Deliverable D4.5

Methods and Specification for the Student Model V3

Identifier: NEXT-TELL-D4.5-BHAM-MethodsAndSpecification_StudentModel_v07.doc
Deliverable number: D4.5
Author(s) and company: Matthew Johnson, Susan Bull, Mohammad Alotaibi, Will Byrne (BHAM)
                      Ravi Vatrapu, Kostas Pantazos, Usman Tanveer, Kiran Kocherla (CBS)
                      Carmen Biel, Gabriele Cierniak (KMRC)
                      Barbara Wasson, Cecilie Hansen (UNI)
                      Michael Kickmeier-Rust (TUG), Roland Unterberger (JRS),
                      Michal Kossowski (BOC-PL), Wilfrid Utz (BOC-AT),
                      Fabrizio Giorgini (EXACT)
Internal reviewer: Gerhilde Meissl-Egghart (TALK)

Work package / task: WP4
Document status: Final
Confidentiality: Public
Version 2013-04-03

© NEXT-TELL consortium: all rights reserved
History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Reason of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2013-03-20</td>
<td>Deliverable content collated from drafts (BHAM)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Document ready for internal review (BHAM)</td>
</tr>
<tr>
<td>2</td>
<td>2013-03-21</td>
<td>Review comments added (TALK)</td>
</tr>
<tr>
<td>3</td>
<td>2013-03-25</td>
<td>Review comments addressed (BHAM)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RGFA v3 content from CBS added to document (BHAM)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extra review comments added (BHAM)</td>
</tr>
<tr>
<td>4</td>
<td>2013-03-25</td>
<td>Review comments addressed (CBS)</td>
</tr>
<tr>
<td>5</td>
<td>2013-03-26</td>
<td>Typos removed and proof reading (BHAM)</td>
</tr>
<tr>
<td>6</td>
<td>2013-03-26</td>
<td>Added more information about discussions with end users (CBS)</td>
</tr>
<tr>
<td>7</td>
<td>2013-03-27</td>
<td>Final version (BHAM)</td>
</tr>
<tr>
<td>8</td>
<td>2013-04-03</td>
<td>Some layout optimisations – final version submitted to EC</td>
</tr>
</tbody>
</table>

Impressum

Full project title: Next Generation Teaching, Education and Learning for Life
Grant Agreement No: 285114
Workpackage Leader: Susan Bull, BHAM
Project Co-ordinator: Harald Mayer, JRS
Scientific Project Leader: Peter Reimann, MTO

Acknowledgement: The research leading to these results has received funding from the European Union’s Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 258114.

Disclaimer: This document does not represent the opinion of the European Community, and the European Community is not responsible for any use that might be made of its content.

This document contains material, which is the copyright of certain NEXT-TELL consortium parties, and may not be reproduced or copied without permission. All NEXT-TELL consortium parties have agreed to full publication of this document. The commercial use of any information contained in this document may require a license from the proprietor of that information.

Neither the NEXT-TELL consortium as a whole, nor a certain party of the NEXT-TELL consortium warrant that the information contained in this document is capable of use, nor that use of the information is free from risk, and does not accept any liability for loss or damage suffered by any person using this information.
# Contents

1 Executive Summary ........................................................................................................... 1
   1.1 OLM ............................................................................................................................ 1
   1.2 CoNeTo ....................................................................................................................... 2
   1.3 RGFA .......................................................................................................................... 2
   1.4 ProNIFA ...................................................................................................................... 2
   1.5 Data transfer between tools ....................................................................................... 2
   1.6 Discussions with Stakeholders .................................................................................. 3

2 Introduction ....................................................................................................................... 4
   2.1 Purpose of this Document ......................................................................................... 4
   2.2 Scope of this Document ............................................................................................. 4
   2.3 Status of this Document ............................................................................................ 4
   2.4 Related Documents .................................................................................................... 4

3 Update to OLM Specifications .......................................................................................... 5
   3.1 SMIL Framework Specification .................................................................................. 5
      3.1.1 Extent of the model accessible ............................................................................. 5
      3.1.2 Presentation ......................................................................................................... 6
      3.1.3 Similarity to the underlying representation ......................................................... 7
      3.1.4 Access to uncertainty .......................................................................................... 7
      3.1.5 Role of time .......................................................................................................... 7
      3.1.6 Access method ..................................................................................................... 8
      3.1.7 Access initiative ................................................................................................... 8
      3.1.8 Access to sources of input .................................................................................. 9
      3.1.9 Control over accessibility (to others) ................................................................. 9
      3.1.10 Awareness of the effect of the model on personalisation ................................ 10
      3.1.11 Flexibility of access .......................................................................................... 10
      3.1.12 Centrality of the OLM ...................................................................................... 10
      3.1.13 Evaluation (evidence) ....................................................................................... 10
   3.2 Update: High Level Software Requirements ............................................................. 11
      3.2.1 Visualising the Learner Model ........................................................................... 11
      3.2.2 Information Content of the Learner Model ....................................................... 13
      3.2.3 Updating the Learner Model .............................................................................. 14
   3.3 Additional OLM Requirements ................................................................................... 15
      3.3.1 Discussion Tool ................................................................................................... 15
      3.3.2 Interaction Logging ............................................................................................ 16
   3.4 Update on OLM Usage Scenarios ............................................................................... 16
4 Update to CoNeTo Specifications ................................................................. 17
  4.1 CoNeTo 3.0 .................................................................................................. 17
    4.1.1 Architecture ......................................................................................... 17
    4.1.2 Frontend ............................................................................................... 17
    4.1.3 Backend ............................................................................................... 18
  4.2 CoNeTo Dashboard ................................................................................ 19
    4.2.1 CoNeTo Dashboard – Database ....................................................... 20
    4.2.2 CoNeTo Dashboard – uVis ................................................................. 20
    4.2.3 CoNeTo Dashboard ................................................................. 21

5 Update to RGFA Specifications ..................................................................... 23
  5.1 RGFA Teaching Analytics Tool Technical Description ......................... 23
    5.1.1 RGFA Dashboard - Database .............................................................. 24
    5.1.2 RGFA Dashboard - uVis ................................................................. 25
    5.1.3 RGFA Dashboard ................................................................. 25
  5.2 Updates for RGFA Version 3.0 .............................................................. 29
    5.2.1 New and Revised Interface Features .............................................. 29
    5.2.2 Technical specifications ............................................................... 34

6 Update to ProNIFA Specifications ............................................................... 37

7 Data Transfer between Tools ...................................................................... 38
  7.1 Update on automated input from sources external to NEXT-TELL .......... 38
  7.2 Update on automated data exchange between NEXT-TELL tools .......... 38
  7.3 Update on manual data exchange between NEXT-TELL tools ............... 38

8 Updated Discussions with Stakeholders .................................................. 39
  8.1 OLM Visualisations Supporting Comparison ....................................... 39
  8.2 OLM for Student Self-Monitoring ......................................................... 40
  8.3 Integration of NEXT-TELL tools: Norwegian Trial .............................. 40
  8.4 CoNeTo – Discussions with End Users ................................................. 41
  8.5 RGFA – Discussions with End Users ................................................... 41

9 Summary ..................................................................................................... 42

10 References ................................................................................................. 43

11 Glossary ..................................................................................................... 44

12 Appendix I ................................................................................................. 46
Tables

Table 1: SMILI: Key ..........................................................................................................................5
Table 2: SMILI: extent of the model accessible ................................................................................5
Table 3: SMILI: presentation ...........................................................................................................6
Table 4: visualisations: their type and availability to stakeholder groups ......................................6
Table 5: SMILI: similarity to the underlying representation .............................................................7
Table 6: SMILI: access to uncertainty ..............................................................................................7
Table 7: SMILI: role of time ............................................................................................................7
Table 8: SMILI: access method .......................................................................................................8
Table 9: SMILI: access initiative .....................................................................................................8
Table 10: SMILI: access to sources of input ......................................................................................9
Table 11: SMILI: control over accessibility (to others) ....................................................................9
Table 12: SMILI: awareness of the effect of model on personalisation ..........................................10
Table 13: SMILI: flexibility of access ..............................................................................................10
Table 14: SMILI: centrality of the OLM .........................................................................................10
Table 15: SMILI: evaluation (evidence) ........................................................................................ 10
Table 16: high level requirements: visualising the learner model - updated ....................................11
Table 17: high level requirements: learner model information content - updated ..........................13
Table 18: high level requirements: updating the learner model - updated .......................................14
Figures

Figure 1: CONETO Architecture ................................................................................................................................................................................................. 17
Figure 2. OLM data using D3 ............................................................................................................................................................................................ 18
Figure 3. Supported formats. .......................................................................................................................................................................................... 19
Figure 4. Overview of the implementation of CONETO Website and CONETO Dashboard .......................................................................................... 19
Figure 5. CoNeTo Dashboard Database, represented by tblConeto. tblConeto contains data from some of the OLM tables .................................................................................................................................................................................................................................................. 20
Figure 6. An example of a vis-file and a vism-file opened in notepad .......................................................................................................................... 21
Figure 7. A screenshot of CoNeTo Dashboard ................................................................................................................................................................. 21
Figure 8. An excerpt of uVis formulas of CoNeTo Dashboard ..................................................................................................................................... 22
Figure 9 Overview of RGFA implementation ................................................................................................................................................................. 24
Figure 10. RGFA Dashboard database .............................................................................................................................................................................. 24
Figure 11. An example of a vis-file and a vism-file opened in notepad ...................................................................................................................... 25
Figure 12. A print screen of the first RGFA dashboard for constructs and rating elements analysis. This dashboard uses data collected from a study in a Norwegian school ........................................................................................................................................................................................................................................ 26
Figure 13. A print screen from the vis-file. uVis formulas for a label and a track-bar control .......................................................................................... 27
Figure 14. A print screen of the first RGFA dashboard for constructs and rating elements analysis. This dashboard uses data collected from a study in a Norwegian school ........................................................................................................................................................................................................................................ 28
Figure 15. A print screen from the vis-file. uVis formulas for a checkbox control. As a result, the screen displays a list of checkboxes ........................................................................................................................................................................................................................................................................................................ 28
Figure 16. RGFA 3.0: User Panel ......................................................................................................................................................................................... 30
Figure 17. RGFA 3.0: User Profile Picture Feature .......................................................................................................................................................... 30
Figure 18. RGFA 3.0: Created Grids Window ................................................................................................................................................................. 31
Figure 19. RGFA 3.0: Functionality to Edit, Add, and/or Delete Elements and Triads ........................................................................................................ 31
Figure 20. RGFA 3.0: Image Preview Functionality ......................................................................................................................................................... 32
Figure 21. RGFA 3.0: Grid Definition Page ................................................................................................................................................................. 33
Figure 22. RGFA 3.0: Example of Specific Error Messages ........................................................................................................................................ 33
Figure 23. RGFA 3.0: Code Snippet Showing HTML, CSS & ASP.NET Integration ................................................................................................. 34
Figure 24. RGFA 3.0: Code Snippet of Image Cropping Functionality ......................................................................................................................... 34
Figure 25. RGFA 3.0: Code Snippet of Fetching from Database ................................................................................................................................. 35
Figure 26. RGFA 3.0: Screenshot of Copying Grid Functionality ................................................................................................................................. 35
Figure 27: RGFA 3.0: Code Snippet of Copying Grid Functionality ................................................................................................................................. 35
Figure 28. RGFA 3.0: Code Snippet Illustrative of Database and .Net Coupling ........................................................................................................ 36
Figure 29. Radar chart sketch, showing comparison of competencies from different information sources .................................................................................... 39
Executive Summary

