History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Reason of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2012-05-16</td>
<td>KMRC: Created structure</td>
</tr>
<tr>
<td>2</td>
<td>2012-05-18 to 2012-06-22</td>
<td>KMRC: framework, studies</td>
</tr>
<tr>
<td>3</td>
<td>2012-07-04/05</td>
<td>UniRes: Workshop</td>
</tr>
<tr>
<td>4</td>
<td>2012-07-11/13</td>
<td>TALK: Input on Collaborative eWriting</td>
</tr>
<tr>
<td>5</td>
<td>2012-07-24 to 2012-08-13</td>
<td>KMRC: framework, studies TALK: Granny Quest</td>
</tr>
<tr>
<td>6</td>
<td>2012-08-19 to 2012-08-23</td>
<td>IoE: TISL in the UK and recommendations TALK: OpenSim (Italian-Austrian)</td>
</tr>
<tr>
<td>7</td>
<td>2012-08-23</td>
<td>TUG: Input on study with division tool</td>
</tr>
<tr>
<td>8</td>
<td>2012-08-24 to 2012-08-30</td>
<td>KMRC: finalizing</td>
</tr>
<tr>
<td>9</td>
<td>2012-08-30</td>
<td>Version for internal review for TUG</td>
</tr>
<tr>
<td>10</td>
<td>2012-09-01</td>
<td>Final Version</td>
</tr>
<tr>
<td>11</td>
<td>2012-09-03</td>
<td>Final version submitted to EC</td>
</tr>
</tbody>
</table>

Impressum

Full project title: Next Generation Teaching, Education and Learning for Life
Grant Agreement No: 258114
Workpackage Leader: Gabriele Cierniak, KMRC
Project Co-ordinator: Harald Mayer, JRS
Scientific Project Leader: Peter Reimann

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.
Table of Contents

1 Executive Summary .......................................................................................................................... 1

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

3 NEXT-TELL’s Conceptual Framework ............................................................................................ 3
  3.1 The Orchestration Metaphor ......................................................................................................... 3
  3.2 The Cognitive Density Framework Elaborated ........................................................................... 5
    3.2.1 First-Order Effects and the Development of NEXT-TELL’s Activity Tracking and Visualising Tools ........................................................................................................... 5
    3.2.2 Second-Order Effects and the Development of NEXT-TELL’s Rating & Reflection Tools ......................................................................................................................... 8
    3.2.3 Optimizing Cognitive Density ............................................................................................... 14
  3.3 Summary and Conclusions ......................................................................................................... 15

4 Scenario Development ................................................................................................................... 18
  4.1 OpenSim: The “Granny quest” in Chatterdale ............................................................................. 18
    4.1.1 Description of the quest ........................................................................................................ 18
    4.1.2 Next steps .......................................................................................................................... 19
  4.2 Collaborative eWriting: From Searching the Web to Generating Content ............................... 20
    4.2.1 Description of the scenario steps ......................................................................................... 20
    4.2.2 First Results ....................................................................................................................... 21
    4.2.3 Conclusions and next steps ............................................................................................... 24
  4.3 Self-Guidance: Learning in the 21st Century Classroom ............................................................ 24
    4.3.1 Self-Guidance .................................................................................................................... 25
    4.3.2 Description of the scenario steps ......................................................................................... 25
    4.3.3 Competencies and next steps ............................................................................................. 27

5 Formative e-Assessment: Studying and Developing for Technology-Rich Classrooms .............. 29
  5.1 Mathematics with Classroom Network Technology ..................................................................... 29
    5.1.1 Abstract ............................................................................................................................ 29
    5.1.2 Introduction ....................................................................................................................... 30
    5.1.3 Methods ............................................................................................................................ 31
    5.1.4 Results: 3 Examples ......................................................................................................... 32
    5.1.5 Development: Routines for Assessing and Changing Misconceptions .............................. 39
    5.1.6 Conclusions and Next Steps ............................................................................................. 41
  5.2 Using the Division Practice Tool Sonic Divider in the Mathematics Classroom ...................... 41
    5.2.1 Abstract ............................................................................................................................ 41
    5.2.2 Introduction ....................................................................................................................... 42
    5.2.3 Competencies and Tool Development ............................................................................... 43
    Procedure: Sonic Divider in the classroom................................................................................... 47
    5.2.4 Results ............................................................................................................................. 48
    5.2.5 Conclusions and Next Steps ............................................................................................. 48
  5.3 Orchestrating and Assessing Second Language Learning in OpenSim ...................................... 49
    5.3.1 Introduction ....................................................................................................................... 49

© NEXT-TELL consortium: all rights reserved
1 Executive Summary

The Deliverable D6.4 provides an overview of conducted studies and workshops during the second half of the second project year. The report is mainly divided into four parts which are (1) extended description of the research framework and its core components, (2) an overview of three implementation scenarios which have been developed or are currently under development, (3) the description and results of the Researcher-led Design Studies 2 (RDS) concerning formative e-assessment and teachers’ inquiry into students’ learning which have been implemented in classes and teacher workshops, and (4) guidelines and recommendations for Teacher-led Design Studies (TDS) and the use of TISL.

Following the purpose and scope of this report described in section 2, the deliverable starts with an extended description of the conceptual framework. Though the core of NEXT-TELL is developing formative e-assessment, this pedagogical concept needs to be described and analysed from a neutral perspective. Thus, the frameworks of cognitive density and classroom orchestration were elaborated on a conceptual level. Moreover, the section describes the development in measuring and analysing cognitive density of teachers (diagnostic power and decision-making) and students (engagement, metacognition, collaboration).

Section 4 describes the current versions of three scenario developments: (1) A new quest was developed for OpenSim based on experiences made during the studies of RDS 1 [see D6.3], (2) a new scenario on collaborative eWriting has been developed and run with a group of students, and (3) a new scenario which seeks to foster self-guided learning in the technology-rich classroom is currently under development.

In the sections 5 and 6, studies and workshops of the RDS 2 are reported. The studies and workshops comprised in total 73 teachers and 58 classes in six countries (Austria, Denmark, England, Italy, Norway, and The Netherlands). Thirty-nine teachers participated in workshops and 50 teachers practiced TISL in 2 schools. Five teachers were observed during their teachings in eight classes with altogether 98 students. As mentioned above, this deliverable reports the RDS of the second half of the second project year but with one exception. The results of the TISL workshop in Norway (section 6.1) was already conducted in the first half of the second project year. In order to learn from the findings, the results were included in this deliverable.

