outgoing interface per relation.

<table>
<thead>
<tr>
<th>ID</th>
<th>Relation name</th>
<th>Description of Relations</th>
<th>Implementation Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>Domain Model Import Interface</td>
<td>Interface for importing the domain model into the Repository C3</td>
<td>This is a receiving interface meaning that the provider of the domain model actively exports the domain model to the interface in the repository. Technology: Web-Service. Format: XML as an exchange format (within a SOAP envelop).</td>
</tr>
</tbody>
</table>

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### Methods and Specification for Activity Capturing Tools V1

<table>
<thead>
<tr>
<th>ID</th>
<th>Relation name</th>
<th>Description of Relations</th>
<th>Implementation Details</th>
</tr>
</thead>
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<tr>
<td>R2</td>
<td>Data Collection Interface(s)</td>
<td>Interface (data adaptors) for collection data into the different databases for assessment outcomes. To be described in detail after deciding for concrete software / tools to use.</td>
<td>This interfaces query data from services and applications used in the scenarios. A generic interfaces definition is made available to the service provider that needs to be implemented to make the data adaptor (wrapper) available to NEXT-TELL. Technology: Web-Service Format: XML format to be received by the data providing service</td>
</tr>
<tr>
<td>R3</td>
<td>Activity Data Collection Interface</td>
<td>Interface to database C5 for capturing learning data</td>
<td>This is a receiving interface meaning that the activity sequence execution engine provides continuously data to the service for storage. This is done as a parallel thread through listeners in the BPEL workflow. Technology: Web-Service Format: well-defined format of interface triggered by engine as a set of parameters (time stamp, URI, User, etc.)</td>
</tr>
<tr>
<td>R4</td>
<td>ePortfolio Database Connector</td>
<td>R4: Interface between e-Portfolio and its database</td>
<td>Internal interface of the ePortfolio system used</td>
</tr>
<tr>
<td>R5</td>
<td>Activity Stepper GUI Interface</td>
<td>R5: Interface between the Activity stepper GUI and its kernel</td>
<td>Internal interface by the Activity Stepper Technology: API calls (exposed as Web-Service additionally) Format: JSON</td>
</tr>
<tr>
<td>R6</td>
<td>Querying calculation results</td>
<td>Interface for the learner model to the combine part of the Assessment Engine</td>
<td>This is a querying interface. The assessment method calculation engine exposes calculated values to the learner model. Technology: Web-Service Format: well-defined format of interface triggered by learner model as a set of parameters</td>
</tr>
<tr>
<td>R7</td>
<td>Learner Model GUI Interface</td>
<td>Interface for displaying data from the Learner Model in the OLM for different purposes</td>
<td>Bidirectional interface to present results from the learner model in the OLM. Technology: TBD Format: TBD</td>
</tr>
<tr>
<td>R8</td>
<td>ePortfolio GUI Controller</td>
<td>Store learning output in e-Portfolio</td>
<td>Internal interface of the ePortfolio system used</td>
</tr>
</tbody>
</table>
### Table 2 NEXT-TELL Execution System Relations Overview

<table>
<thead>
<tr>
<th>ID</th>
<th>Relation name</th>
<th>Description of Relations</th>
<th>Implementation Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>R9</td>
<td>Mashup Central Controller</td>
<td>Interface to a central entry point which may provide login status of a user and a central logging facility</td>
<td>Bidirectional interface to integrate services in a mash up format. Portal functionality integration on a central basis. Technology: TBD Format: TBD</td>
</tr>
<tr>
<td>R10</td>
<td>Activity Model Import</td>
<td>Interface for importing the activity model (sequence for the ADOxx/ADOweb based Framework Stepper)</td>
<td>This is a receiving interface meaning that the provider of the sequence model actively exports the model to the interface of the engine (organisational regarded as a “release”) Technology: Web-Service Format: XML as an exchange format (within a SOAP envelop).</td>
</tr>
<tr>
<td>R11</td>
<td>Assessment Model Import</td>
<td>Interface for importing the Assessment model</td>
<td>This is a receiving interface meaning that the provider of the assessment model actively exports the model to the interface of the engine (organisational regarded as a “release”) Technology: Web-Service Format: XML as an exchange format (within a SOAP envelop).</td>
</tr>
<tr>
<td>R12</td>
<td>Replication and Combination interface</td>
<td>Interface for storing a change of the domain model</td>
<td>Update interface to integrate updates in the model by the learner in the designed environment Technology: Web-Service Format: XML as an exchange format (within a SOAP envelop).</td>
</tr>
<tr>
<td>R13</td>
<td>Feedback Integration Interface</td>
<td>ECAAD feedback circle interface</td>
<td>Update interface to integrate updates in the model by the learner in the designed environment Technology: Web-Service Format: XML as an exchange format (within a SOAP envelop).</td>
</tr>
</tbody>
</table>

The main input for the system architecture comes from the design tools – the NEXT-TELL ECAAD Toolset. Three different models will be created there and have to be used during the execution of the learning and assessment process:

1. Domain Model(KSA)
2. Assessment Model
3. Activity Model as well as the integration/combination with the assessment model
The Learner Model (C9) is a product of the enactment² of the activities and assessments designed with the ECAAD method and represented as respective activity/assessment models.