1.1 OLM

OLM release 3 will draw information from multiple sources. Using the API, NEXT-TELL tools such as ProNIFA, and external systems such as OLMlets [Bull, 2010] may contribute competency-based information automatically to student models. Students, teachers and peers may also manually add formative assessments of student competency. The learner model is available for inspection by students, teachers, and also peers (where the student has given their consent for their model to be viewed, and the teacher has allowed this.) In this report we give an update to the specifications for the OLM in terms of the SMILI framework [Bull, 2007] (Section 4.1) and high level requirements from D4.1/D4.3 (Section 4.2). An update on discussions with stakeholders is presented in Section 9. The following are the abstract specifications:

1. Extent of the model accessible. All have access to the model. Students see their own data, and their peers if consent is given (and named or anonymous specified). Teachers can see all information. Information is about student competency and competency level. Learning issues, social issues and preferences are treated by the model in the same way as competencies. Group information is available to teachers by default and available to students if the teacher permits this.

2. Presentation All may see an overview and more detailed components. Visualisations are specified as the following:

<table>
<thead>
<tr>
<th>Visualisation</th>
<th>Graphical</th>
<th>Textual</th>
<th>Student</th>
<th>Peer</th>
<th>Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skill Meter</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Table</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Smiley Face</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Word Cloud</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Histogram</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Interactive Tree Map</td>
<td>✓</td>
<td></td>
<td>*</td>
<td>*</td>
<td>✓</td>
</tr>
<tr>
<td>Anonymised Histogram (proposed)</td>
<td>*</td>
<td>✓</td>
<td>*</td>
<td>*</td>
<td>✓</td>
</tr>
<tr>
<td>Radar Plot (proposed)</td>
<td>*</td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

3. Similarity to the underlying representation. The visualisation of learner model data differs from the model, to represent subtly different aspects of the data, of different levels of complexity, and at different levels of granularity. The format is flexible enough to allow future visualisations to be added and tailored to pedagogical requirements.

4. Access to uncertainty. The OLM should allow the modelling process to be inspected, showing how information is combined and detailing the relative influences of items of evidence.

5. Role of time. All stakeholders can see the current state of the model. Past states (documenting the learning process) are to be visualised as part of WP3 work. Ideas are proposed for visualising future learning states, beyond the work of the current release.

6. Access method. All may inspect aspects of the learner model. Teachers, students and peers may add information. The teacher may edit some items of information. CoNeTo allows for manual and potentially automated editing of evidence data.

7. Access initiative. Each stakeholder may view the model at any point. A notifications mechanism (system initiated) prompts users to inspect the model when changes are made.
by other stakeholders. Future work will look at other stakeholders prompting each other to view learner model content.

8. Access to sources of input. Teachers may see all information and its origins. Students can presently see all information that is relevant to them. Peers may only see information sources if the teacher and student allow this.

9. Control over accessibility to others. The NEXT-TELL OLM will always have access to its data. External systems (e.g., ProNIFA, CoNeTo) will have access if the teacher allows. Students may release their model to their peers. The student is in control over which peers have access to their own data, and whether this is anonymous or named.

10. Awareness of the effect of the model on personalisation. The NEXT-TELL OLM cannot contain an adaptive teaching system component. However there is potential for other external systems to use its data to influence adaptation and personalisation.

11. Flexibility of access. The OLM will continue to support individual differences and preferences. The teacher may enable and disable features.

I. Centrality of the OLM. The OLM is a central tool within NEXT-TELL and may integrate with other systems.

II. Evaluation (evidence). Students, peers, and teachers will continue to evaluate the tool in real settings.

1.2 CoNeTo

CoNeTo’s specifications are revised to allow more in depth information from the OLM database to be represented, displaying more hierarchical and relationship based information. A dashboard is proposed to allow students and teachers the option to drill down into large sections of their data; this is supplement to the negotiation interface itself. This report presents technical specifications and prototypes for the implementation of revisions for release 3. (See Section 5 for more information.)

1.3 RGFA

RGFA specifications are revised based on feedback from teachers in NEXT-TELL partner schools in Denmark and Norway. Technical implementation of RGFA v3 is detailed. Further, RGFA is extended to provide a more dashboard based approach to the inspection of repertory grid data. Additional data controls such as filter by frequency, or filter by triads are added. Data may be visualised in multiple formats, such as a bubble chart or word cloud. Opposite constructs and similar constructs are now able to be grouped and displayed accordingly. (See Section 6 for more information.)

1.4 ProNIFA

ProNIFA’s modelling capabilities provide a link between learner/teaching/assessment software (e.g., Google Docs, particular learning tools, a Moodle course, or a learning session in OpenSimulator) to provide an inferencing mechanism to convert learners’ interactions into competencies. It transforms information for use by other modelling tools and stakeholders within the project. (Please refer to D2.5 for more information.)

1.5 Data transfer between tools

Each of the NEXT-TELL tools involved in modelling student learning has potential for data import and export about student competency. This is already realised in the case of the OLM, ProNIFA and CoNeTo, which exchange information through API interfaces. NEXT-TELL tools may be used as standalone applications, or may be optionally used with others from the set. Other NEXT-TELL tools such as the e-portfolio use information such as competency lists and structures to synchronise current learning content for a given student. Each tool may
be integrated flexibly with another if the data items are compatible and the information for the API is specified in the correct format. (See Section 8 for more information.)

1.6 Discussions with Stakeholders

The current set of OLM visualisations present information for individual competencies separately, and can display information from different data sources one at a time. Discussions with German teachers have highlighted the addition of facilities to compare information from different sources and viewpoints together. Suitable visualisations will allow teachers and students to identify areas of discrepancy: supporting dialogue, promoting reflective practices and permitting informed planning of future learning to take place.

All teachers liked, and were enthusiastic for facilities such as self- and peer-assessments, and were keen for the student to play a key role in the updating of this information for their own self-monitoring purposes. We propose that self- and peer- formative assessment facilities are enabled by default, that students should be able to add information for competencies outside the scope of current learning activities specified by the teacher, and that textual information exchange facilities are made available, to support the self-monitoring purpose of the OLM.

Norwegian teachers’ impressions and uptake of OLM usage are also discussed in Section 9. Please refer to Section 9 for more information.
2 Introduction

2.1 Purpose of this Document

This document provides specification updates for the student modelling and negotiation tools, as at Month 31. Namely we consider the status of development of the OLM, CoNeTo, and RGFA and propose new specifications and specification amendments. Updates to ProNIFA are reported in D2.5. Three tasks are reported here: T4.1 open learner model architecture, T4.2 Representing and visualising learner models, and T4.3 Communicating and negotiating learner models.

2.2 Scope of this Document

This document covers specification amendments and addendums for the months 19 - 31 and documents what can be expect in release 3 of the OLM, CoNeTo, and RGFA tools.

2.3 Status of this Document

This is the final version of D4.5.

2.4 Related Documents

This deliverable builds upon D4.1 and D4.3. It should be read in conjunction with D3.5 and D2.5.
3 Update to OLM Specifications

This section updates the specifications for the open learner model, building on those already reported in D4.1 and D4.3. The Student Models that Invite the Learner In (SMILI) Framework [Bull, 2007] is used as a basis for the tool specification. We report updates in terms of the initial specification, the currently implemented, features which may be enabled and disabled by stakeholders, and future work. Section 3.2 considers high level requirements from D4.1/D4.3 and proposed revisions.

3.1 SMILI Framework Specification

Work is currently focusing on the stakeholders student, teacher, and peer; we therefore provide an update of the SMILI framework definition in terms of these key stakeholders. The definition for other stakeholders may be assumed to be unchanged at this point in the project.

### Table 1: SMILI: Key

| ✓  | specification implemented |
| *  | specification not yet implemented |
| ?  | specification not yet finalised |
| T  | if teacher allows |
| S  | if student allows |
| n/a | not applicable |

#### 3.1.1 Extent of the model accessible

<table>
<thead>
<tr>
<th>1. Extent of the model accessible</th>
<th>Student</th>
<th>Peers</th>
<th>Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Partial</td>
<td>✓ T</td>
<td>✓ T S</td>
<td>✓</td>
</tr>
<tr>
<td>Competency level</td>
<td>✓</td>
<td>✓ T S</td>
<td>✓</td>
</tr>
<tr>
<td>Knowledge level</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Knowledge</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Difficulties</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Misconceptions</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Learning issues</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Social issues</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Preferences</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Other users’ LM (individual)</td>
<td>✓ T S</td>
<td>n/a</td>
<td>✓</td>
</tr>
<tr>
<td>Other users’ LM (group)</td>
<td>✓ T</td>
<td>✓ T S</td>
<td>✓</td>
</tr>
</tbody>
</table>

Initial specifications in D4.1 state that “all stakeholders have partial access to OLMs”. In the present implementation students and teachers can see all data that is relevant to their learning or teaching, and peers can see model content when the teacher and student permit this. Future work may implement a facility for the teacher to keep some elements of learning data private from the student, if this is consistent with the current pedagogical aim.

The NEXT-TELL OLM models competency level information. Additional items of textual information such as guidance and areas of difficulty are collated alongside the model. Competency level information is numerical and is transformed by the modelling process, whereas the textual information captured is of a much finer granularity and is unchanged. It would not be appropriate to amend data in this specific format unless a
domain model was present, and semantic reasoning could take place. “Knowledge level”, “Knowledge”, “Difficulties” and “Misconceptions” are revised to “?” in the above matrix for the next release, as the project is now taking a more flexible competency framework approach, and this will be the focus of the OLM in release 3. (See D2.5 for more information.)

Learning issues, social issues, and preferences may be treated by the NEXT-TELL OLM in the same manner as competencies, and may be modelled in the same way as items configured in the competency framework. They do not receive their own facet within the learner model, as the differentiation from the approach used to model competencies is minimal and user configured. The requirement permitting flexible definition of items to be modelled has facilitated this.

Teachers may see students’ learner models on an individual or grouped basis. Students may always see information from their own student model, and may be permitted to also group information if the teacher allows. Peers will be allowed to view information in a student’s model if the teacher has enabled this facility, and the student has released their model.