In the Netherlands, NEXT-TELL observed how formative e-assessment (FeA) looks like in a mathematics classroom with networked graphing calculator technology in order to develop (1) routines for FeA and (2) ideas how to get students’ data from the classroom technology into the NEXT-TELL OLM. In Austria, NEXT-TELL observed the use of a Division Practice Tool (which was developed by NEXT-TELL partner TUG) to (1) support students in their learning, (2) teachers in formative assessing specific activities, and (3) develop ideas for refinement of the tool. A further OpenSim study was run with a tandem-class of Italian and Austrian students with the aims to refine automatized assessment of students’ activities in OpenSim and to investigate teacher’s classroom orchestration. The participatory design workshop which was conducted in Denmark aimed at inquiring current perceptions, practices, and challenges with teaching (with and without ICT) as well as formative (e-)assessment. The given feedback will be used for the further development of RGFA and the CoNeTo. The Norwegian TISL-workshop analysed how teachers investigate their students’ learning to develop and change their own teaching. Participating teachers created models on how they collect data, investigate and share them. In England, teachers actively conducted TISL in their classrooms and evaluated the method. The results of this evaluation led to insights into potential difficulties teachers have with the TISL approach and into teachers’ ways of interpreting their students’ results.

Section 7 provides guidelines and recommendations for the use of TISL and Teacher-led Design Studies (TDS). The research in WP5 shows that the implementation of TISL needs lots of time and further refinements of the TISL-planner.

Section 8 finalizes D6.4 with conclusions drawn from the framework and scenarios under development as well as the conducted research.
2 Introduction

2.1 Purpose of this Document

The deliverable D6.4 documents the on-going Researcher-led Design Studies (RDS) of the second project year within NEXT-TELL. It provides an elaborated overview of the NEXT-TELL integrative Framework and the on-going scenario development for implementing NEXT-TELL tools and methods into 21st century classrooms. In order to learn as much as possible, all experiences made from the research are presented critically. Furthermore, guidelines and recommendations for the upcoming TDS are given.

2.2 Scope of this Document

The Deliverable specifies the framework of cognitive density and describes the development of its measurements. Furthermore, it gives an overview of implementation scenarios which are under development and reports on classroom studies and research workshops that go hand in hand with NEXT-TELL’s progression. With regard to different types of contents the research topics cover formative e-assessment, cognitive density, immersive learning environments, OLM, and TISL. Following this overall approach this Deliverable contains the NEXT-TELL partners’ presentations of their context-specific (considering country-specific and school-specific characteristics) research in its current status.

This Deliverable does not contain the detailed description of the current status or rationale of the methods (e.g., modelling with ECAAD planner or assessment methods), or NEXT-TELL tools (e.g., OLM or data transfer). Information on these issues is provided in the deliverables of the respective work packages (WPs). Moreover, this Deliverable does not provide a comprehensive and in-depth analysis of all the research data gathered so far. This is due on the one hand because data collected is still under analysis. On the other hand because some of the research data collected represents direct information to other work packages, and in order to prevent redundancy, will be presented in the respective deliverables (references are made respectively).

2.3 Status of this Document

This is the final version of Deliverable D6.4.

2.4 Related Documents

Before reading this document it is recommended to be familiar with the abbreviations used in the NEXT-TELL deliverables. Therefore, we recommend to first have a look in the glossary section at the end of this document. Furthermore, for a comprehensive understanding we recommend the following public deliverables which present former steps within the project:

- D4.2: Student Model Tools R1
- D5.1: TISL (Teachers’ Inquiry into Students’ Learning), SPICE (Strategic Planning with ICTs in Education)
- D6.3: Report on RDS 1

We further recommend three deliverables following end of August 2012 which explain in more detail scenarios, methods, and tools we partially refer to in this Deliverable:

- D2.8: Classroom Assessment
- D3.4: Activity Capturing Tools (however restricted)
- D4.4: Student Tools R2
3  NEXT-TELL’s Conceptual Framework

As introduction into this deliverable and as conceptual background of NEXT-TELL we summarize the NEXT-TELL framework and describe its two sources. The NEXT-TELL framework integrates two frameworks: (1) the framework of classroom orchestration [Dillenbourg, 2010; Drijvers, 2010] and (2) the cognitive density framework by Crawford and colleagues [Crawford, 2008]. In order to investigate NEXT-TELL’s core concept – the pedagogical concept of formative e-assessment (see D6.3, section 3) – we combine the two frameworks because formative e-assessment takes place as dynamic processes during technology-enhanced educational (classroom) interactions. This section describes the two frameworks. The paragraphs about cognitive density include the developments of the second project year with regard to its measurement and with our assumptions about optimal cognitive density. The section will end with a summary of the NEXT-TELL framework.

3.1  The Orchestration Metaphor

As mentioned above NEXT-TELL aims at improving pedagogical decision making to enhance students’ content as well as 21st century learning (e.g., www.p21.org) within collaborative and self-guided learning arrangements which are adapted to students’ learning needs by formative e-assessment [e.g., Pachler, 2009]. In order to make this vision come true teachers need to competently handle the technology-rich classroom which can allow for more self-guidance in collaborative settings consisting of face-to-face and technology-mediated communication. We define the “handling” of technology-rich classrooms as classroom orchestration [e.g., Dillenbourg, 2010; Drijvers, 2010] instead of traditional classroom management with its focus on behaviour control [e.g., Brophy, 2006] but also as an advancement of modern classroom management [Evertson 2006a, 2006b]. Before we explain in more detail what we mean by the metaphor of orchestration in the educational context, we provide a definition of orchestration as given in its original context, namely music.

The Oxford Dictionary of Music defines orchestration as the “art of scoring for orchestra or band” as well as the “arrangement of a work for orchestra which was composed for another medium” [p.533, Kennedy, 1995]. Furthermore, the information is given that arranging is used for the “adaptation of a piece of music for a medium other than that for which it was originally composed” [p. 28], a free (compared to a faithful) treatment of the material in the USA, and that in Jazz arrangement means more or less orchestration [Kennedy, 1995]. Although McKenzie [McKenzie, 2008] criticizes that Kennedy’s definition is confusing for the comprehensive field of music, we find his definition helpful for the educational field because of the following reasons.