The domain model (C8) will be stored in a database (C3) using the interface (R1) and updated during the ECAAD process using the interface (R12).

The assessment model is the main input for the Assessment Method Calculation Engine (C1) using the Interface (R11). Outcomes of applying assessment methods will be stored within the Learner Model Repository – defined within the Relation (R2). Running the ECAAD process ends up in updates of the domain model, the assessment model (R6) and in creation of the Learner Model that is also stored in de Learner Model Repository.

The hand-over from the ECAAD Activity & Assessment model to the run-time environment is done in C7.

The NEXT-TELL Portal (C13) provides password protected and encrypted access to all relevant tools and resources / places. At the moment there are three different applications planned:

1. Activity Stepper
2. ePortfolio Frontend
3. Open Learner Model

The activity stepper is the “process clock” of the NEXT-TELL architecture. All activities are triggered from there. It guides the student through the activity model which is derived during the running ECAAD process and received from the activity model repository of the core system using interface (R10).

The activity stepper (D2) and the assessment engine (C1) can be seen as the central components that have access to all databases.

Inside the Learner model repository (C4) and the ePortfolio database (C6) the history and knowledge of the student is stored in a processed, compiled format.

The learning environment Database (C5) is used for storing raw log data to have a time based history of the systems activity. The portal is in general not only the place to provide information to teachers (and students) about their ongoing learning, but is also instrumental for the interaction in NEXT-TELL.

The interaction of the various components may become clearer when we apply a temporal perspective, with three main stages:

1. Design
2. Enactment and
3. Evaluation

as illustrated with the following figure (Figure 5):

---

² We prefer to speak of 'enactment' rather than 'execution', because of the role of human agents, in addition to software components. For instance, many assessment methods will require that part of the assessment is performed by teachers and/or students.
Design/Execution Hand Over

The system architecture of NEXT-TELL as depicted above shows a clear distinction between design and execution time of the system. The handover from design to execution follows an approach to apply standards where available.

Learning Activity Sequence Design -> Execution: The interface exposed to receive the learning activity sequence model builds upon available standards in the domain SCORM for content sequencing or IMS\(^3\) as a process description language. This approach allows the use of any runtime system that supports the specific standards. On a domain independent level, standard mechanisms for human workflows such as BPEL4People, BPMN2BPEL allow an interpretation of activity models in a standardized engine.

Assessment Method Design -> Execution: Due to the lack of standards for assessment calculation/execution NEXT-TELL will a pattern-based approach driven by standardized workflow/service orchestration mechanisms (BPEL, YAWL, etc.). The main objective for NEXT-TELL is to a) provide an environment that is manageable by non-technical experts, allowing configuration, update, change etc. where needed (“pattern approach”) also utilizing on already existing solutions in the domain such as the Moodle Reporting tool.

4.2 Data processing and data abstraction

The following description has a strong link to “Assessment modelling” in Deliverable D2.1.

\(^3\) http://www.imsglobal.org/learningdesign/ldv1p0/imsld_infov1p0.html#1495294
This can be the Open Learner Model or in many cases a basic representation will be delivered by the assessment method as a by-product of the Diagnose and/or Combine step.

Complex diagnosis may be achieved by combining multiple interpretations from the Diagnose step.

Data are interpreted in terms of assessment categories. Calculate Rubric dimensions for assessment.

Data need to be transformed, e.g. normalized; observational data need to be mapped into categories, using check lists, rubrics etc.

Raw data from log files have to be filtered. Different filter configurations to be put on top of the data adopters, returning high quality information (relevant).

Data adaptors to be used, including adaptors to those data that come from humans (teachers, peers, others)

Figure 6: NEXT-TELL data processing stack

This deliverable focuses on the collection part of the stack in Figure 6. The main assumption is that data is available and can be accessed by the NEXT-TELL system through available interfaces. The main objective for the environment to allow an evaluation is the harmonisation of the data structure and access mechanisms. In the following an overview on systems currently foreseen by the use cases and related log/tracking information is provided. This list is regarded as a first draft and validation possibility for the suggested harmonisation on access APIs.