### 3.1.2 Presentation

<table>
<thead>
<tr>
<th>2. Presentation</th>
<th>Student</th>
<th>Peers</th>
<th>Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textual (i.e...)</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Graphical (i.e...)</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Other (i.e...)</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Overview</td>
<td>V</td>
<td>*T</td>
<td>V</td>
</tr>
<tr>
<td>Targeted details</td>
<td>*T</td>
<td>V</td>
<td>TS</td>
</tr>
<tr>
<td>All details</td>
<td>V</td>
<td>V</td>
<td>TS</td>
</tr>
<tr>
<td>Support to use</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
</tbody>
</table>

As D4.1 states, each stakeholder may see the general forms of learner model visualisation available and different stakeholders may have different options available. Visualisation methods are revised to be as the following table. Each stakeholder has a mix of graphical and textual presentations. Two extra visualisations are proposed to aid comparison, showing student position with relation to other members of a group (anonymised histogram), or student data from differing sources, for example peer-, teacher-, and student-assessment (radar plot). The teacher will have control over when these are available to the student/peer, as is in alignment with their current pedagogical goal. At the present point in the project, current needs do not demand the learner model be opened in forms other than textual and graphical presentations (e.g. audio, multimedia, haptic). These specifications are as such revised to a “?” in the above matrix.

<table>
<thead>
<tr>
<th>Visualisation</th>
<th>Graphical</th>
<th>Textual</th>
<th>Student</th>
<th>Peer</th>
<th>Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skill Meter</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Table</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Smiley Face</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Word Cloud</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Histogram</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Interactive Tree Map</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Anonymised Histogram (proposed)</td>
<td>*T</td>
<td>*T</td>
<td>*T</td>
<td>*T</td>
<td>*T</td>
</tr>
<tr>
<td>Radar Plot (proposed)</td>
<td>*T</td>
<td>*T</td>
<td>*T</td>
<td>*T</td>
<td>*T</td>
</tr>
</tbody>
</table>

Each stakeholder will be able to access an overview presentation of the information (a higher granularity). In the case of the peer this will be when the teacher has permitted this to be done anonymously, or when the student has released their model. The mechanism by which a student may release the content of their model
(anonymously or named) allows for targeted information to be released, where the student makes the decision about the informational content. At present the student may see the entire content of information held about them in their learner model. Future work will look at ways in which teachers may focus the learner towards aspects of the learner model information that are most relevant to the current education goal, thus targeting the learner towards specific details.

Each stakeholder currently receives limited passive support in the form of a help section on every page, descriptive comments within the page, and the use of keys where these are appropriate. Future work may consider placing further instructions on the screen during first use to point the user towards features, in a tutorial fashion (similar to when Google releases new updates). Tutorials and training materials external to the OLM system remain available and up to date.

3.1.3 Similarity to the underlying representation

<table>
<thead>
<tr>
<th>Table 5: SMILI: similarity to the underlying representation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3. Similarity to the underlying representation</strong></td>
</tr>
<tr>
<td>Identical</td>
</tr>
<tr>
<td>Student</td>
</tr>
<tr>
<td>Peers</td>
</tr>
<tr>
<td>Teacher</td>
</tr>
</tbody>
</table>

No change. The visualisation of the learner model differs from the underlying representation in the database to allow the user to easily understand its meaning. The information may be accessed flexibly, and so is combined from different sources at the point of access. This is to display information relevant to the stakeholder’s current informational needs. External representations of the model’s content show subtly different aspects of the data, and may be of different levels of abstraction and granularity. The underlying representation is flexible enough to allow for future representations of its content tailored to different pedagogical requirements (e.g. comparisons between teacher- and student- assessments)

3.1.4 Access to uncertainty

<table>
<thead>
<tr>
<th>Table 6: SMILI: access to uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4. Access to uncertainty</strong></td>
</tr>
<tr>
<td>Complete</td>
</tr>
<tr>
<td>Student</td>
</tr>
<tr>
<td>Peers</td>
</tr>
<tr>
<td>Teacher</td>
</tr>
</tbody>
</table>

The OLM shows a screen detailing the modelling process, how information is combined, and stating the extent to which items of evidence have contributed to the state of the model for any given element of visualisation. This description of the modelling process details the weightings assigned to individual elements of evidence. The reliability of the information may be determined from its constituent sources. It is important that all stakeholders have at least partial access to where information has come from, in order to interpret and trust the external representation of the student model. Future work may allow for specific reliability factors to be assigned to individual evidence sources to provide a further quantitative description of modelling reliability.

3.1.5 Role of time

<table>
<thead>
<tr>
<th>Table 7: SMILI: role of time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5. Role of time</strong></td>
</tr>
<tr>
<td>Previous</td>
</tr>
<tr>
<td>Current</td>
</tr>
<tr>
<td>Future</td>
</tr>
</tbody>
</table>

© NEXT-TELL consortium: all rights reserved
D4.1 specifies that each stakeholder will have access to “past and predicted future states”. Each stakeholder has access to learner model content presenting the current state of student understanding. Previous states of the learner model are logged in the learner model database, and are visualised separately as a learning process visualisation (see D3.5), showing learners’ competencies in a temporal dimension. There is potential for the teacher to allow students and peers access to this information if it is suited to the current educational purpose.

Future work may look at predicting future learner model states based on learning progressions and known future knowledge acquisition related attributes.

3.1.6 Access method

<table>
<thead>
<tr>
<th>6. Access method</th>
<th>Student</th>
<th>Peers</th>
<th>Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspectable/view</td>
<td>√</td>
<td>√ T</td>
<td>√</td>
</tr>
<tr>
<td>Co-operative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sys persuade user</td>
<td>√ T</td>
<td></td>
<td></td>
</tr>
<tr>
<td>User persuade sys</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>User add evidence</td>
<td>√ T</td>
<td>√ T</td>
<td>√</td>
</tr>
<tr>
<td>Negotiated</td>
<td>√ T</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Editable</td>
<td>√ T</td>
<td>√ T</td>
<td></td>
</tr>
</tbody>
</table>

No change. All stakeholders can inspect learner model data. For peers, this is where the teacher and student have allowed this. Each of the key stakeholders (student, peer, and teacher) can add information to the model. In the case of students and peers, this is where the teacher has permitted this action to take place. Furthermore, teachers may directly edit and delete pieces of evidence from the learner model.

Students may influence the model’s content using NEXT-TELL CoNeTo (Communication and Negotiation Tool). CoNeTo facilitates an evidence based negotiation dialogue between the student and teacher over the model’s content. The teacher may manually update the model’s content following the negotiation process. Thus, this is currently a manual negotiation update. Future work will look at the potential for making this into an automated process, using the OLM API.

3.1.7 Access initiative

<table>
<thead>
<tr>
<th>7. Access initiative</th>
<th>Student</th>
<th>Peers</th>
<th>Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>System initiated</td>
<td>√</td>
<td>√ T</td>
<td>√</td>
</tr>
<tr>
<td>Self-initiated</td>
<td>√</td>
<td>√ T</td>
<td>√</td>
</tr>
<tr>
<td>Other initiated (student)</td>
<td>n/a</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Other initiated (peer)</td>
<td>*</td>
<td>?</td>
<td>*</td>
</tr>
<tr>
<td>Other initiated (teacher)</td>
<td>*</td>
<td>*</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Minimal change. D4.1 outlines that each stakeholder may initiate inspection of OLM information that they have access privileges to view, at any point during interaction with the system. Supplement to this, each stakeholder may be prompted to view the learner model by another, if this is perceived to suit the current learning setting.

The present version of the OLM software allows each stakeholder to view OLM information at any point (in the case of peers, this is when the teacher has enabled this feature and the student has released their learner model.) When new information is added to the learner model (e.g. self-assessment, peer-assessment, and teacher assessment) a notification is sent to the student/teacher/peer who is the recipient of the information. The system thus prompts the stakeholder to view their learner model by identifying that a change has taken place. Manual prompts by each stakeholder to view the learner model of another is future work.
3.1.8 Access to sources of input

Table 10: SMILI: access to sources of input

<table>
<thead>
<tr>
<th>8. Access to sources of input</th>
<th>Student</th>
<th>Peers</th>
<th>Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Partial</td>
<td>✓ T</td>
<td>* TS</td>
<td>✓</td>
</tr>
<tr>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aggregated</td>
<td>✓</td>
<td>* TS</td>
<td>✓</td>
</tr>
<tr>
<td>System</td>
<td>✓</td>
<td>* TS</td>
<td>✓</td>
</tr>
<tr>
<td>Student</td>
<td>✓</td>
<td>* TS</td>
<td>✓</td>
</tr>
<tr>
<td>Peer</td>
<td>✓</td>
<td>* TS</td>
<td>✓</td>
</tr>
<tr>
<td>Teacher</td>
<td>✓</td>
<td>* TS</td>
<td>✓</td>
</tr>
<tr>
<td>Other program</td>
<td>✓</td>
<td>* TS</td>
<td>✓</td>
</tr>
</tbody>
</table>

Teachers may see all underlying evidence that contributes to a student’s learner model. As information comes from a variety of sources, the full extent of inferences made by third party systems may not be present, and so this may be considered partial access. Similarly a student by default can see the full content of inferences in their model. The student may grant their peer access to their learner model, if the teacher has permitted this.

Evidence from each source is available to each stakeholder in both an aggregated form and its constituent parts. Future work will enable the peer to see underlying evidence, if this is deemed appropriate by the teacher, and may also include work to restrict access to the evidence layer, if this fits with the current pedagogical goal.

3.1.9 Control over accessibility (to others)

Table 11: SMILI: control over accessibility (to others)

<table>
<thead>
<tr>
<th>9. Control over accessibility (to others)</th>
<th>Student</th>
<th>Peers</th>
<th>Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete</td>
<td>✓ T</td>
<td>* TS</td>
<td>✓</td>
</tr>
<tr>
<td>Partial</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System</td>
<td>n/a</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Student</td>
<td>✓ T</td>
<td>n/a</td>
<td>?</td>
</tr>
<tr>
<td>Peer</td>
<td></td>
<td>n/a</td>
<td>?</td>
</tr>
<tr>
<td>Teacher</td>
<td>✓ T</td>
<td>n/a</td>
<td>✓</td>
</tr>
<tr>
<td>Other program</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In agreement with D4.1, the teacher has ultimate control over access privileges for student data for which they are responsible. The teacher may always see the full extent of the student data, and may enable features to allow students to share data with their peers, if this is in alignment with the current educational context.

The NEXT-TELL OLM will always have access to all the student data it contains, although the teacher may instruct the system to disregard items of data. Other NEXT-TELL tools, such as CoNeTo or ProNIFA, will have access to a student's data if the teacher has allowed this.

Teachers may allow students the facility to release the content of their learner models to each other, although they cannot override the final decision of the student about whom they share their model data with, and whether they do this anonymously or with an association with their name.