- First, orchestration aims generally at dealing not only with a group (band) but with a group using rather complex tools or instruments. We see this as an important step beyond classroom management because teachers and students are now confronted not only with learning content but with learning how to play new instruments, that is, how to use ICTs in order to learn the content [cf. Artigue, 2002; Drijvers, 2008; Trouche, 2004]. Drijves and Trouche [Drijvers, 2008] call this instrumental genesis. When talking with teachers in NEXT-TELL one of their essential concerns is how to make students learn using technology in such a way that they benefit and don’t suffer from it. Mathematics teachers within NEXT-TELL who teach with graphing calculators reported their concerns on how to make their students, who are weaker in Mathematics, use the graphing calculator and not stop doing Mathematics at all because of it. One teacher of a Swedish school that have 1-to-1 classrooms and uses a lot of ICT writes “All the material being digital, the teachers using presentations or sometimes even digital whiteboards leads to the students not taking notes or copying the teachers’ sketches any more. Some even stop listening, because they think it is enough to download everything later on – or the night before the exam. Unfortunately, we discovered that the students’ reading and also writing skills are decreasing. E.g., it seems to be hard for them to focus on a longer text and extract important information, because they are so used to only scan a website and quickly (which of course also is important)” [Andersson, submitted]. Such experiences raise the question what teachers need to consider in their instructions additionally when they make students learn with technology [cf. Mishra, 2006].
Besides this general connection to music, the definition distinguishes between the “art of scoring” and the “arrangement of a work”. This distinction is well in line with our assumption in NEXT-TELL that in order to benefit from ICT in education it is helpful to distinguish between (a) learning design as the art of lesson planning and (b) the actual real-time deployment of a lesson which needs adaptation and improvisation beyond the lesson plan.

- (a) Although it is known among researchers that if a teacher wants to use technology effectively it requires some considerable planning of teachers (e.g., preparing new tasks, defining formative assessment criteria to collect data) [Bolicic, 2006]. Teachers in NEXT-TELL who are not that trained in using ICT do not want to engage too much in lesson planning and see the method of evidence-centred activity and assessment design (ECAAD) as too time consuming and difficult [cf. D6.3 by Cierniak, 2012]. Planning comprises teachers’ long-term decision-making compared to ad-hoc decisions during teaching.

- (b) Concerning the real-time deployment we share the interpretation of Drijvers and colleagues who see the teacher less “... as a conductor of a symphony orchestra consisting of highly skilled musicians, who enters the concert hall with a clear idea on how to make the musicians play Mahler the way he himself reads the century-old partition..." but more as a band leader of “… a jazz band, consisting of both novice and more advanced musicians...who prepared a global partition but is open for improvisation and interpretation by the students, and for doing justice to input at different levels.” [p. 37, Drijvers, 2010]. We think that this perspective is well in accordance with more recent developments in classroom management [Bohl, 2010; Evertson, 2006] in which there is a shift from teacher centred arrangements in which the teacher is seen as “sage on the stage” to learner centred arrangements in which the teacher is rather seen as “guide on the side” supporting students in collaborative and self-guided learning as suggested by cognitive-constructivist and sociocultural perspectives [Evertson, 2006; King, 1993]. One needs to be aware that a teacher as “guide on the side” does not mean that (s)he has nothing more to do. In contrast, Bohl [2010] assumes that if teachers increase self-guided learning settings, they need to elaborate their pedagogical decision making with regard to organizational, content-related as well as methodological issues (e.g., Who is doing what? Who is doing fine, who is struggling with the content or the group? In which group is conversation/quietness a sign for engagement in learning, in which is it a sign of distraction? When is the time right to switch from group learning to individual learning or to classroom discussion?) [Bohl, 2010].

- Closely related to learner centred teaching approaches but not mentioned in Drijvers’s jazz analogy is the aspect of “vocals” that is interpreted as classroom communication. The fact that communication can be influenced by technology need to be considered by a teacher. Laferrière [2010] summarizes that in typical teacher centred classrooms the average discourse structure has the following pattern consisting of three turns: (1) initiation: the teacher asks a question, (2) response: one student is selected and provides an answer, and (3) evaluation: the teacher evaluates the student’s answer. This communication pattern or I-R-E routine [DeBarger, 2010] comprises about 70% of all classroom communication [Wells, 1993]. Moreover, Flanders [1970] found that a teacher speaks about 70% of the communication time. The shift to a learner centred approach should change this type of teacher centred classroom communication and increase students’ amount of communication time. ICT is thought to have the potential to change classroom communication in favour of the learner centred approach because it allows students to communicate more actively.

To sum up, orchestrating a classroom means to design before and manage in real-time “multiple classroom activities, multiple learning processes and multiple teaching actions” [p. 527, Dillenbourg, 2010; Fischer, 2005] as well as classroom communication. We prefer the metaphor of classroom orchestration compared to classroom management. Classroom orchestration comprises the aspects of modern classroom management [Evertson, 2006] but with an explicit focus on technology-use in addition [Drijvers, 2010]. The technology-rich classroom is seen as a challenge because students and teachers need to learn new methods and tools (e.g., instrumental genesis). On the other hand, technology is seen as a chance to support students’ collaborative and self-guided learning by shifting from a teacher centred to a more student centred teaching approach which should be mirrored in classroom communication. Classroom communication is also an important aspect in the framework of cognitive density which is described next.
3.2 The Cognitive Density Framework Elaborated

According to Crawford and colleagues the aim of using technology in classrooms is to optimize the communicative interactions of students with their teacher and peers but also with the learning content in order to engage students in learning [Crawford, 2008]. The authors’ perspective of the classroom is that of “a highly integrated system of actors, tools, and content engaged in individual and social learning activities over time” [p. 121 Crawford, 2008]. This system has to be orchestrated (see above). The term cognitive density is used by Crawford et al. to describe the “aggregate level of students’ engagement with learning materials and thinking, their progress in learning, their communication, and their use of time - that is, productive activity in the classroom at a given time” [p. 121, Crawford, 2008]. Crawford et al. distinguish cognitive density in first-order (section 3.2.1) and second-order effects (section 3.2.2). Whereas first-order effects can be described as traceable activities or characteristics of interactional or communicative activities, we describe second-order effects as experiential constructs. To prevent possible misunderstandings we want to point out that cognitive density should not be mixed with cognitive load which is described within a cognitive and not a pedagogical theory. Cognitive load theory refers to an individual learner’s working memory load only. This load mirrors cognitive processes mainly irrelevant for learning and which result from sub-optimal designs of the content to be learnt [Sweller, 2010]. Cognitive density, however, relates to behavioural as well as cognitive, metacognitive, emotional, and motivational aspects. For an overview of cognitive density see the following sections.