- Second life in TESL: details on logging data are described in D2.1 Use Case 3. Currently 7 patterns use log files within the scenario. All log information is stored in chat protocols (actual chat, but also event driven chat, that is not visible) and accessible through an interface.
- SSLExplorer logging information on activities executed
- ePortfolio (video, pictures, documents, weblogs, diary entries etc.)
- Moodle logging information on activities performed in the system
- Google Docs API for monitoring activity within a document
- Specific data artifacts (non-portfolio) from a Google Docs, Wiki entry or a Skype chat log

In a first step (“Collect”), the data interfaces need to be harmonized. To guarantee openness and extendibility a generic interface is defined that is regarded as a wrapper for available data sources. The main objective is to:

- Allow access through a common interface
- Harmonize result as an XML stream (syntax and semantic of XML is targeted) in the “Filter” step

Any data providing service that is needed for an assessment method calculation has to implement the interface. The result will be a Web-Service that can be triggered and executed by the assessment calculation engine in a similar manner for all data sources.

Syntactical and semantic harmonization of XML stream is supported by a generic XSL transformer and available templates for the translation process.

**Automatically collected versus manually entered data**

Collecting manually entered data is straightforward – for example creating a diary entry in an ePortfolio or creating a document in a shared Google docs space. The manual entry has to be confirmed of the student in the activity stepper. This confirmation triggers a log file entry in the Learning environment DB.
A bigger challenge is to automatically log data from student’s activities. It was decided to have a central entry point to the NEXT-TELL system, where the users have to log in explicitly. The login has to be provided in a portal style which then gives access to all NEXT-TELL related applications and places. Having all users using this central entry point the log files of this component deliver the NEXT - TELL system logs automatically. In chapter 4.3 a software solution will be presented, that fulfils most of the portal – style requirements.

**Example for collecting and filtering data:**

**Task:** Summarizing outcomes of a group work activity

Students have to summarize their work and use different media like Skype chat, WIKI entries, and Google-Docs.

**Collect:** The access wrappers are triggered for skype, wiki and Google Docs. The XML Streams are validated and available

**Filter:** (based on the assumption that the granularity of text and the style of words are different in different media types)

- Skype Chat Filter: look for a phrase like “to sum up”
- Wiki Filter: look for a heading called “summary”
- Google-Docs Filter: look for a chapter called “abstract”

**Example for Analysing log files for user names and dates:**

A student has written a summary using Google Docs and the NEXT – TELL system wants to capture relevant information according to the current course. Therefore the system log files are queried for “username”, a date range and “Google docs”.

If the search result in the system logs delivers a result, the document can be fetched via the Google API directly from Google docs. The document is then filtered and the text of the chapter “abstract” is used for assessment activities. The assessments output will be an entry in the ePortfolio and or the Learner Model of the student.

### 4.3 Capturing learning activities from different sources

The openness inherent to NEXT-TELL, along with the challenges that schools offer for ICT deployment, require a generalizable approach to low level data capturing and logging.

We present one such approach here.

**SSL-encrypted proxy software solution**

SSL-Explorer is one example for SSL-encrypted proxy software and was developed by an open source community for some distinct user – groups:

- **University students** – Connecting often from various locations at various campuses, an SSL VPN solution (especially one that is clientless / browser based) is useful to provide ad-hoc access to webmail and other basic applications. This Scenario fits perfectly for NEXT-TELL needs.
- **Road warriors** – Users who spend a lot of time “on the road” who may connect back into the company on an ad-hoc basis from a number of different computers.
- **Technical support staff** – In many corporations, technical support is often located off site at another branch office. By using an SSL VPN, support can be extended to remote locations.
- **Telecommuters** – By their nature these workers work almost exclusively from their home offices and require dedicated remote working facilities.
- **Collaborative project workers** – By extending remote access across geographical boundaries, the limitations of distance and time zones become less restrictive when working on collaborative projects.
SSL-Explorer is an application written in Java and contains its own database and web server that is used to serve secure web pages in order to access back-end network resources. It acts as a web-based proxy that mediates requests for resources from external users while also providing a means of authenticating these users’ identities.

Network resources that may be externalized by SSL-Explorer using the HTTPS protocol include the following:

- Intranet websites
- Rich web-based applications such as Microsoft Outlook Web Access
- Access to workstation desktops
- File resources published on FTP/SFTP/SMB file mounts
- Other company resources accessible by TCP/IP, e.g. databases and other custom applications

The server can be placed inside a trusted network. Figure 7 shows the network architecture in more detail. When correctly set up it should be technically possible to close all firewall ports apart from the HTTPS/SSL port 443. The SSL Explorer solution provides controlled and authenticated access to services and applications within a network rather than full, unchallenged network access. Figure 3 shows an overview of the architecture of SSL-Explorer.