In the present implementation, a teacher may not see student data that is associated with another teacher’s provision of learning, even if they share a student. A given teacher may only see aspects of the student’s learning that are relevant to their educational relationship with the student.
3.1.10  Awareness of the effect of the model on personalisation

Table 12: SMILI: awareness of the effect of model on personalisation

<table>
<thead>
<tr>
<th>10. Awareness of the effect of the model on personalisation</th>
<th>Student</th>
<th>Peers</th>
<th>Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Partial</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>None</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

No change. The NEXT-TELL OLM cannot contain an adaptive teaching system component. However, the data held in the learner model may be connected to through the API. In this way the NEXT-TELL OLM can form a data source for other systems who wish to use this information for adaptation or personalisation purposes. For example ProNIFA could use the learner model’s competency data and may send it back to OpenSim for adaptation purposes, or for the teacher to adapt the course of interaction.

3.1.11  Flexibility of access

Table 13: SMILI: flexibility of access

<table>
<thead>
<tr>
<th>11. Flexibility of access</th>
<th>Student</th>
<th>Peers</th>
<th>Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete</td>
<td>v</td>
<td>v</td>
<td>v</td>
</tr>
<tr>
<td>Partial</td>
<td></td>
<td>v</td>
<td>* T</td>
</tr>
<tr>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Minimal change. The OLM will continue to support individual differences and preferences, with regard to information access, for example, addressed through the use isomorphic presentations of the same underlying information. The teacher may decide to enable or disable informational features as best suits each stakeholder’s current aims of engagement. For example, allowing students to release their models to their peers, or permitting students to submit self-assessments.

3.1.12  Centrality of the OLM

Table 14: SMILI: centrality of the OLM

<table>
<thead>
<tr>
<th>12. Centrality of the OLM</th>
<th>Student</th>
<th>Peers</th>
<th>Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can be used as central focus or additional support</td>
<td>v</td>
<td>v</td>
<td>v</td>
</tr>
</tbody>
</table>

No change. The OLM is a key tool within the NEXT-TELL project for each of the above stakeholders. As initially envisaged, it may be used on its own or in conjunction with other NEXT-TELL tools.

3.1.13  Evaluation (evidence)

Table 15: SMILI: evaluation (evidence)

<table>
<thead>
<tr>
<th>13. Evaluation (evidence)</th>
<th>Student</th>
<th>Peers</th>
<th>Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deployment in real settings</td>
<td>v</td>
<td>v</td>
<td>v</td>
</tr>
</tbody>
</table>

No change. Students, peers, and teachers will continue to be involved in the evaluation of the tool in real settings. The OLM is prepared and available for school studies.
3.2 Update: High Level Software Requirements

Development of the OLM is in alignment with the specifications in Appendix 1 of D4.1. No updates to these high level requirements were proposed in D4.3. In this deliverable we propose five revisions, in requirements D4.1:2, D4.1:6, D4.1:13, D4.1:15, and D4.1:17.

3.2.1 Visualising the Learner Model

<table>
<thead>
<tr>
<th>No.</th>
<th>Formulation (D4.1)</th>
<th>Rationale (D4.1)</th>
<th>Update and Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>D4.1:1</td>
<td>Open learner model presentations (visualisation) should be appropriate for the experience and skill level of each stakeholder.</td>
<td>Each stakeholder is intended to use the information in a different way and will be of a different ability/background. All must be able to use the OLM for their needs.</td>
<td>Visualisations of different complexity are available to each stakeholder. Two more are proposed that are of greater detail. These are for optional use. Visualisations are presented as alternatives that may be viewed in juxtaposition.</td>
</tr>
<tr>
<td>D4.1:2</td>
<td>The teacher is ultimately in control of when learner model information is released to students. Access needs to be reconciled with issues of trust and consistency.</td>
<td>Information should be available as is pedagogically appropriate at a given time. The partial availability of information must not detract from the usability and aims of the system.</td>
<td>The teacher may enable and disable features in the OLM, governing the different types of inspection (e.g. of peer models). Revision. Information in the student’s own OLM is always available to the student for inspection, although some of the more detailed components may be optionally turned off by the teacher.</td>
</tr>
<tr>
<td>D4.1:3</td>
<td>Information will encompass a wide range of subjects, modules, topics and concepts. These will need to be displayed hierarchically, in an appropriate form for each stakeholder.</td>
<td>The scope of interest for information will vary between different stakeholder groups and between different activities. The open learner model may be used for different purposes at different times. The hierarchical structure of information will ensure clarity is retained.</td>
<td>Information includes subjects, units of work, activities, competencies, groups and students, presented together for comparison and available individually. Information is displayed hierarchically where the view type supports this.</td>
</tr>
<tr>
<td>D4.1:4</td>
<td>Quick navigation to parts of the model recently inspected would be beneficial.</td>
<td>Stakeholders may wish to access the same part of the model in quick succession (e.g. during a learning activity).</td>
<td>The OLM remembers the last model inspection made by the user, and starts from this point when the page is returned to. Adding a list of recent searches could improve this functionality.</td>
</tr>
<tr>
<td>No.</td>
<td>Formulation (D4.1)</td>
<td>Rationale (D4.1)</td>
<td>Update and Revisions</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------</td>
<td>-----------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>D4.1:5</td>
<td>The system must be able to justify claims it makes about the student, i.e. it must present detailed evidence, as is appropriate.</td>
<td>This reconciles issues of trust and clarity, and permits substantiated general claims to be made about students. Detailed information may be optionally inspected, as is appropriate to a task.</td>
<td>It is possible to drill down to the evidence layer, and also for a description of the modelling process to be inspected.</td>
</tr>
<tr>
<td>D4.1:6</td>
<td>In addition to current model information, the system should show historical information and be able to make predictions about future knowledge levels.</td>
<td>This helps facilitate planning, promotes reflection and supports various aspects of metacognition such as student self-assessment.</td>
<td>Current information is shown. Historical information forms part of WP3 work to visualise the learning process. Comment. Predictions and availability of historical information is not present in the OLM. There is potential for this to be included at a later date.</td>
</tr>
<tr>
<td>D4.1:7</td>
<td>The OLM interface must support different granularities of inspection.</td>
<td>Dependent upon the short term goals of the stakeholder, sometimes summary information is required, sometimes more detail is helpful.</td>
<td>The OLM presents high level overviews, and information down to canonical components is available. A filter mechanism exists to tailor the search results.</td>
</tr>
<tr>
<td>D4.1:8</td>
<td>Avoid information overload, but allow sufficient detail to be inspected, if required.</td>
<td>Information overload can cause confusion and demotivation on the part of the stakeholder. Detailed information needs to be available if required for a specific task.</td>
<td>High level abstraction OLM visualisations are available. Information can be drilled down into to get at the evidence layer, together with information about the modelling process. A filter mechanism is available to tailor results.</td>
</tr>
<tr>
<td>D4.1:9</td>
<td>OLM presentations must account for individual differences (particularly amongst students, parents and teachers).</td>
<td>Each stakeholder group is not homogeneous. This is particularly the case with students and parents. Each group will contain a range of backgrounds, skills and experiences in addition to different approaches to learning and preferences.</td>
<td>OLM views of different complexity are implemented. Each stakeholder has a set suited to their needs and alternatives are available. Each show subtly different aspects of the information, and may be used on their own or together with others.</td>
</tr>
<tr>
<td>D4.1:10</td>
<td>Visualisations must be intuitive to use.</td>
<td>The open learner model should not confuse its users. Good usability is important for sustained usage.</td>
<td>Implemented visualisations follow standard metaphors, and are presented with supporting information, such as keys.</td>
</tr>
<tr>
<td>No.</td>
<td>Formulation (D4.1)</td>
<td>Rationale (D4.1)</td>
<td>Update and Revisions</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>D4.1:11</td>
<td>The visualisation mechanism should be quick to load in the web browser.</td>
<td>Good usability is important to retain users’ engagement with the system.</td>
<td>All features in the OLM load within several seconds. Data transfer is minimal. Algorithms execute on the server side wherever possible, and cached information is retained to enable quick display of information. Some database information is denormalised to reduce query times.</td>
</tr>
</tbody>
</table>

### 3.2.2 Information Content of the Learner Model

#### Table 17: high level requirements: learner model information content - updated

<table>
<thead>
<tr>
<th>No.</th>
<th>Formulation (D4.1)</th>
<th>Rationale (D4.1)</th>
<th>Update and Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>D4.1:12</td>
<td>Information should only be modelled if it is intended to be used.</td>
<td>For reasons of ethics, rights of access to information, software efficiency and data storage, data should not be captured without purpose.</td>
<td>Everything captured is available for inspection by the teacher. All information is used.</td>
</tr>
<tr>
<td>D4.1:13</td>
<td>The format in which the learner model is kept must be flexible and able to encompass new information formats</td>
<td>The learner model tools may be used beyond the scope of the project and may adapt to any changes in specification that might occur. Issues of extensibility, flexibility and future proofing are important.</td>
<td>The OLM can cope with numerical relating to student competencies. Textual information is collated alongside the model, although is not transformed by the modelling process. The API interface allows information of different formats to be patched into the system. <strong>Future work. Extra supported information formats may need to be added, e.g. to support formats such as the output from repertory grid analysis.</strong></td>
</tr>
<tr>
<td>D4.1:14</td>
<td>Finer grained model information should be kept, which may then be abstracted to the level to which it is to be externalised.</td>
<td>The system is able to give justification of its inferences, without presenting information overload. Detail may be inspected in contexts in which it is useful.</td>
<td>Information is stored in the repository in its canonical components. Several tables record different aspects of the data e.g. historical states, raw evidence, cached states.</td>
</tr>
<tr>
<td>No.</td>
<td>Formulation (D4.1)</td>
<td>Rationale (D4.1)</td>
<td>Update and Revisions</td>
</tr>
<tr>
<td>-----</td>
<td>-------------------</td>
<td>-----------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>D4.1:15</td>
<td>Single pieces of information may update multiple parts/facets of the model.</td>
<td>Different inferences can be made about a single piece of evidence.</td>
<td>A single piece of evidence can be associated with the update of multiple competencies, and comprise numerical and textual content. <strong>Comment.</strong> The software calls the update routines multiple times, treating the single inference as multiple pieces of information, in this instance.</td>
</tr>
<tr>
<td>D4.1:16</td>
<td>Information from different parts of the model may be combined to create secondary inferences.</td>
<td>Some inferences may result from the triangulation of more fine grained metrics. (e.g. time on task, competency and confidence to infer affective motivational states)</td>
<td>Numerical information is combined at different levels of abstraction, according to the modelling process. Textual information is collated.</td>
</tr>
<tr>
<td>D4.1:17</td>
<td>The format/language of the learner model must be flexible enough to represent qualitative and quantitative information.</td>
<td>The learner model is required to hold information about competencies in addition to epistemic beliefs and 21st Century skills.</td>
<td>Numerical information is modelled and textual information is collated. <strong>Revision.</strong> Because of the introduction of RGFA, the originally envisaged epistemic information now takes a lesser role in the project.</td>
</tr>
</tbody>
</table>