3.2.1 First-Order Effects and the Development of NEXT-TELL’s Activity Tracking and Visualising Tools

First-order effects refer to characteristics of communication scenarios and are further differentiated into (1) communicative density, (2) content density, and (3) temporal density. These three types of densities are interconnected with each other and describe how often, how long, how immediately, and how well in time students interact with their teachers and peers but also how they engage with contents to be learnt and feedback. Technology (or media in general) is said to influence communication by five media characteristics like immediacy of feedback, symbol variety, parallelism, rehearsability, and reprocessability [Dennis, 1999]. Hence, technology is thought to influence each of the three density types in several possible ways. Depending on how technology is used in and beyond the classroom the three density types are influenced and thereby students’ learning. Before describing cognitive density as conceptualized second-order effect in NEXT-TELL, the three first-order density types are explained in more detail with relations to NEXT-TELL’s technological developments. At the classroom level NEXT-TELL aims at collecting data by activity capturing tools (see WP3) which fit to the first-order effects described within the cognitive density framework. Such information tracking and visualising it to teachers and students is thought to support their meta-communication (knowledge and thinking about own communication behaviour). A more detailed overview about the developments of how classroom activities or interactions can be collected and visualised within NEXT-TELL is presented in the deliverable D3.4 about activity tracking and activity visualising tools.

Communicative Density

*Description.* Communication is a central process for knowledge acquisition at schools that can occur in different modalities (orally, written, gesture-based) and codalities (verbal, pictorial) and which can occur face-to-face or mediated by technology. In non-technological classrooms a communication pattern often used is that the teacher speaks to many students and that one student replies to the teacher (although there are differences if small group-work is done) [Wells, 1993]. Technology can be used to influence such a one-to-many/one-of-many-to-one communication pattern by offering the possibility that all students reply at the same time to a teacher without being disturbed by the speech of somebody else’s response (e.g. many-to-one/many by clicker systems or chat). This media characteristic is called *parallelism* by Dennis and Valacich [Dennis, 1999] and *interactional bandwidth* by Crawford et al. who assume that communication is affected by it. The communication characteristic that describes how many persons communicate with each other at a given time but also over time is called *communicative density* in Crawford’s framework. In line with Crawford et al. NEXT-
TELL assumes that if students are included more actively in relevant communication they engage more in learning relevant processes (see second-order effects).

**NEXT-TELL’s data tracking/visualising.** As mentioned above already existing web tools like clicker systems (e.g., Clickerschool), chat tools (in Moodle or OpenSim), forum tools (in Moodle or Mahara) or even twitter can be used in the classroom. The usage of these tools influences communication density. Although NEXT-TELL includes the joint development of scenarios that include the usage of these tools, NEXT-TELL goes beyond the mere application of these tools in two ways. First, NEXT-TELL develops tracking possibilities for log-file data of students’ tool usage in order to make behavioural data accessible by visualizations. For instance, a Moodle discussion thread that shows who interacted with whom can be visualized by a network visualization [see D3.4]. Second, NEXT-TELL develops a communication and negotiation tool (CoNeTo) in order to influence communication density not necessarily in classroom scenarios only but among system-students-teachers-parents about students’ learning [see D4.4]. Aims are for example to promote learners’ argumentation, to increase their reflection processes, or to encourage them in metacognitive activities [e.g., Bull, 2010]. This leads to the possibility that a student might learn while negotiating his/her model. This type of negotiation also includes a special type of content students reflect and negotiate about, namely their own learning behaviour and progress.

**Analysing.** If such ICT-mediated communication is collected, it is possible to analyze the data quantitatively (in a rough way if there is no further coding, for example, without categorizing whether an entry was a question or off-topic). It is possible to compare between classrooms (or groups within one class) to see whether the class or group with a higher level of communication entries via ICT or with bigger networks has also better learning outcomes (e.g., grades). Furthermore, within one classroom there is also the possibility to investigate relations between students’ number (or length) of communication entries via ICT and their grades in order to investigate whether the individual amount of entries or the individual number with how many other peers a student is communicating with via ICT is responsible for better learning outcomes at the individual level or whether it is rather a phenomenon at the classroom level.

**Content density**

**Description.** Content density refers to all learning resources (or materials) students can access and work with. Crawford distinguishes between two types of learning contents or resources: (1) learning materials that contain the content to be learnt and which is provided in books but also all information in the internet and (2) feedback which students can use for learning and teachers for instructional purposes (e.g., for feed-forward). According to Crawford the availability of information resources of type one is more or less limitless via the internet. Nevertheless, they notice that it is almost impossible to find optimal resources in the internet for a given moment in learning. With regard to feedback technology is said to support the possibility of providing feedback immediately and by building (open) learner models (OLM; Bull, 2004). Technology (internet) might increase content density in the classroom because it first allows the access to multiple learning resources, that is students in one class do not necessarily need to study the same materials but they or the teachers might choose among many different resources which allows more individualization in the classroom. Different resources can also mean, for example, that students in the Mathematics classroom work on the same task with a graphing calculator but depending on students’ preferences and understanding some solve the task via formulas and others via graphical representations [Drijvers, 2010]. Second, it offers opportunities to get individual feedback in shorter time intervals and different formats.

**NEXT-TELL’s data tracking/visualising.** In order to go beyond studying mere books or internet resources (in a Web 1.0 fashion) NEXT-TELL offers the opportunity to increase learning resources by recommending scenarios for Web 2.0 tools with sharing and collaboration options like the ePortfolio tool Mahara or the writing tool Google Documents (including spreadsheets and more). When such tools are integrated into teaching scenarios students get the opportunity to a third type of learning resources, namely the artefacts of their peers either in a more or less final version (e.g., uploaded in Mahara) or even in the phase of generation like in Google Documents. Here, students can learn from studying what their peers have generated and from providing peer-feedback but also from receiving peer-feedback. Moreover, NEXT-TELL aims at providing feedback in an automatized manner about students’ learning activities by activity tracking (see WP3) but also about students’ learning progression by building open learner models (see WP4). **Bullet charts** are suggested as one option to
visualise for example students’ activities or learning in a Moodle chat (see D3.4). Additionally, as mentioned above the CoNeTo tool is developed to make students negotiate about their learning.