Taking into account the technical specification of a proxy software like SSL – Explorer compared to the system requirements worked out in the previous chapter makes it obvious to use it for the first prototype of NEXT – TELL. User studies in real life environments in schools will show if all aspects are covered or if the architecture has to be adopted.
The major advantage of using a proxy based solution like this is to have a centralized place for logging student’s activities within the NEXT-TELL system. It provides access to all NEXT-TELL relevant tools and places. As a side effect the abilities to collect usage data of students, teachers and parents interacting with the NEXT-TELL system are provided.
5 Visualising learning activities

Outside of open learner modelling a wide variety of information visualisation techniques are currently used in the presentation of learning activities. A useful framework for understanding the application of information visualisation techniques to learning processes and product data can be found in the work of Harrer et al. (2007). Harrer et al. (2007) propose a process model (CAViCoLA) that describes the process sequence from capture to interpretation. Of particular relevance is the role of visualisation of data. Among them are charts, tag clouds, network diagrams, timelines, and dashboards. In addition to these more graphical representations, it is also possible to present tabular information about learning activities, as suggested by the CAViCoLA model.

In NEXT-TELL, we distinguish between tracing (and visualising) learning activities and tracing (and visualising) knowledge changes. The later are:

- **Charts** include bar chart, histograms, line charts, and scatter plots. These are among the more commonly encountered and can be used to represent a wide variety of data types.

- **Timelines** represent a specialisation of line charts in which the horizontal axis is a time scale. Timelines allow the viewer to see trends over time. So for example, one could visualise a timeline showing the number of students actively engaged in a task.

- **Sparklines** are further refinements of timelines and represent dense, small, high-resolution graphics that are designed to be embedded in text.

- **Tag clouds** are visual representations of the content of some collection of text. In general, tags are either assigned by the author of the text or through some automated procedure. The frequency of each tag in the collection is used to determine the scaling or shading of the tag in the tag cloud, so that more common tags are represented as bigger or more intensely coloured text.

- **Network diagrams** (graphs) show the relationships between elements. The usual approach is to portray elements such as students or documents as nodes and the selectively connect nodes with edges that represent some sort of relationship. Social network analysis, which is used to investigate the relationships between people, can be used to determine which nodes should be connected.

- **Dashboards** are commonly used to provide representations of group processes. Often using Tufte’s (1991) concept of small multiples, dashboards typically use semiotic elements such as traffic lights or speedometers to provide a visual metaphor that is, presumably, easily interpreted by the viewer.

5.1 Process visualisation

There are two kinds of monitoring provided to teachers (and students) in (see Figure 3 above): The monitoring of the progress in learning activities (what students do currently), and the progress in knowledge (what they have learned from engaging in the learning activities).

Visualising progress in learning activities that are not interpreted by diagnostic methods is valuable for many purposes: For the teacher to track progress through tasks (which is in turn important for decision making, in particular timing decisions, and decisions if, when and where (for which students?) to intervene).
An important function for students is to get ‘mirroring’ feedback\(^4\). Visualisations of pedagogically interpreted information (feedback in the strong sense) are provided in NEXT-TELL through the OLM (see D4.1)\(^5\).

Visualisation of un-interpreted mirroring information is provided in NEXT-TELL through the Activity Stepper. The Stepper guides learners through the learning activities specified in a learning activity sequence model, and at the same time keeps track of the performance of students in each of these activities (e.g., records time). At the same time, it provides monitoring information, in a variety of formats. Which formats exactly will be part of the research in NEXT-TELL, since there are many formats possible to render process information.

The first version of the Stepper will include a time-line based visualisation of students’ progress in learning activities, similar to functionality available in, e.g., LAMS. (see Figure 8)

\[\text{Figure 8: Time line based progress visualisation}\]

However, since there is no single “optimal” visualisation of learning activities (because these need to be sensitive to the decision making purpose and context), different to LAMS the process visualisation in NEXT-TELL will be realized in a more flexible manner. We will in particular exploit the fact that the Activity Stepper is essentially a workflow engine, and that the data logged correspond on a certain level of abstraction to workflow events. Hence, the variety of methods for process mining and visualisation can be brought to this task, currently best represented by the PROM process mining framework (www.processmining.org). In addition, in the field of computer-supported collaborative learning, methods have been developed to visualize

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\(^4\) Strictly speaking, to provide ‘feedback’ requires to compare current performance against a target (norm, standard). Often, normative targets are not available, and if they are available the comparison may involve interpretation of the performance in terms of the target. This is an assessment process, and only available in NT in those cases where respective methods have been specified during the learning activity planning phase. However, performance data can be visualized without reference to a target, e.g. by showing frequencies of certain activities over time. In this case, one speaks of ‘mirroring’, as performance information is mirrored back to students without judgment or appraisal.