### 3.2.3 Updating the Learner Model

**Table 18: high level requirements: updating the learner model - updated**

<table>
<thead>
<tr>
<th>No.</th>
<th>Formulation (D4.1)</th>
<th>Rationale (D4.1)</th>
<th>Updates and Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>D4.1:18</td>
<td>The teacher should have control over configuration settings of the learner model (e.g. information weightings).</td>
<td>The same information contributing to the learner model may be more or less relevant, depending upon a current pedagogical strategy.</td>
<td>The teacher has control over configuration settings, and may enable and disable features.</td>
</tr>
<tr>
<td>D4.1:19</td>
<td>The learner model needs to comprise current information that is weighted accordingly.</td>
<td>The learner model is a model of the current state of the learner and so recent evidence is considered to be more important. Different information sources provide different qualities of information; the data should not be distorted through addition of something with lesser relevance. Weightings may also depend on pedagogical aspects of the teacher’s chosen strategy.</td>
<td>The content of the learner model is always current. Weighting mechanisms define the influence information has, and recent information is counted with greater influence, where multiple pieces of information exist.</td>
</tr>
</tbody>
</table>
### D4.1: Formulation (D4.1) vs. Rationale (D4.1) vs. Updates and Revisions

<table>
<thead>
<tr>
<th>No.</th>
<th>Formulation (D4.1)</th>
<th>Rationale (D4.1)</th>
<th>Updates and Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>D4.1:20</td>
<td>Teachers should be able to override inferences, in specific cases.</td>
<td>Teachers should be able to edit the learner model. They perform an administrator role in the learning process.</td>
<td>Teachers are able to edit and delete pieces of evidence.</td>
</tr>
<tr>
<td>D4.1:21</td>
<td>Key stakeholders should be able to add information that the system does not currently have, or cannot infer.</td>
<td>Classroom deployed technology cannot automatically infer many aspects of the human affective state that humans can readily interpret. The NEXT-TELL system will also rely on accounts and evidence for activities that take place away from a computerised environment.</td>
<td>Manual information input is possible for students, teachers and peers.</td>
</tr>
<tr>
<td>D4.1:22</td>
<td>The learner model / modelling process must be able to contain/deal with conflicting and incomplete information.</td>
<td>Learners will demonstrate conflicting understanding. Different learners may contribute different types of information depending upon activities specified, their particular class group and their engagement outside of the classroom environment.</td>
<td>The learner model can deal with conflicting inferences, and works with the information it has available.</td>
</tr>
<tr>
<td>D4.1:23</td>
<td>The learner model must be able to store information and viewpoints from key stakeholders separately.</td>
<td>Open learner models for different stakeholders will have different access privileges. Information from different sources may have different weightings, in different contexts. Particularly with epistemic information, it is important to be able to discern one stakeholder’s account from another.</td>
<td>Information and evidence is flagged in the OLM database as originating from a specific stakeholder. This information is used when data is presented to the user.</td>
</tr>
<tr>
<td>D4.1:24</td>
<td>Model updates should be instantaneous.</td>
<td>The model information should always be current. To maintain engagement and usability of the NEXT-TELL system, information needs to be available immediately when it is requested.</td>
<td>Updates to the learner model propagate through the modelling process with immediate effect.</td>
</tr>
</tbody>
</table>

### 3.3 Additional OLM Requirements

Further to specifications covered by the SMILI Framework [Bull, 2007], we consider two additional areas of specification for facilities to be made available in release 3 (August 2013).

#### 3.3.1 Discussion Tool

The NEXT-TELL OLM tool is to provide a discussion facility, allowing students and teachers to communicate and discuss the content of their learner models. The data from the discussion itself does not contribute to the learner model, but the facility allows learners to consider issues surrounding the model’s content in a collaborative way. This is to promote student reflection in terms of competencies held, and allows for collaborative sensemaking to take place.

The tool should allow students to communicate with their peers and teacher about specific competencies with which they are currently working. This should allow for both synchronous and asynchronous communication, and allow conversation history to be retrievable. The discussions should be available by default to the whole group of peers. Whereas information in student models is only available to peers once the student has given...
their consent for the information to be viewed, information in the discussion is available to all, allowing for real
time dialogue.

3.3.2 Interaction Logging

In order for the project to capture information about the way in which the OLM is used, we propose to keep
interaction logs, recording mouse clicks, page loads, and items of data representative of usage (e.g. particular
visualisations used). The interaction logs will be required to categorise the information, and record the time of
events to the nearest second. The data may then be anonymised and used to provide a quantitative description
of usage for evaluation purposes. Future work could consider making a simplified version of these log files
available to teachers, to describe their students’ use of the OLM, as part of WP3 learning process visualisation
work.

3.4 Update on OLM Usage Scenarios

This report focuses on the stakeholders student, peer, and teacher. No amendments to scenarios for these
stakeholder groups are proposed at the time of this deliverable. Similarly, scenarios for parents, administrators,
policy makers and researchers should be considered unchanged. Scenarios of usage may be revised in D4.7.
Please refer to D4.3 for more information on usage scenarios.
4 Update to CoNeTo Specifications

This section reports on the updates to the specification of the Communication and Negotiation Tool (CoNeTo) to incorporate a state-of-the-art visualisation library for data-driven documents. Further, it reports on specifications for, and prototype implementations of, dashboards that allow students and teachers to explore and negotiate their OLM data using visual analytics techniques such as filtering, grouping, overview/detail, or linking/brushing.

4.1 CoNeTo 3.0

CoNeTo\(^1\) is a web-based application that is built using HTML5, JavaScript and ASP.Net. HTML5 and JavaScript are primarily used for the front-end whereas ASP.net serves as the backend providing basic server side functionality. CoNeTo facilitates an artefact-centred discussion of the OLM between students and teachers.

4.1.1 Architecture

The general architecture of CoNeTo 3.0 is an evolution from the previous version. It consists of a Web layer, which is responsible for the user interaction and visualisation, and a Model layer that provides communication with the various supported formats through an IServiceProvider interface that now includes the D3.js library for data-driven documents. The high level architecture is illustrated in Figure 1.

![Figure 1: CONETO Architecture](image)

The following sections briefly describe the new specifications and implementations of the frontend and the backend functionality respectively.

4.1.2 Frontend

The frontend is designed using HTML5 and JavaScript. The new specification and implementation supports the visualisation of the OLM data consisting of activities and competencies is done using D3.js\(^2\), which is a

---

\(^1\) The NEXT-TELL Communication and Negotiation Tool

\(^2\) [http://d3js.org/](http://d3js.org/)
JavaScript library utilising HTML, SVG and CSS for manipulating documents based on data. This ensures access to full capabilities of modern browsers without dependency on any proprietary framework. A snapshot of the OLM represented as a D3 document as provided in Figure 2.

![Figure 2. OLM data using D3](image)

### 4.1.3 Backend

The design specification for the backend consists of the *Model layer* and the *IServiceProvider interface* as well as the concrete implementations for the interface.

The *IServiceProvider* exposes methods to save and load information to and from the corresponding repositories, which maybe refer to a locally residing database, local file system or a database exposed through a web service. There are three concrete implementations, one each for each of the supported formats, which are OLM (the xml format provided by OLM), Diagram (the native xml format of the CoNeTo web application) and the newly implemented D3 (json format supported by the D3 framework).

The back end also provides methods enabling conversion between the various supported formats. An illustration is provided below.
The json format for D3 supports nested objects; therefore it expects the OLM activity nodes to be in a specific format in order to be converted into a correct hierarchical tree structure. If the titles of the activity matches the regular expression ^\(\text{d}\.\text{ }\text{d}\)\(\text{d}\.\text{d}\)\text{\text{\text{s}}\text{\$}}\), it can correctly interpret its level within the hierarchy, however if it fails, that particular activity node is assumed to be directly under the root node. Sample D3 json Format is provided in Appendix I.

Once the OLM data is loaded into CoNeTo, the activity and competence nodes become available for artefact-centred discussion as with the previous version of CoNeTo.

4.2 CoNeTo Dashboard

This section describes the design and development of CoNeTo Dashboard. This new functionality is designed as a Teaching Analytics tool for teachers and students to analyse, compare and relate activities and competencies. Figure 4 presents a schematic diagram that shows and overview of CoNeTo web application including the CoNeTo Dashboard.
4.2.1 CoNeTo Dashboard – Database

The CoNeTo dashboard uses data from the OLM database. The specification and implementation of IServiceProvider exposes methods to save and load information to and from the corresponding repositories, which refers to a locally residing database. Data is exported and stored in a MS Access database. The database consists of a single table named tblConeto. This table is a result of an extraction from five OLM tables, as shown in Figure 5.

Figure 5. CoNeTo Dashboard Database, represented by tblConeto. tblConeto contains data from some of the OLM tables.

4.2.2 CoNeTo Dashboard – uVis

The specifications for CoNeTo Dashboard are based on uVis [Pantazos, 2013], a software toolkit that facilitates visualisation development process. CoNeTo Dashboards based on uVis allow interactive visualisations of the OLM data with the added ability for students and teachers to create custom visualisations. uVis contains the necessary files to compile and open uVis applications. In order to avoid security limitations that may exist in educational settings, we use a precompiled version of uVis that includes all the necessary files to run uVis applications without any local installation of uVis. However, to execute uVis applications, the .Net application framework should be installed in advance. After extracting the data from the OLM database and creating a MS Access database, an uVis folder is created and exported locally. The folder, located in the C: drive (e.g. C:\CONETO), contains the database and several .dll files, which encapsulate the core functionalities of uVis, uVis controls, and other .Net libraries. The uVis folder also contains an executable file, which opens CONETO Dashboard.

The CoNeTo Dashboard consists of two files:

- Dashboard.vis: a visualisation file (Vis-file) contains the formulas needed to generate a Windows form with data visualisations and simple controls. A Vis-file will normally be generated and edited through uVis Studio (the development environment), but might also be created and edited outside uVis Studio. A user interface might use several forms. In this case several Vis-files are used.
- Dashboard.vism: a mapping file (Vism-file) contains information about the database. It lists the available tables and relationships in the database. In this case, it will have only one table, and not relationships. uVis handles data accessing internally through ADO.NET. Whenever a user runs the executable file in the uVis folder, first the vism-file is compiled, and next the vis-file (Dashboard.vis) is opened showing the CoNeTo dashboard.

Figure 6 shows an example of a vis-file and a vism-file opened in notepad. This is an example of the dashboard dimensions that may be controlled in the course of future development work.
D4.1
Methods and Specification for the Student Model V1

Figure 6. An example of a vis-file and a vism-file opened in notepad

4.2.3 CoNeTo Dashboard

Figure 7 shows how students’ activities and competencies are to be visualised. The screen is divided in two areas to enable comparison between two or more students. The word cloud technique is used to provide an overview of activities. Competencies related to an activity are presented below the activity word cloud. Colour and size encodings are used in the display of activities and competencies. Hierarchical structure of competencies is encoded through colour. A click on a competency or sub-competency is reflected in both competency word clouds. As a result, teachers can easily identify competencies and sub-competencies of the same category, and compare competencies for different groups of students.