**Analysing.** In order to analyse how content density influences learning outcomes the number of feedback entries (either provided by the teacher to the students but also peer-feedback, for example, in Mahara) can be counted automatically via the activity tracking tool. Moreover, students’ visits to their OLM can be counted. Such data can be used to investigate how much feedback is provided and used via ICT across classes and whether using feedback options is related with learning outcomes. Moreover, if students search the internet or work with bookmarking (e.g., Diigo, www.diigo.com) one can count how many different sites they viewed for how long and how many they bookmarked or even commented. Such information can be used to be set in relation with the quality (e.g., grade) of students’ artefacts (e.g., essay). Gathering information about such internet-search behaviour and working with multiple documents seems to be very necessary because as mentioned above a teacher from a Swedish school, for instance, reported about the experience that students from her one-to-one school tend to scan texts instead of reading them carefully. Here, a good balance between gathering information from different sources and depth of cognitive processing needs to be found. In other classrooms (e.g., Mathematics classroom with graphing calculator) data might be collected on how many different problems a teacher provided to his/her students in relation to their grades and prior knowledge or how many problems each student solved in a lesson on his/her own pace. Such data provide not only information about which content students dealt with but may allow for detailed diagnostic information about which student has difficulties with which problems, if the correctness of solutions is considered.

**Temporal Density**

**Description.** Temporal density is defined by Crawford et al. to be high when downtime in the classroom is reduced and time for learning is increased. An increase of temporal density can be reached, if for example all students provide answers at the same time to a teacher’s question instead of waiting until other students have provided their answers or instead of leaning back and hoping that some peer will provide the answer to a teacher’s question. Making all students work on an answer at the same time should increase the time in which students actively deal with the content to be learnt. Another example how technology can influence temporal density is how much time it takes until students get feedback for their work. Temporal density increases the faster the feedback is provided to the students. Feedback should be delivered in time, that is, as long as the task is still relevant for students in order to make them actively process the feedback and integrate it into their knowledge representation. If technology supports teachers and students in delivering and receiving feedback in time the probability increases that students benefit from it.

We see temporal density as an integral part of communication as well as content density because each communication - no matter what the communication is about - occurs over time and therefore has temporal characteristics like for example duration or pacing of providing or receiving information. As soon as information relevant for learning can be provided/received immediately, teachers and students get the opportunity to process it when it is still relevant for them that is when they are still engaged or interested in the content. However, the possibility of storing feedback or other information by technology offers also the opportunity to process the otherwise often transient information. Such a possibility offers the opportunity for students to reflect on the information visualized (e.g., feedback, conversations on a topic or their own communication behaviour) at a later point in time and at several times (cf. reheasability and reprocessability as media characteristics) and thereby triggering and supporting metacognition.

**NEXT-TELL’s Data tracking/visualising.** Clicker systems or forum and chat tools offer the opportunity to influence not only communication but also temporal density in the classroom. Hence, by using the Moodle forum or chat teachers can influence the temporal density of their lessons. In order to go beyond the mere usage of such communication tools, NEXT-TELL provides teachers and students with information about students’ content work but also temporal characteristics of it by extracting data from the Moodle forum and chat and visualizing it. A scatter-plot of a forum discussion thread can provide teachers and students with information not only about word count but also about time of interaction. Such information might help the teacher in diagnostics and decision-making. There is also the opportunity that students might use such information in order to reflect about their learning behaviour together with peers when negotiating with the CoNeTo tool.
As temporal density is seen as an integral part of communicative and content density it focuses on the temporal aspects of these types. As mentioned above, the duration and frequency with whom students communicate and from whom students process learning content and feedback can be set in relation with learning outcomes. Furthermore, students can be grouped according their learning outcomes or learning progression and it can be analysed how higher performers differ from lower performers with regard to how long, how often, at which time points, they communicate with peers or the teacher, give and process feedback or process learning contents. Moreover, one can also investigate with how much delay feedback is given to students’ work and whether and how long students process the feedback (investigating the thumb rule “feedback after three days is useless”) and whether they react on it or not.

3.2.2 Second-Order Effects and the Development of NEXT-TELL’s Rating & Reflection Tools

The differences in interactions caused by technology use (see section on first-order effects above) should have an effect on second-order effects which refer to psychological-pedagogical constructs. Crawford and colleagues comprise students’ engagement, participation, time on task, metacognition, and accountability as well as teachers’ decision making, diagnostic power, time on task, metacognition, and accountability under the term cognitive density. We have specified the model by Crawford et al. over the last project year and describe second-order effects as students’ experienced engagement, metacognition, and collaboration occurring over a lesson or teaching unit, as well as teachers’ experienced diagnostic power and decision-making during a lesson or teaching unit. This implies that we do not measure students’ or teachers’ traits or competencies. Rather, we are interested in how long students experienced, for example, that they were engaged during a lesson. Concerning teachers we are not interested in the correctness of a teacher’s diagnosis [cf. Hoge, 1989; Südkamp, 2008; 2011] but whether the teacher is informed comprehensively. In order to adapt teaching to students’ needs as is assumed in the orchestration metaphor and in formative assessment, teachers first need to be informed about their students and then use this information to react respectively in their instructions.

Measuring Second-Order Cognitive Density

Over the second project year, we have developed scales for measuring teachers’ and students’ second-order cognitive density. First, we developed scales for specific scenarios. Then we evaluated how informative these scales are. We decided to develop new scales with unspecific formulations of the items. The aim of the scale development process is to come up with a research tooling that not only researchers can use but also teachers (or schools) for professional (or school) development. The scales should support the documentation of what and how education has happened from the perspective of teachers and students in addition to the above-mentioned objective data tracking. Hence, the tools are not evaluation tools determining who performed well or badly but should support to investigate which general cognitive processes or behaviour take place during learning. This information should help to find out whether the teaching and learning activities trigger the processes assumed to accompany learning (e.g., focusing on task assignments). Moreover, this information can be related with students’ learning outcomes (or competence levels). Thereby cognitive density can function as mediator between activities and learning outcomes. The next paragraphs summarize the development of the measurement tools (1) for teachers and (2) for students. Figure 1 visualises the development process.
Figure 1: Development of 2nd–order cognitive density measurements

(1) Measuring teachers’ cognitive density

We developed two questionnaires and one reflection-sheet that prompts cognitive density issues and that should help teachers to inquire their own teachings from a more qualitative perspective.