\(^5\) In the general methodological framework of the ECAAD methodology (see D2.1), a distinction is made between the Evidence Model and the Student Model. Correspondingly, during execution we can distinguish between information in the system about a learner that pertains to the evidence layer and comprises in particular learning activity traces, and information about the learner that belongs to her or his learner model.
group interaction processes (e.g., CALICO project, http://woops.crashdump.net/calico/). Also of relevance are the rapidly growing approaches to web analytics applied to education (ref from Ravi).

Figure 9: Visualisation of group decision making using the PROM framework (Reimann & Frerejean, 2009)

The same methods, on various levels of aggregation, can be fruitfully employed by teachers when inquiring into students’ learning on the TISL level (D5.1).
6 Initial specification of ePMS integration

6.1 Introduction

An electronic portfolio or ePortfolio is a generic term encompassing as wide a range of types and products as there are reasons for using them. The simplest starting point is to consider an ePortfolio as an extension of the paper based-portfolio, bringing with it the obvious benefit of making a portfolio of evidence portable and shareable anywhere that you have Internet access – “the new generation of the three ring binder” JISC My World Project Final Report, Roberts. 2006

In fact, an ePortfolio has a much broader scope as an online collection of reflections and digital artefacts (such as documents, images, blogs, résumés, multimedia, hyperlinks and contact information). Learners and staff can use an ePortfolio to demonstrate their learning, skills and development and record their achievements over time to a selected audience.

"ePortfolios are personal online spaces for students to access services and store work. They will become ever more useful as learners grow up and start moving between different types of learning and different institutions” Secretary of State for Education and Skills, UK, January 2006.

They have the potential to provide a central, linking role between the more rigid, institution-led learning management system and the learners’ social online spaces.

6.2 The ePortfolio in NEXT-TELL

In NEXT-TELL the ePortfolio is used to create and store collections of artefacts to share with fellow students, teachers and peers for appraisal.

The NEXT-TELL ePortfolio is also meant for meeting the needs of established and emerging pedagogy and approaches to learning like the reflective learning. Reflective learning is “a form of mental processing that we use to fulfil a purpose or to achieve some anticipated outcome. It is applied to gain a better understanding of relatively complicated or unstructured ideas” HE Academy Guides for busy academics, no 4, Moon 2005

The ePortfolio allows for building in reflective activities for learners and staff, through blog functions and the creation of ‘Critical incident diaries’ in which users reflect on their learning and experiences over a given period or for an assigned learning activity. For example, this could be reflections on how a student dealt with a problem, or processed some new information on a given topic. This can become a two way process with a tutor or peer providing feedback via the same diary.

Processes that led to the preparation of some artefacts (like reports) in answer to a request of a learning activity and students’ reflections on the process and products are stored in the ePortfolio as activity logs. These logs are available to the teacher through the ePortfolio system or to the other NEXT-TELL tools via web-service.

6.3 Use Cases

In a typical software project, development starts with requirements analysis, and only after the first milestone in this activity is achieved, the functional architecture is being derived from the captured requirements. In the NEXT-TELL context, this approach could not be taken because it would have taken too long to wait for the outcome of the requirements analysis task (this task is going in parallel with the preparation of this document). On the other hand, it was possible to take advantage of the information captured within the already existing systems, which were brought in as starting point for the development process. Examples of these systems are the ePortfolio, the virtual worlds (e.g. Second Life), the LMS, etc. Also, a visionary description of the future NEXT-TELL system (components and functionality) had already been devised as part of the proposal and technical annex work, which was used to guide the architecture design. Therefore, the work on the functional architecture of the activity capturing tools started independently from requirements analysis and took emerging requirements under consideration as soon as they became available. However, during the project meetings and various discussions with the partners it was possible to focus on the following use cases for the
ePortfolio system integration. The use cases form the basis for the initial definition of those interfaces and services offered by the ePortfolio for the learner activity capture.

6.3.1  **Use Case 1: Evidence of an activity**

**Name:** Evidence of an activity  
**Identifier:** UC eP1  
**Description:** The teacher assigned a task to the student which requires a learning activity. The student is asked to give evidence to the learning achievements by preparing a report where s/he details the results of the learning activity.

**Preconditions:**
- The teacher assigned a task  
- The student is registered in the ePortfolio system  
- The teacher is registered in the ePortfolio system

**Post conditions:**
- Report stored in the ePortfolio

**Basic Course of Action:**
1. The student performs the learning activities requested by the task assigned by the teacher  
2. The student prepare the report to document the results achieved  
3. The student creates a new Group for discussing the results with the teacher  
4. The student invites the teacher to join this Group  
5. The student upload the document to the Group  
6. The ePortfolio notifies the teacher that a new document (i.e. the report) has been uploaded

6.3.2  **Use Case 2: Assessment and feedback**

**Name:** Assessment and feedback  
**Identifier:** UC eP2  
**Description:** The teacher assesses the document(s) produced by the student and provides the student with feedback on her/his work. The student, on the basis of the evaluation, performs new activities and updates the report.