Figure 7. A screenshot of CoNeTO Dashboard

To develop this dashboard, we use three types of controls: label, panel and checkbox. Figure 8 shows an excerpt of uVis formulas. More precisely, to create the lists of students, we used two checkboxes. The first one is defined in lines 47-58, and the second in lines 60-71. Both controls are bound to tblConeto, and uVis compiles the formulas and creates a list of instance for each checkbox. We specify a formula for Top (see line 52 and 65) so that instances do not overlap. Whenever a student is selected or deselected (line 57 and 70), the screen is updated. The word cloud of activities is created using a label control. The formulas are shown from line 73 till 93. Also in this case, we bound the label to tblConeto using a ‘where’ and ‘group by’ clause.
In this deliverable, we document the update of the methods and tools for the communication and negotiation layer. Evaluation of CoNeTo web application and the teaching analytics dashboards will be conducted in participating schools starting April and reported in the next deliverable. The results from these design-based research studies will inform research into and further development of CoNeTo.

Figure 8. An excerpt of uVis formulas of CoNeTo Dashboard
5 Update to RGFA Specifications

This section describes a Teaching Analytics tool designed and developed by CBS as a general-purpose spatial diagnostic tool for teachers and students for the Repertory Grids for Formative Assessment (RGFA) application. The release of RGFA Teaching Analytics tool takes into account results from prior participatory design workshops with teachers and current classroom usage by participating teachers. The dashboards visualise repertory grid data, where teachers and students can investigate personal constructs and rating of elements by students at the individual and/or group level. In addition, this section also reports on updates to RGFA web application based on feedback from Danish and Norwegian teachers.

Teaching Analytics is conceived as a subfield of learning analytics that focuses on the design, development, evaluation, and education of visual analytics methods and tools for teachers in primary, secondary, and tertiary educational settings. Teachers’ professional practices with visual analytics methods and tools are a central concern of teaching analytics. Teaching analytics methods and tools aim to develop innovative solutions to assist and augment teachers’ dynamic diagnostic decision-making in the classrooms of the 21st century. An example usage scenario (but not limited to) within the context of the NEXT-TELL project is the use of teaching analytics methods and tools in high-performance classrooms that are characterised by 1:1 computing, high cognitive density, and digital data.

5.1 RGFA Teaching Analytics Tool Technical Description

RGFA Teaching Analytics Tool is divided in two parts: the RGFA Website and RGFA Dashboard. We first discuss the specifications for and prototype implementation of RGFA Dashboards and then describe the updates to RGFA Website (version 3.0) based on teachers’ feedback. RGFA Dashboard is developed using uVis [Pantazos, 2013]. uVis is a formula based visualisation toolkit that supports visualisation development by combining controls and writing spreadsheet-like formulas for control properties. uVis uses the .Net Framework and currently supports development of desktop applications. uVis applications use relational databases such as Microsoft Access, MSSQL and MySQL. Below is a schematic diagram that shows an overview of RGFA Website and RGFA Dashboard implementation (Figure 9). Teaching Analytics Dashboards based on uVis address the need raised by teachers in classroom usage of RGFA for increased diagnostic power and visual analytics support for individual vs. group comparisons. Further, uVis based Teaching Analytics Dashboards of RGFA data also allow teachers to create custom visualisations.

---

[^3]: http://www.NEXT-TELL.eu/iwta-2013/
[^4]: http://cssl.cbs.dk/software/rgfa/
5.1.1 RGFA Dashboard - Database

The RGFA Dashboard uses the repertory grid data from the RGFA Website consisting of students’ responses to the repertory grid exercise (Figure 9). Data is exported from the web-application after selecting one of the grids. This dataset is processed and a MS Access database is created. The database consists of two tables: tblWord and tblUserWord. tblWord contains the repertory grid data that can be downloaded from RGFA website, and tblUserWord is an additional table extracted by pre-processing tblWord. Words are extracted from similar and opposite constructs texts (see D4.2 for a description of the repertory grid technique and the triadic sorting method that RGFA implement), and word frequency is computed. Figure 10 shows the fields of each table in the RGFA Dashboard database consisting of elements used in the repertory grid exercise and the identifiers such as username, and triad number. This database contains data from the Norwegian study (Section 8.3).

Figure 9 Overview of RGFA implementation

Figure 10. RGFA Dashboard database
5.1.2 RGFA Dashboard - uVis

As mentioned in Section 4.2.2, uVis [Pantazos, 2013] contains the necessary files to compile and open uVis applications. In order to avoid IT security restrictions that may exist in educational settings, we use a precompiled version of uVis that includes all the necessary files to run uVis applications without any prior installation of uVis. However, to run uVis applications, it is required that the .Net Framework has been installed. After selecting a grid from the RGFA website, pre-processing the data, an uVis folder is created and exported locally. The folder, located under the C: drive (e.g. C:\RGFA), contains several .dll files, which encapsulate the core functionalities of uVis, the uVis controls, and other .Net libraries. Also, this folder contains an executable file, which opens the dashboard.

A user interface created with uVis, in this case a RGFA Dashboard, has two kinds of files:

- A visualisation file (Vis-file) contains the formulas needed to generate a Windows form with data visualisations and simple controls. A Vis-file will normally be generated and edited through uVis Studio (the development environment), but might also be created and edited outside uVis Studio. A user interface might use several forms. In this case several Vis-files are used.
- A mapping file (Vism-file) contains information about the database. It lists the available tables and relationships in the database. uVis supports data accessing through ADO.NET. The vism-file has information for which vis-file to open first because a uVis application may have several vis-files. Whenever a user runs the executable file in the uVis folder, first the vism-file is compiled, and next the vis-file is opened showing the RGFA dashboard.

Figure 11 shows an example of a vis-file and a vism-file opened in notepad. Compared to CoNeTo Dashboard’s default specification of 1600x600 screen resolution (see Figure 6), RGFA Dashboard’s default specification is set to 800x600 taking into account the repertory grid data format of triads, elements, and constructs. Again, this is an example of the dashboard dimensions that may be controlled in the course of future development work.

5.1.3 RGFA Dashboard

We provide specifications for and prototype implementations of two dashboards that allow teachers (and students) to explore personal constructs and element ratings, and perform word analysis of constructs. Word analysis of constructs is important for knowledge diagnostic tasks to detect misconceptions and was also a feature requested by the participating teachers. Below we present each dashboard and briefly explain them. Also, we present some uVis formula snippets.
Analysis of Construct Elicitations and Element Ratings

Figure 12 shows how repertory grid data are visualised. The screen is divided in two areas to enable comparison between two or more students. The word cloud technique is used to provide an overview of all elicited constructs (i.e. Opposite and Similar Construct). Details-on-demand are shown in the bubble chart after clicking on a word in the word cloud. Colour and size encodings are used in the bubble chart to distinguish easier element ratings. Small red letters (S-similar and D-different) are positioned above bubbles that represent triad’s elements. In this way, teachers and students can easily view the opposite and the similar elements, and relate them to the other elements. In addition, they can filter words by frequency and triads using the track bar and checkboxes respectively.

This dashboard uses six types of controls: label, panel, trackbar, checkbox, ellipse and line. We specify uVis formulas for control properties to refer to data and other control properties. As a result, uVis compiles the formulas and creates an interactive dashboard as shown in Figure 12. Figure 13 shows the formula snippet.
More specifically, to create the word cloud with uVis formulas, we use a label control and write formulas for its properties. This control is bound to the rows of table `tblUserWords`. Line 67 in Figure 13 shows how the `Rows` formula is specified. uVis formulas can refer to properties of other controls, and in this case the `Rows` formula refers to a property another control (`value of tblBarWordFreq`, see line 91) in the ‘where’ clause.

uVis compiles the `Rows` formulas and returns a list of table rows. For each row in the list, uVis creates a label instance. The `Left` and `Top` property of each instance is computed using the formulas in line 68 and 69. uVis formulas can refer to data as well. Line 67 shows how the `Word` field is mapped to the `Text` property.

Interaction is implemented using uVis statements (see line 79 and 99). Whenever the `Requery()` statement is called, uVis compiles the formulas, computes the changed values, and finally refreshes the screen.

Analysis of Construct Words

The Word Analysis Dashboard also uses a word cloud. After investigating constructs and elements ratings, teacher use this dashboard to investigate further details about construct elicitations. They click on a word in the word cloud, and students’ construct elicitations related to this word are shown, which are categorised in two groups: Opposite and Similar Constructs. To facilitate text analysis, the selected word is also underlined in red in the details view. Figure 14 presents a screenshot of the Word Analysis Dashboard.
Another example of uVis formulas is shown in Figure 15.

```plaintext
64  Checkbox: chkBoxStudentGroup1
65  Rows: tblWordUserWords group by userid
67  Height: 20
68  Left: 0
69  Text: userid
70  Top: 60+index*20
71  Width: parent.width
72  Canvas: cnGroupList
73  Parent: cnGroupList
74  Checked: init chkBoxAllGroup1!Checked
75  CheckedChanged: Reqery()
76  Font: "arial", 8
```

Figure 15. A print screen from the vis-file. uVis formulas for a checkbox control. As a result, the screen displays a list of checkboxes

To create the lists of student, we use a checkbox control and bound it to tblWord. As a result, several checkbox instances are generated and using *Index* (correspond to the index of the rows in the list), uVis positions them in a way that they do not overlap (see *Top* in line 70). uVis formulas use the *Init* keyword to make a property value changeable at run-time (see line 74).

These dashboards can be helpful for teachers’ planning and for immediate use in the classroom. In particular, they address the expressed need of visual analytics support for exploring personal constructs as well as
element ratings at the individual as well as collective levels. Further, they allow the comparison and contrasting of student responses from different classes and collaborative analysis by teachers. These dashboard specifications and prototype implementations will be evaluated with teachers from Denmark and Norway starting April. Design based research studies in the classrooms in the next months will inform the future research and technical developments of the use of Repertory Grids for Formative Assessment (RGFA) and the RGFA Teaching Analytics Dashboards.

5.2 Updates for RGFA Version 3.0

The previous section described the specifications for and implementations of the new teaching analytics solutions for RGFA. This section briefly describes the technical and functional aspects of the existing web solution Repertory Grids for Formative Assessment (RGFA) that has been described D4.2. RGFA v3 is a completely new system that has been specified and developed based on the feedback from teachers and students in NEXT-TELL partner schools.

RGFA v3 provides the same core functionality as previous versions along with many improvements specifically around the Grid creation functionality (such as editing of grids, sharing of grids, preview of image elements, user profile information, extended time-out of the grid creation sessions, and the cropping of images).

5.2.1 New and Revised Interface Features

RGFA v3 has the following new features as compared to RGFA v2.