- **Questionnaire T1 – OpenSim Scenario:** With regard to teachers’ cognitive density UniRes and KMRC collaborated to construct questionnaire items in order to find out how the Norwegian teachers experience the OpenSim session with their students in Norway and the students in Austria. This session was led by TALK (for an overview of the classroom scenario see D6.3). With the OpenSim session in mind we came up with a questionnaire consisting of five parts. The first three parts (teacher’s : diagnosing, activities, and feelings) consist of altogether 19 items with a 6-point Likert-scale (from “really disagree” to “really agree”). The latter two parts consisted of 10 items with a 5-point Likert-scale (from “much less difficult” to “much more difficult”) asking for a comparison of the OpenSim lesson with a “normal” English class.

**Evaluation of T1:** After several classroom observations and further considerations about the theoretical underpinnings we evaluated the questionnaire and came to the following conclusions. At first, it contained items on specific ICT concerning OpenSim (e.g., I used most of my time giving help on the TeamSpeak tool). Hence, these items cannot be used identically for teaching scenarios with other ICTs and especially not for lessons without ICT, and therefore, they make it impossible to compare different classroom settings, especially ICT and non-ICT classrooms. This drawback holds true for items concerning non-specific ICT items (e.g., The use of the tools took focus from learning the content). Second, although several items asked for diagnostic information the scope of them were rather general (e.g., My impression is that the students needed a lot of help). Furthermore, these items asked for the teacher’s evaluation of his/her students but gave no information about the teacher’s diagnostic experience itself. Only a few asked broadly for information about the teacher’s diagnostic experience itself (e.g., It was difficult to follow what the students were doing). Moreover, part two of the questionnaire concerning the comparison of the OpenSim lesson with a “normal” English lesson was evaluated as a rather vague measure because it stays unclear which lesson or experience teachers take for comparison. Therefore, we suggest to better let teachers rate all lessons investigated with the same questionnaire in order to be able to compare the answers. Although the questionnaire was very helpful in finding out how the Norwegian teachers experienced the OpenSim session and this also in comparison to a “normal” English lesson, the questionnaire has the above mentioned drawbacks. With this experience in background, we developed a second questionnaire.
Questionnaire T2 – Unspecific Scenario: At this stage, the second questionnaire consists of five parts (see Table 1) with a focus on teachers’ self-estimated diagnostic power and adaptivity with regard to decision-making. Four parts of the questionnaire consist of twelve sentences respectively describing mainly cognitive, but also emotional, and motivational characteristics of students.

For example, “I had a selective/comprehensive overview on ...”

1. ... from which knowledge level my students started into this lesson.
2. ... how good (happy, competent or awake) my students felt.
3. ... what drove/ attracted my students’ learning during the lesson.

The four parts (diagnosing, evidence, ad-hoc decision-making, and long-term decision-making) differ from what should be rated quantitatively with regard to the twelve sentences or which information should be provided qualitatively to these sentences.

Additionally, this version includes feedback questions asking for how difficult teachers find the items with a 6-point Likert-scale and with an open text field in order to revise the questionnaire, if necessary. Before the use of the questionnaire for teachers, we tested the revised version.

Table 1 provides an overview of the questionnaire.

Evaluation of T2: Two teachers filled in the questionnaire. Teacher 1 (T1) was 26 years old and was in her first year after graduating university and filled in the questionnaire for one of her biology lessons at a German Grammar school with the topic Mendel’s laws (lesson 3 out of not yet clear how many). Teacher 2 (T2) was 41 years old and lead the four lessons of the TESL Scenario in OpenSim with Austrian and Norwegian students (see e.g., D6.3) and also had one year of teaching experience at an Austrian school. Before we discuss the feedback, we shortly summarize the results of the questionnaire.

<table>
<thead>
<tr>
<th>Part</th>
<th>Aims Finding out ...</th>
<th>Item structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ad-hoc Diagnosing</td>
<td>... how comprehensively teachers are informed about different student characteristics during teaching. Which student characteristics can teachers consider for adaptive teaching? Does the use of ICT or NEXT-TELL data tracking and visualising support teachers’ in diagnosing their students?</td>
<td>The first part asks for how comprehensively teachers were informed about cognitive, emotional, and motivational characteristics of their students with a 6-point Likert-scale.</td>
</tr>
<tr>
<td>Evidence</td>
<td>... which evidence can and do teachers consciously use for their diagnosing? Is the evidence transient only or documented somehow and thus shareable?</td>
<td>The second part asks teachers for describing the data they used to come to their diagnoses.</td>
</tr>
<tr>
<td>Ad-hoc Decision-making/ Adaptation I</td>
<td>... how much and to which students’ characteristica teachers adapt consciously on the fly? Does (NEXT-TELL) ICT influence to which characteristics teachers adapt?</td>
<td>The third part asks teachers for rating on a 6-point Likert-scale how much they used the different information to adapt their teachings. Furthermore, an open question ask for how they adapted their teachings.</td>
</tr>
<tr>
<td>Long-term Decision-making/ Adaptation II</td>
<td>... whether and which information teachers consider for further planning? Does (NEXT-TELL) ICT influence teachers’ planning for the class?</td>
<td>The fourth part asks for describing how the information gained during the lesson was used or will be used for planning the next lessons.</td>
</tr>
</tbody>
</table>
**Part Aims**  
Finding out …  

**Item structure**  
Part V consists of three sub-parts asking for estimations about the class as a whole.  
- It is asked for the range, mean, and mode of a class’s engagement time.  
- It is asked on a 6-point Likert-scale how heterogeneous the class was regarded concerning cognitive, emotional, and motivational characteristics.  
- It is asked on a 6-point Likert-scale how much in control the teacher felt during the lesson.