**Preconditions:**
- The same as UC eP1  
- The student produce a document as the evidence of the assigned activity

**Post conditions:**
- New report stored in the ePortfolio

**Basic Course of Action:**
1. The student creates a new Group for discussing the results with the teacher  
2. The student invites the teacher to join this Group  
3. The student upload the document to the Group  
4. The ePortfolio notifies the teacher that a new document (i.e. the report) has been uploaded  
5. The teacher comments the report and suggests few tasks to do for completing the work  
6. The ePortfolio notifies the student about the teacher’s comment  
7. The student performs the new learning activities and updates the report accordingly

6.3.3  **Use Case 3: Complex activity and products**

**Name:** Complex activity and products  
**Identifier:** UC eP3
Description:
The teacher assigns a learning activity to the student. Since the activity is complex, the student accomplishes the task step-by-step, as a sequence of sub-activities. For each sub-activity which can happen inside or outside the ePortfolio (for example in the LMS) s/he provides a description of the activity, its completion date (when completed), self-reflection about the activity done and any material produced as the result of the activity. Activities and products are stored in the ePortfolio. Then they are shared with the teacher.

Preconditions:
- The teacher assigned a complex learning activities
- The student is registered in the ePortfolio system
- The teacher is registered in the ePortfolio system

Post conditions:
- Activities and products stored in the ePortfolio

Basic Course of Action:
1. The student starts to describe the first sub-activity
2. The student prepare the report to document the results achieved for the sub-activity
3. Points 1,2 are repeated for any identified sub-activity
4. When finished, the student shares the sub-activity list and products with the teacher
5. The teacher provides a comment to each single activity

6.3.4 Use Case 4: Activities and products in a log

Name: Activities and products in a log
Identifier: UC eP4

Description:
The teacher assigns a learning activity to the student. Since the activity is complex, the student accomplishes the task step-by-step, as a sequence of sub-activities. For each sub-activity s/he provides a description of it, its completions date (when completed), self-reflection about the activity done and any material produced as the result of the activity. Activities and products are stored in the ePortfolio. The student agrees to allow other modules of NEXT-TELL to access to this information via web-service (for example, the web-service can be called by the Assessment Engine for retrieving information useful at the analysis of the data).

Preconditions:
- The teacher assigned a complex learning activities
- The student is registered in the ePortfolio system
- The teacher is registered in the ePortfolio system

Post conditions:
- Activities and products stored in the ePortfolio
- Activities and products retrievable via web-service

Basic Course of Action:
1. Same as points 1-3 of the UC eP3
2. When finished, the student stores the sub-activity list and products in the ePortfolio
3. The student sets the permissions to allow other tools to access and retrieve the activity log and related products via web-service

6.4 Offered Services to other components

As already described in the document, NEXT-TELL will be developed based on a service-oriented architecture. This approach has the advantage that existing, autonomous components can be loosely and flexibly coupled.
The usual service implementation nowadays is web services, which are also employed here for the ePortfolio system. Since it is not the aim of NEXT-TELL to develop a new ePortfolio system from scratch, we will use an existing open source ePortfolio system (likely Mahara) and will extend it to achieve the planned integration.

The first step in defining the architecture was to capture the basic data flows which regard the ePortfolio. As part of this activity, also the core information types exchanged can be identified.

For the Activity Capturing Tools V1, the UC eP4 is the only scenario in which interoperability is required. The technical details in this scenario have been deliberately left vague or were simplified in order to avoid over-complicating the user story and to resist writing a technical solution into the scenario when alternative approaches are possible to achieve the same ends and the implementation details are yet to be completely decided.

From the use case UC eP4 it’s possible to derive the following simple UML Sequence Diagram:

---

Figure 10 shows the simple calls of methods of the ePortfolio web-service performed by an external module to retrieve the activity log of a student who described and stored her/his learning activities in her/his ePortfolio. A necessary pre-condition is that the same student also gave the authorization to the external modules to access via web-service the log file and created artefacts.

---

6 http://mahara.org/
The first step consists of verifying if the student is present in the ePortfolio system. This is done by calling the method `IsePUser.name` can be the name and surname of the student or any other word which can be used to identify uniquely the student (e.g. student id or the email).

If the student has an account in the ePortfolio, the ePortfolio system returns her/his User Id. The User Id can be used to ask the list of all log files stored by that user. Some filter will be used to limit the scope of the search (for example by searching for log files produced after a date or between two dates).