1) Compared to the old layout that was optimised for lower resolution desktop monitors, the new layout for the whole grid that allows more screen space to be used (Figure 16).
D4.1
Methods and Specification for the Student Model V1

Multilevel navigation menu has been added that makes it easier to navigate around the solution.

Users can provide extended details for the profile.

To make the system more personalised for users, a feature has been added that makes it possible to add a picture to the profile. Users also get an opportunity to crop image while uploading according to their personal preferences. Cropping feature is important for allowing different sizes of images to render correctly in a limited container (Figure 17).

Teachers are now able to complete creation of grids in steps instead of completing the grids in one go (this was one of the main requirements from Bergen school use). Previously the grid was saved in the
memory of the client machine and then saved in the server database at the end after teachers had finished creating all the elements and triads. This has been changed towards saving Grid into persisted database. A new windows on the MyGrids page have been added were all the incomplete grids have been listed and teachers can click on edit Grid to carry on building their Grid and once grid has been completed, it will move to CreatedGrids window (Figure 18).

![Figure 18. RGFA 3.0: Created Grids Window](image)

6) If a RGFA exercise hasn’t already been answered by a student, it is now possible to edit grids. That is, a grid can be edited as long as it hasn’t been answered by a student (editing answered grids can corrupt existing data). Teachers can edit labels for elements and triads, add more triads and elements, and also delete them (Figure 19).

![Figure 19. RGFA 3.0: Functionality to Edit, Add, and/or Delete Elements and Triads](image)

7) Adding new elements functionality has been improved. The image preview will be provided at the runtime while an element of image type is being created to minimise possibility of having selected the wrong image (Figure 20).
Figure 20. RGFA 3.0: Image Preview Functionality

8) On the Grid definition page all the created images and videos are rendered instead of displaying labels only. This will give teachers opportunity to see how images and videos appear for students without actually answering grid (Figure 21).
9) More noticeable error messages, where needed, in form of modal windows (Figure 22).

Figure 21. RGFA 3.0: Grid Definition Page

Figure 22. RGFA 3.0: Example of Specific Error Messages
10) Copy grid functionality has been added. This feature allows generation of new grids by simply copying an existing grid. This can be useful for creating grids faster by copying an existing one that eventually resembles the new grid to be generated. Copying a grid copies all the elements and triads. The new grid can then be edited to make necessary adjustments.

5.2.2 Technical specifications

RGFA v3 is built using Microsoft .Net 4.0, JQuery, AJAX, HTML, CSS and Microsoft SQL Server as database. The visual part of the solution has been built using Html, JQuery, CSS and Asp.net. For example code in Figure 23 shows how HTML, CSS and Asp.net are working together to render a localised label for heading of Grid Creation web page. The class name in the following Figure 23 is pointing to the CSS definition class that dictates the web browser about how to format the text for heading. Similarly the text enclosed in "<% %>" tags is the Asp.net syntax to inform the compiler that a localised text should be found with this key and that should be rendered.

```html
<asp:Image ID="imgControlIcon" ImageUrl="/images/icon_gridsIcon_ Created_small.png" runat="server" />
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
</div>
navigation from the database using the filter role type of the user. This design specification allows us to extend teaching analytics support based on the different types of user roles (teachers, students, grid creators, grid responders etc).

```csharp
public IEnumerable<NAVIGATION> GetParentNavigationByRole(int roleId) {
    return 
        Context.NAVIGATIONs.Where(n => n.ROLEID == roleId && (n.NAVIGATIONID == n.PARENTITEMID || n.PARENTITEMID == null))
        .OrderBy(n => n.SORTORDER);
}
```

**Figure 25.** RGFA 3.0: Code Snippet of Fetching from Database

It can be noted that not one traditional SQL query was needed to be written to fetch this information from database. This framework provides an efficient way of interacting with the database. For example in the Figure 25 the return type of `IEnumerable` is indicating that the actual call to the database will not be made until this data actually has to be used in the application. Another example of C# code is displayed in Figure 26, Figure 27, and Figure 28 that respectively show how copying grid functionality is achieved from interface to actual database instructions. For example if a new grid has to be generated that is more or less similar to one existing grid so instead of generation whole new grid a previous grid can be chosen to copy. Copying of grids for future courses and school years is an expressed need of the Norwegian teachers and the below specification and prototype implementation supports copying and editing of grids.

```csharp
if (e.CommandName == "OnCopy") {
    CopyGrid(Int32.Parse(e.CommandArgument.ToString()));
}
```

```csharp
private void CopyGrid(int gridId) {
    DbModel.CreateCopy(gridId, Localization["gridcopy-templateText"],
    RefreshControl());
}
```

**Figure 26.** RGFA 3.0: Screenshot of Copying Grid Functionality

**Figure 27.** RGFA 3.0: Code Snippet of Copying Grid Functionality
Figure 28 depicts how database and .Net work tightly coupled. Another advantage of using Entity framework is that it makes the applications very scalable. For example there is no need of manually editing entity objects if for example a change or addition has been made in the database entities. Instead only a refresh on the entity schema will be called and it updates the business entities accordingly. This technical specification and implementation supports functionality requested by teachers such as editing of grids, sharing of grids, preview of image elements, user profile information, extended time-out of the grid creation sessions, and cropping of images.

In conclusion, RGFA 3.0 is a radical overhaul of the previous version based on feedback from school teachers and our own experiences of using in university classrooms. It is built using the state of the art technologies in the software development world right now. Further, the specification for RGFA 3.0 is scalable and can with minimal effort be adapted to changes as well as provision of new features without requiring fundamental transformation of the overall architecture of the system.

```csharp
public void CreateCopy(int gridId, string copyName) {
    GridDef gridDef = Context.GridDefs.SingleOrDefault(e => e.GRIDID == gridId);
    Grid grid = new Grid();
    newGrid.GRIDNAME = gridDef.GRIDNAME;
    newGrid.ELEMENTNAME = gridDef.ELEMENTNAME;
    newGrid.ELEMENTNAMEPLURAL = gridDef.ELEMENTNAMEPLURAL;
    newGrid.GRIDACTIONSINGULAR = gridDef.GRIDACTIONSINGULAR;
    newGrid.GRIDACTIONSINGULAR = gridDef.GRIDACTIONSINGULAR;
    newGrid.GRIDACTIONPLURAL = gridDef.GRIDACTIONPLURAL;
    newGrid.EXERCISENAME = string.Format("{0}({1})", copyName, gridDef.EXERCISENAME);
    Context.GridDefs.Add(newGrid);
    CommitChanges();
}