### Table 1: Structural overview of the cognitive density questionnaire T2 for teachers

<table>
<thead>
<tr>
<th>Ad-hoc Diagnosing</th>
<th>Evidence</th>
<th>Ad-hoc and long-term Adaptation</th>
</tr>
</thead>
</table>
| In sum, T1 rated to have an overview with regard to the items of 68%. Her highest ratings were for difficulties with technology (no difficulties), students’ errors and correct solutions of tasks and motivation. However, she lacked information on students’ prior knowledge, concentration, and emotions. T2 reported to have an overview on her students of about 75% (average of all 4 lessons). She had her best overview on students’ emotions but also lacked information about students’ prior knowledge in one lesson but also which difficulties they had with the task and technology in that lesson. | T1 but also T2 (and the teachers from the ECAAD workshop described in D6.3) had difficulties with reporting which evidence or students’ data they used to come to their diagnosis or assessment. Although “students’ presentations”, “students’ questions”, “noise”, and “doing tasks” are mentioned, teachers also mentioned “observations”, “walking around”, or “tasks” and some others. Hence, these teachers mixed evidence (that is data which can be interpreted) and the methodology which they used to gather data. The answers given are often rather unspecific. This is an observation which is in line with the results from the teachers with whom a workshop on ECAAD was conducted at a German secondary school [see D6.3, Cierniak, 2012]. Moreover, especially with regard to motivation none of them reported any evidence but instead reported the trigger of motivation assumed (T1 - she as the teacher; T2 - the fact that students can contact students abroad). This answer was probably a result of the item sentence which asked what drives or attracts students in the lesson, although it was not the task to answer this question but to provide evidence that shows what drives or attracts the students. Most of the evidence they reported is transient (e.g., data from observations) and/or not easily accessible for the teacher when it is written in the student’s booklet or when it was written on the blackboard. Students’ questions are an important source for diagnosing, however, they are very transient.  
Ad-hoc and long-term Adaptation. As assumed, T1 adapted only to students’ characteristic she had a rather comprehensive overview about. That is, she reported to adapt ad-hoc to students’ errors and solutions, but she did not adapt to students’ prior knowledge or concentration level of which she only had a selective overview. This pattern of results was not so clear for T2 who reported to be adaptive in one lesson in which she provided more help than planned but she reported not to be adaptive in the other lessons, although she had the same overview about the class. Concerning long-term decision-making, T1 did not fill out the items, except one with the idea of elaborating the repetition, if the lesson was too difficult for the students. She commented that she did not understand the task. T2 reported on how to change the OpenSim scenario in general [see D6.3, Cierniak, 2012]. The interesting finding was that she did not conclude further changes for the following lessons of the class but that she mentioned changes for the scenario which will then be done with different students. This decision-
making seems to be rational with regard to her focus on developing scenarios for immersive learning environments (OpenSim) but is in contrast to adaptive teaching for students. However, if a topic is over in a class, it is not possible to adapt it for the specific class.

**Class descriptions.** An interesting finding is that for part V (class description) T1 rated her students to be “very heterogeneous” with regard to all characteristics (from knowledge over engagement to emotions) and she commented that there is no homogeneous class at all. This rating looks as she did not rate her students during the specific lesson but rather that she gave a general answer which is always correct on a very basic level. Contrary to T1, the variable ratings of T2 across her four lessons show that this teacher experienced differences with regard to heterogeneity among her students depending on the lesson.

**Evaluation summary and conclusions:** The feedback ratings for how difficult the different parts of the questionnaire were for the teachers differed a lot between them. Whereas T1 rated most of the parts, especially the two about decision-making, from rather difficult to very difficult (except the rating-items for ad-hoc diagnosing), the ratings of T2 varied between very easy and easy. As T2 is familiar with formative assessment, we assume that the difficulty of the questionnaire items stem mainly from the fact that T1 does not seem to be familiar with reporting on her process of diagnosing and decision-making. Nevertheless, despite T2’s higher prior knowledge on formative assessment she also mixed evidence and methodology. However, she could answer the long-term decision-making part. Other important feedback comments of T1 were that first, she could not describe her class with regard to students’ engagement concerning range, mean, and mode. Second, she did not understand part IV, that is using the information for planning the following lessons. We assume that it is not the formulation of the items themselves, which made it difficult for T1 to answer but probably the combination of a lack of a detailed concept of formative assessment and adaptive teaching and lacking explanations of concepts like comprehensiveness. When speaking with teachers we realized that the concepts within the questionnaire (e.g., evidence or data, using information from one lesson for further planning of the following ones) are rather difficult for them to describe.

Hence, we need to explain in more detail the concepts of comprehensiveness, adaptation during the lesson, and adaptation for further lesson planning. Furthermore, although we were interested in whether and how teachers describe their classes with respect to range, mean, and mode, in order to see which information they rely on, we realized that this item is much too difficult although we described what the descriptors mean (e.g., range means the lowest % value of your students’ engagement (min. 0%) and highest % value of your students’ engagement (max. 100%)). This is also important information for TISL, because making teachers inquire their students’ learning in relation to their use of ICT in teaching needs to be analysed not only qualitatively but also quantitatively.

Besides the questionnaires, a reflection-sheet was developed in order to offer a second tool which teachers can use for their development in orchestrating technology-based classrooms.

- **Reflection-sheet:** Learning how to orchestrate technology in classrooms and how to benefit from e-assessment will become increasing topics on teachers’ professional development agenda [Mishra, 2011; Woolf, 2010]. As this development needs its time and should last over the whole span of work-life, we have developed a reflection script for teachers which is based on the ALACT model (Action, Looking back, Awareness of essential aspects, Creating alternative methods, Test) that was developed within the field of teacher education [Korthagen, 1985; 1999; 2005]. As the ALACT model per se is very open without any specific focus, we provided a structure for a reflection cycle from the perspectives of classroom orchestration and cognitive density. Figure 2 shows the steps “awareness of essential aspects” which we divided into positive and negative categories (blue and red) and “creating alternatives” (green fields). The prompts comprise for example students’ engagement, collaboration, and feedback. The reflection sheet was not yet tested.
(2) Measuring students’ cognitive density

With regard to measuring students’ cognitive density KMRC started to generate questionnaire items at the beginning of the second project year. We started with formulating and collecting items concerning all cognitive density types (including temporal, communicative, and content density). Moreover, we developed different rating scale options. Literature of metacognition [Dinsmore, 2008; Wernke, 2011] and flow [Jackson, 2010; Nakamura, 2002; Rheinberg, 2003] was also considered. This resulted in an item pool of about 100 items and four possible rating-scales. With this item pool in background, three questionnaires were developed.

- **Questionnaire S1 – OpenSim Scenario:** The first questionnaire was developed for the “Chatterdale mystery” scenario in OpenSim which was run in classrooms in Norway and Austria (see D6.3). The questionnaire consisted of nine items with a 4-point Likert scale which focused on students’ engagement. On the cognitive level we asked, for example, “I was focused during the lesson”. On the emotional level we asked, for example, “I enjoyed the lesson”.

- **Questionnaire S2 – Collaborative eWriting Scenario:** The second questionnaire was developed for the collaborative eWriting scenario which was done in Austria (see Chapter 4.2) and consisted of 25 items for three parts: (1) engagement, (2) collaboration, and (3) technology. Twenty items used a 4-point Likert-scale and five items used a free text field for an open answer (e.g., Describe how you collaborated with your classmates).