When the ePortfolio returns the list of the identifiers for those logs that matched the search criterion, the external module can ask the log data of interest. It will contain information like the name of the activity, the description of the activity, if completed or ongoing and the reference(s) to the artefact(s) produced. The artefact(s) can be then retrieved by invoking the method `GetArtefact`, with the parameter `ArtefactId`. 
7 Video Capture and Annotation

Further sources for capturing student activities are videos. Within NEXT-TELL we will be prepared to also accept video as evidence on students’ learning activities (e.g. from performing arts classes, virtual TESL sessions in Second Life, or wood work in technology classes). The same video annotation tool will be employed in TISL also to teachers (and peer students) when they need to appraise video documents for knowledge exchanges. These video technologies are increasingly being used to support teachers’ professional development (Borko et al., 2008, Armstrong and Curran, 2006). Further, to support such activity, a range of specially adapted video analysis tools, e.g. EVA, VAST, VITAL and VAT (Rich and Hannafin, 2009) and related research design methods (Sherin et al., 2009) have been developed which aim to guide teachers’ in developing effective approaches to data capture, analysis, interpretation and data-sharing for the purposes of improving teaching, learning and assessment. Such research activity is often conducted as a platform for dialogue between pre-service teachers, their mentors and university tutors to provide evidence for acquisition of standard competencies (Rich and Hannafin, 2008). In other studies, video analysis tools have been used among teachers to promote collaboration on and the dissemination of good practice (Gamoran Sherin and van Es, 2009, Sherin and van Es, 2002, van Es and Sherin, 2006).

![Figure 11: A graphical overview of study procedures using VAT (Rich and Hannafin, 2008)]
The kinds of data captured in video annotation activity are: video clips of classroom activity and interactions; textual transcriptions of such data; time-stamped data for sequential tracking of activity; coded themes around interactions or topics of analysis; teacher reflections and commentaries; related documentation (e.g. student work, lesson plans). Video annotation tools may be standalone or web-based and may incorporate a multiplicity of supporting tools, e.g. ability to display related documents, to annotate video, to highlight and segment relevant activities, to annotate using text or other labelling, the ability to synchronise and view dual video clips synchronously and so on. Teachers may wish to incorporate individual video clips or segments and/or related documents/commentaries/annotations in a teacher ePortfolio as evidence of reflection, progression of professional practice and so on. Video data may be captured using a wide range and variety of tools, from handheld video cameras to mobile phone cameras and even wearable video capture devices designed to capture activity on-the-fly (Yang et al., 2010, Rosenberg et al., 2009).

7.1 Video Analysis Tools for Teacher Inquiry - High level requirements

<table>
<thead>
<tr>
<th>Req. No</th>
<th>Formulation</th>
<th>Rationale</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Available tools should be flexible in design and easy to use and access</td>
<td>Teachers do not have a lot of time to learn how to use tools</td>
<td>Literature, Interviews</td>
</tr>
<tr>
<td>2</td>
<td>Tools should be free, low cost and offer multi-lingual interfaces</td>
<td>Schools don’t have large budgets; EU wide use</td>
<td>Interviews</td>
</tr>
<tr>
<td>3</td>
<td>It should be possible to export data from specific tools or to combine data sets from a range of tools</td>
<td>A bricolage approach will facilitate needs expressed in req. no. 2; teachers may wish to re-use data in reports or individual ePortfolios as evidence</td>
<td>Literature</td>
</tr>
<tr>
<td>4</td>
<td>Privacy, security of video material is required</td>
<td>Video clips of lesson observations will show students and should not be able to accessed publicly without a password</td>
<td>Literature, Interviews</td>
</tr>
</tbody>
</table>
7.2 Use case with a tool like EVA and rubrics annotation

One possible use case that will be investigated in NEXT – TELL is the annotation of videos stemming from Second Life Sessions or from a camera directly placed in a classroom.

This use case is tailored to be used in the TESL Conversation scenario described in D2.1.

For the transformation of the material into a NEXT-TELL assessment suitable format the teacher thinks about rubrics for assessment for a specific role-play in Second Life and annotates this information with the help of a web based tool like EVA, which has the ability to do web based temporal video annotations. The annotation is done collaboratively in real time and stored in html format. The annotations are indexed for better navigation and search facilities (Wong et al., 2009).

![Image of EVA tool](image.png)

Figure 13: Example1 of annotating videos with EVA
Figure 14: A possible interface for rubric definition
8 Summary

This report has presented a preliminary set of methods and specifications for activity capturing for the first prototype of NEXT-TELL. This includes a view on the data abstraction approach, methods and interfaces for capturing learning activities from different sources, visualising learning activities, ePortfolio integration as well as a scenario description for video capturing and annotation. These specifications enable the realisation of the first prototype.
9 References


[Borko et al., 2008] Video as a tool for fostering productive discussions in mathematics professional development. Teaching and Teacher Education, 24, 417-436.