Dictionary<int, int> elements = new Dictionary<int, int>();
foreach (var element in Context.GridDefElements.Where(e => e.GRIDID == gridId)) {
    newElement.GridDef = newGrid.GridDef;
    newElement.GRIDID = gridDef.GRIDID;
    newElement.GRIDNAME = gridDef.GRIDNAME;
    newElement.ELEMENTNAME = element.ELEMENTNAME;
    newElement.ELEMENTNAMEPLURAL = element.ELEMENTNAMEPLURAL;
    newElement.GRIDACTIONSINGULAR = gridDef.GRIDACTIONSINGULAR;
    newElement.GRIDACTIONPLURAL = gridDef.GRIDACTIONPLURAL;
    newElement.EXERCISENAME = element.EXERCISENAME;
    newElement.EXERCISENAMEPLURAL = element.EXERCISENAMEPLURAL;
    Context.GridDefElements.Add(newElement);
    CommitChanges();
    elements.Add(element.GRIDDEFELEMENTID, newElement.GRIDDEFELEMENTID);
}
foreach (var sourceTriad in Context.GridDefTriads.Where(t => t.GRIDID == gridId)) {
    newTriad.GridDef = newGrid.GridDef;
    newTriad.GRIDID = gridDef.GRIDID;
    newTriad.GRIDDEFELEMENT1 = elements[sourceTriad.GRIDDEFELEMENT1.Value];
    newTriad.GRIDDEFELEMENT2 = elements[sourceTriad.GRIDDEFELEMENT2.Value];
    newTriad.GRIDDEFELEMENT3 = elements[sourceTriad.GRIDDEFELEMENT3.Value];
    newTriad.INSTRUCTIONS = sourceTriad.INSTRUCTIONS;
    newTriad.SORTORDER = sourceTriad.SORTORDER;
    Context.GridDefTriads.Add(newTriad);
}
```
6 Update to ProNIFA Specifications

ProNIFA is a software platform that builds upon learner/teaching/assessment software (e.g., Google Docs, particular learning tools, a Moodle course, or a learning session in OpenSimulator) to provide an inferencing mechanism to convert learners’ interactions into competencies. It allows a heuristic-based analysis and interpretation of activity, performance, and test data coming from various sources, and in that sense ProNIFA builds also upon several learning analytics and data mining algorithms. It transforms information for use by other modelling tools and stakeholders within the project.

The theoretical foundation is Competence-based Knowledge Space Theory (CbKST) and its extensions towards micro and macro level assessment and adaptation. In the first instance, the results of the reasoning services are subsequently passed to the OLM platform – although ProNIFA itself has certain visualisation features. The tool has been continuously developed in the course of the NEXT-TELL project and is described in the deliverables of WP2. Accordingly, the recent specifications and development are described in deliverable D2.5.
7 Data Transfer between Tools

Each of the NEXT-TELL tools involved in modelling student learning has the potential for data import and export. This is already realised in the case of the OLM, which has an API that allows it to be updated and queried. Each tool may be integrated flexibly with another if the data items are compatible and the information for the API is specified in the correct format. In this section we briefly consider the issues of external data sources contributing information to NEXT-TELL tools, and how information may be passed between tools.

7.1 Update on automated input from sources external to NEXT-TELL

In line with the intended flexibility of the NEXT-TELL OLM, it should also have the capacity to work with external systems. This can be realised using the OLM API if an external system is configured to transfer data accordingly. The OLM can transport out competency frameworks into suitably configured external systems such that, when the competencies acquire learner data within that system, this can feed back into the NEXT-TELL OLM. This is being realised through linking with an independent OLM already in use elsewhere [Bull, 2010].

7.2 Update on automated data exchange between NEXT-TELL tools.

NEXT-TELL tools may be used as standalone applications, or may be optionally used with others from the set. As such information exchange and integration are highly important. The NEXT-TELL OLM, for example, is the central resource for collating competency information across different students and different areas of learning, and accepts data from other tools such as ProNIFA, to update student models. i.e. a tool such as ProNIFA provides a link between learner/teaching/assessment software (e.g., Google Docs, particular learning tools, a Moodle course, or a learning session in OpenSimulator) and competence-related data gathered, stored, and visualised in the OLM platform.

Information from tools such as the OLM may be utilised by other NEXT-TELL tools, not just to provide a picture of student competency, but also for configuration purposes. For example Mahara is able to synchronise its competency list for a given user with that of the OLM, so that students may store information in their e-portfolio for each of these competencies. Optional student-peer- and teacher-assessments of these artefacts can lead to the learner model being updated.

7.3 Update on manual data exchange between NEXT-TELL tools.

CoNeTo can query the OLM through the API and CoNeTo Dashboards can access the OLM database. Based on CoNeTo activities, teachers can update a student’s OLM if needed. RGFA 3.0 and RGFA Teaching Analytics Dashboards will also allow teachers to manually update the students’ OLMs based on the detection of misconceptions.
8 Updated Discussions with Stakeholders

Following contact with end users, the following are some arising issues to be considered within the next period of software development, worthy of highlight. This section covers the OLM, CoNeTo and RGFA tools, as part of WP4.

8.1 OLM Visualisations Supporting Comparison

The current set of OLM visualisations present information for individual competencies separately, and can display information from different data sources one at a time. Addition of facilities to compare information from different sources and viewpoints together will allow teachers and students to identify areas of discrepancy: supporting dialogue, promoting reflective practices and permitting informed planning of future learning to take place.

Engagement with five German stakeholders (one teacher educator, one school leader, two teachers, and one student teacher) in Hamburg identified the possibility of using visual methods such as radar charts to address this issue and to provide an overview of commonalities and differences in self-, peer- and teacher-assessments (see Figure 29 for an example).

![Radar chart sketch](image)

**Figure 29.** Radar chart sketch, showing comparison of competencies from different information sources.

The radar chart visualisation (Figure 29) was first mentioned by the teacher educator. She was familiar with this visualisation because it was used as a reflection tool in a pilot project which introduced netbooks and a specialised software to selected schools in Hamburg [Behörde für Schule und Berufsbildung, 2010] [Kammerl, 2010], and teachers have some familiarity with this presentation [Hechenleitner. 2008]. When this idea was presented to the other stakeholders, they all agreed this kind of visualisation might be very useful for the purpose of the “Lernentwicklungsgespräche” (learning development meeting), for example, which are held at least once a year in Hamburg schools. Learning development meetings are mandatory since 2010 and according to the school law of Hamburg the students’ individual learning development, reached learning goals, multidisciplinary competencies (such as 21st century skills) as well as the planning of the next learning steps...
should be discussed between teachers, students, and parents during the meeting. Basis for these meetings are not only oral and written exams but also all monitored activities [Hamburgisches Schulgesetz, 2013].

The OLM seemed very suitable for the purpose of monitoring the learning development to the teachers and the radar chart visualisation was found to be valuable for preparing such meetings. The NEXT-TELL approach has much to offer teachers and students in this setting. Future work could take visualisations such as these and extend them to encompass historical aspects of performance, as part of WP3 learning process visualisation work, describing how competencies have changed over time.

8.2 OLM for Student Self-Monitoring

The OLM presents a body of formative information to both the student and teacher about student competency. Information from multiple sources is collated and combined to influence planning, promote reflection and help with metacognition amongst other key aims of the OLM. Engagement with five German stakeholders, as in Section 8.1, highlighted the issue of allowing learners more control over the configuration and contributions of data to the learner model. All teachers liked, and were enthusiastic for facilities such self- and peer-assessments, and were keen for the student to play a key role in the updating of this information for their own self-monitoring purposes. Following this dialogue, we suggest the following as ways to enhance this role of the OLM:

- Allow self- and peer-formative assessment facilities to be enabled by default, and switched off by the teacher if they are not desired (see also Sections 4.1.6, 4.1.8 and 4.1.9 above).
- Allowing students to add information for competencies outside the scope of the current learning activities being completed, as specified by the teacher.
- Promote the facility for students to input textual information which doesn't contribute directly to the model, where this supports the self-monitoring purpose, and allows learner model information to be well thought out and qualified by additional comments and information. Students may enter textual feedback, feedforward, guidance and difficulties as part of self- and peer-assessments and may use a discussion facility discuss information in, and issues surrounding their learner model.

8.3 Integration of NEXT-TELL tools: Norwegian Trial

The spring 2013 trial being conducted in Norway lies between a research-led study and a teacher-led study as the teachers are choosing the tools and how to use them, but the researchers are supporting the process, both by giving advice and by facilitating the tool use. From the NEXT-TELL perspective we are investigating whether a combination of the NEXT-TELL tools RGFA, OLMlets [Bull, 2010], ProNIFA Quiz and the Open Learner Model (OLM), provide teachers with a state-of-art student-achievement overview that is useful for improving their teaching, in particular formative assessment, and student’s learning. The teachers themselves, from a TISL perspective, are interested in whether the unit increases motivation for their students. The research data will be based on semi-structured interviews with teachers and a selection of students, observations, notes and pictures, assessment results, and a questionnaire about the OLM for teachers and students.

When first introduced to the OLMlets and OLM tools, the teachers were immediately intrigued and interested in how the tools could engage students in being more aware of their achievements of the competence goals for the unit, and were willing to integrate their use into this year’s science unit on “Energy for the Future”, a unit which we followed in detail the previous year (see D2.4 and D6.4).

The trial is conducted with students from three different classes, and two STEM teachers. At the beginning of the unit on Energy for the Future, the teachers are formatively assessing students by using the RGFA tool6 in

---

6 The use of RGFA with the two teachers has resulted in a number of reportings of user interface issues and user requirements that have been fed to the RGFA team and resulted in RGFA 3.0.
order gain an overview of student’s knowledge and misconceptions. Based on this student data, the teachers are currently making questions to be used in the OLMlets tool, which will be made available to students not only for the remainder of the unit, but also for use until the exam at the end of the year. The student data collected through their use of the OLMlets tool is directly integrated with the OLM, thus providing another type of feedback to the teachers and students. Teachers will use the OLM to gain an overview of students’ achievement, and for adapting their teaching, and the students will use the OLM to track their competence development. In addition, the OLM will be fed (manually and automatically) with student data from several assessment situations, including the RGFA, a quiz (through ProNIFA) and through rubric evaluation, peer and teacher, of an oral presentation on their sun collector project.

8.4 CoNeTo – Discussions with End Users

The CoNeTo tool trial and design workshops conducted with one Danish teacher from NEXT-TELL partner school, eight University College teachers, and our own use in 3 university classrooms, led to the specification of and implementation of data-driven documents in CoNeTo to better support multi-level hierarchical tree structures of competency frameworks and learning activities. The teachers were concerned with the scalability of the interface as well as the support for state-of-the-art interaction design. Further, the specification and implementation of CoNeTo Dashboards based on uVis address the expressed need for state-of-the-art visual analytics support for communicating and subsequently negotiating OLM data at individual as well as collective levels of analysis and the ability to create custom visualisations. (See Section 4.2.3 for more information.)

8.5 RGFA – Discussions with End Users

RGFA 3.0 incorporated the feedback from two teachers in the Bergen school trial, evaluation by the Danish school teacher and testing in four university classrooms with more than 150 students. As with CoNeTo, the expressed need for state-of-the-art visual analytics support and the ability to create custom visualisations led to the specification of and implementation of RGFA Teaching Analytics Dashboards using uVis. Further, there were a number of usability specifications (such as automatic refresh of pages, focus control, alignment of elements, longer session time-outs etc) and new feature specifications (copying, editing, and deletion of grids, preview of images, cropping of images etc) that were incorporated into the current specification and prototype implementation of RGFA. (See Sections 5.2 and 8.3 for more information.)
9 Summary

This report has presented an overview of student modelling facilities and tools in the NEXT-TELL project at Month 31, and have proposed specification and technical requirements for implementation for release three (August 2013).

- The OLM is being integrated with a wider set of data sources, and is being developed along with the specifications of D4.1 and D4.3 with minimal changes. (See Section 4).
- CoNeTo integrates with the OLM drawing upon its data to provide a basis for negotiation. Its interface is being extended by a teaching analytics solution that takes a more dashboard-based approach and representing more fully the hierarchical and granularity aspects of the learner model database content, allowing the student and teacher to drill down into student competency information. (Section 5).
- Similarly the RGFA website is being completely overhauled, providing teacher requested features and simpler user controls, with new specifications for and prototype implementations of teaching analytics dashboards that provide aggregated representation of the repertory grid information and the ability for teachers to create custom visualisations. (Section 6)
- ProNIFA is being linked to the OLM, and provides an inferencing link between learner/teaching/assessment software (e.g., Google Docs, particular learning tools, a Moodle course, or a learning session in OpenSimulator) and the learner model. (D2.5)
- Data transfer between tools is being extended to allow optional integration between a variety of NEXT-TELL components, in an automated fashion. (Section 8)
- Discussions with stakeholders have led to additional requirements, involving end users in the design and development of NEXT-TELL tools. Some information about studies currently being undertaken involving NEXT-TELL tools have been described. (Section 9)

A summary of the technical content of this document is given in the executive summary (Section 1). This document will allow us to proceed to the next stage – the implementation of student modelling tools for release three (August 2013).
10 References


11 Glossary

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

Partner Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>JRS</td>
<td>JOANNEUM RESEARCH Forschungsgesellschaft mbH, AT</td>
</tr>
<tr>
<td>UniRes</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, DM</td>
</tr>
<tr>
<td>BHAM</td>
<td>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. Z. 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>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS</td>
<td>Baseline Study</td>
</tr>
<tr>
<td>CAS</td>
<td>Central Authentication Service</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 (e.g. PADI project)</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>Epistemic Network Analysis</td>
</tr>
<tr>
<td>ESL</td>
<td>English as a Second Language; refers to learning English in the target language environment</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>
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

Acknowledgement: The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 258114.
A sample D3 json format for CoNeTo.

```json
{
  "children": [
    {
      "children": [
        {
          "children": [
            {
              "children": null,
              "name": "1.3.3 sufficient time allowed for participant feedback",
              "size": 0
            }
          ],
          "name": "1. Creation of agenda",
          "size": 0
        }
      ],
      "name": "1. Planning Meetings",
      "size": 0
    },
    {
      "children": [
        {
          "children": [
            {
              "children": null,
              "name": "2.3.3 prioritising items",
              "size": 0
            }
          ],
          "name": "2.3 Sorting data (as appropriate)",
          "size": 0
        }
      ],
      "name": "2. Meeting Facilitation",
      "size": 0
    },
    {
      "children": [
        {
          "children": [
            {
              "children": null,
              "name": "3.2.1 distributing minutes",
              "size": 0
            }
          ],
          "name": "3.2 Communicating outcomes",
          "size": 0
        }
      ],
      "name": "3. Documentation and Communication of Meeting Outcomes",
      "size": 0
    },
    {
      "children": [
        {
          "children": [
            {
              "children": null,
              "name": "4.8.5 assign tasks, people, deadlines",
              "size": 0
            }
          ],
          "name": "4.8 Strengthen good ideas",
          "size": 0
        }
      ],
      "name": "4. Meeting Activities",
      "size": 0
    },
    {
      "name": "C21 Skills: Meetings",
      "size": 0
    },
    {
      "name": "All Competencies",
      "size": 0
    }
  ],
  "name": "Summary",
  "size": 0
}
```