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D3.1
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[Rosenberg et al., 2009] First-Person Videography, a Novel Technology for Teacher Evaluation.
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[Sherin et al., 2009] Selecting Video Clips to Promote Mathematics Teachers’ Discussion of Student Thinking. Journal of Teacher Education, 60, 213.

[Sherin et al., 2002] Using video to support teachers’ ability to interpret classroom interactions. TECHNOLOGY AND TEACHER EDUCATION ANNUAL, 4, 2532-2536.


[Yang et al., 2010] Integrating video-capture virtual reality technology into a physically interactive learning environment for English learning. Computers & Education.


## 10 Glossary

Terms used within the NEXT-TELL project, sorted alphabetically.

### Partner Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>JRS</td>
<td>JOANNEUM RESEARCH Forschungsgesellschaft mbH, AT</td>
</tr>
<tr>
<td>Uni Research</td>
<td>UNI RESEARCH AS, NO</td>
</tr>
<tr>
<td>KMRC</td>
<td>Medien in der Bildung Stiftung, DE</td>
</tr>
<tr>
<td>TUG</td>
<td>Technische Universität Graz, AT</td>
</tr>
<tr>
<td>CBS</td>
<td>Copenhagen Business School, DK</td>
</tr>
<tr>
<td>BHAM</td>
<td>The University of Birmingham, UK</td>
</tr>
<tr>
<td>IOE</td>
<td>Institute of Education, University of London, UK</td>
</tr>
<tr>
<td>EXACT</td>
<td>eXact Learning Solutions SPA, IT</td>
</tr>
<tr>
<td>TALK</td>
<td>Verein offenes Lernen, AT</td>
</tr>
<tr>
<td>BOC-AT</td>
<td>BOC Asset Management GmbH, AT</td>
</tr>
<tr>
<td>BOC-PL</td>
<td>BOC Information Technologies Consulting SP.Ż.O.O., PL</td>
</tr>
<tr>
<td>MTO</td>
<td>MTO Psychologische Forschung und Beratung GmbH, DE</td>
</tr>
</tbody>
</table>

### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS</td>
<td>Baseline Study</td>
</tr>
<tr>
<td>CbKST</td>
<td>Competence-based Knowledge Space Theory Training Course</td>
</tr>
<tr>
<td>CBT</td>
<td>Computer Based Training</td>
</tr>
<tr>
<td>DBR</td>
<td>Design-Based Research</td>
</tr>
<tr>
<td>ECAAD</td>
<td>Evidence Centered Activity and Appraisal Design (builds on the ECD)</td>
</tr>
<tr>
<td>ECD</td>
<td>Evidence Centered Assessment Design (PADI project eg)</td>
</tr>
<tr>
<td>EFL</td>
<td>'English as a Foreign Language'; EFL refers to learning English in a non-English-speaking region, such as studying English in an Asian or Latin American nation. Typically, EFL is learned as part of a student's school curriculum or for career purposes if working for an international corporation.</td>
</tr>
<tr>
<td>ENA</td>
<td>E-Network Assessment</td>
</tr>
<tr>
<td>ePMS</td>
<td>e-Portfolio Management System</td>
</tr>
<tr>
<td>ESL</td>
<td>English as a Second Language</td>
</tr>
<tr>
<td>HCI</td>
<td>Human Computer Interaction</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communication Technology</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>LEPP</td>
<td>Longitudinal Evaluation of Performance in Psychology (2nd generation e-portfolio)</td>
</tr>
<tr>
<td>NEXT-TELL</td>
<td>Next Generation Teaching, Education and Learning for Life</td>
</tr>
<tr>
<td>OLM</td>
<td>Open Learner Model</td>
</tr>
<tr>
<td>PADI</td>
<td>The PADI project aims to provide a practical, theory-based approach to developing quality assessments of science inquiry by combining developments in cognitive psychology and research on science inquiry with advances in measurement theory and technology.</td>
</tr>
<tr>
<td>RA</td>
<td>Requirement Analysis</td>
</tr>
<tr>
<td>RDS</td>
<td>Researcher-led Design Study</td>
</tr>
</tbody>
</table>
Methods and Specification for Activity Capturing Tools V1

SRI Stanford Research Institute

STEM The Science, Technology, Engineering, and Mathematics (STEM) fields are collectively considered core technological underpinnings of an advanced society, according to both the National Research Council and the National Science Foundation

TDS Teacher-led Design Study

TEL Technology Enhanced Learning

TESL Teaching English as Second Language

TISL Teachers Inquiry into Students Learning

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