**Evaluation of S1 and S2:** The questionnaire S1 focused on engagement only and lacked other components of cognitive density. The questionnaire S2 comprised engagement and collaboration. However, many of the items of version 3 focused on information which was specific for the scenario (e.g., It was difficult for me to decide which websites were relevant. / It was easy for me to write the text with a classmate.). Moreover, some items were specific with regard to the technology used. In order to generate a scale independent of specific technology and useable for each classroom scenario a third questionnaires was developed.
**Questionnaire S3 – Unspecific Scenario:** Questionnaire S3 distinguishes three parts: (1) engagement, (2) collaboration, and (3) metacognition instead of technology. The questionnaire consists of 30 items. The items use a 6-point Likert-scale because four rating levels seemed to not distinguish between the students optimally. However, we tried to avoid a middle category. The items are currently reformulated in order to use the same rating-scale description for all three parts. As we are interested more in whether students do the processes and less in how well they perform them (competence), the rating-scale description focus on temporal aspects. Table 2 provides an overview of the parts with an item example. The questionnaire was not yet tested.

<table>
<thead>
<tr>
<th>Part</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engagement</td>
<td>I was focused on my work.</td>
</tr>
<tr>
<td>Metacognition</td>
<td>I know for sure what I wanted to or should have learnt during the lesson.</td>
</tr>
<tr>
<td>Collaboration</td>
<td>I felt supported in learning by my classmates.</td>
</tr>
</tbody>
</table>

**Table 2:** Item examples for the different parts of the cognitive density questionnaire

**Next Steps**

Concerning teachers’ cognitive density, we want to revise the questionnaire and reflection script in such a manner that it becomes clear that the processes underlying these tools support professional development by supporting teachers reflecting about their practices of using technology, diagnosing (e.g., which kind of evidence do I use for which student at which time?) and lesson planning. Hence, we want to find out how collecting student information and analysing these data can be integrated into the TISL method. One starting point would be to use special fields in NEXT-TELL’s ECAAD and/or TISL planner in order to link which learning activities resulted in which student reactions or to mark where the teacher wants to get more information, and therefore, needs to develop for example a new assessment method.

Concerning students’ cognitive density we will discuss with teachers the most relevant items and reduce the items per cognitive density part because teachers can only implement such scales in addition to their teachings, if they do not take too much time. Furthermore, we want to implement the items in Moodle. So far, they are implemented in an online-survey system with limited or non-existing functions concerning the sharing and visualisation of the results. However, if teachers should be able to use the questionnaires and benefit from them, the analyses of the data need to be user-friendly (see WP4).

**3.2.3 Optimizing Cognitive Density**

When it comes to Crawford’s aim of optimizing cognitive density, the question arises what does an optimized cognitive density mean for students and teachers?

Our general view in NEXT-TELL is that optimizing densities is an inquiry process which needs to be based on evidence. It is assumed that researchers and teachers need to explore how they can apply different ICTs with different students and inquiry how their students learn with them [see TISL in D5.1 and D5.3]. Activity tracking as mentioned above is one way to gather activity data and setting these data into relation with learning progression/outcomes helps to learn about teaching and learning with ICT. Another way is to have a closer look on the cognitive density concepts Crawford et al. subsume under second-order effects and relate first-order data with second-order data and learning outcomes. These two types of data and their correlational analyses should help to investigate what optimal cognitive density might mean for different classrooms and technologies. The development of teaching patterns or routines [e.g., DeBarger, 2010] from the perspective of formative assessment and cognitive density should support this process.

Concerning teachers’ cognitive density, NEXT-TELL argues that an optimized cognitive density would be a teachers’ comprehensive overview on relevant student information (e.g., prior knowledge, difficulties with the tasks). Hence, optimized diagnostic power means to have immediate access to relevant student information of all students in the class at any time in order to use it when it is relevant and to support students’ learning. Moreover, it means that such relevant information cannot only be used consciously for pedagogical decision-
making on the fly by the teacher during the lesson but it can also be used later on for further lesson planning or in order to share it with parents, students, colleagues, and principals in order to discuss and reflect about it. However, what relevant information means for a specific teacher depends heavily on his/her knowledge about content, pedagogy as well as about technology, that is, how to use this information to adapt to students' learning needs supportively [Mishra, 2006; 2011]. The adaptation of teaching to students’ needs implies teachers’ decision-making (which is based on his knowledge and skills) on the fly or ad-hoc during the lesson but also in a delayed way when planning the following lessons [Shavelson, 1981]. An optimized decision-making means that from all potentially information accessible for the teacher, (s)he can access and select the important information and uses it for classroom orchestration (thereby changing one or more density types of the first-order) and further lesson-planning. This also includes the knowledge to tell why some information is available but nevertheless not used. Hence, although technology can support teachers diagnostic power directly by visualising information on students’ learning (see D3.4 and D4.4) and keeping it accessible for a delayed decision-making and/or reflection, it depends on teacher characteristics like for example teachers’ technological, pedagogical, and content knowledge how they use this information for their pedagogical decisions.

Concerning students’ optimized cognitive density we argue that cognitive density types should not be mixed with competencies (skills or knowledge). Rather, we argue that an optimized cognitive density is students’ balanced investment of time in dealing with the content, fruitful collaborations with their peers but also working on their own, as well as thinking about their learning. Behaviours like chat entries or feedback processing might reveal patterns that correlate with students’ engagement or metacognition. Whether students develop their competencies in collaboration or metacognition depends, however, not only on technology use per se but also on how technology is used or orchestrated in the classroom. The development of a scenario supporting self-guided learning deals with these competence-based issues (see section 4.3).

### 3.3 Summary and Conclusions

NEXT-TELL aims at supporting formative e-assessment in order to enhance adaptive teaching [Pachler, 2009]. Figure 3 depicts the cyclic procedure (from planning to negotiating) which can take place in ICT-rich classrooms in which orchestration supports collaborative and self-guided learning [for a more detailed description of NEXT-TELL’s support in adaptive teaching see D6.3: cycle of formative e-assessment; Cierniak, 2012].

---

**Figure 3: Cyclic process of formative e-assessment embedded in classroom orchestration, collaboration, and self-guidance**
The cycle of formative e-assessment is regarded as embedded in the framework of classroom orchestration and the framework of cognitive density. Both frameworks focus on classroom behaviour where students’ learning should be supported (blue parts in Figure 4). NEXT-TELL highlights that teachers benefit when they are supported in inquiring their own teachings with ICT and its related students’ learning. Therefore, classroom orchestration and cognitive density are embedded into the method of teachers’ inquiry into their students’ learning (TISL; green frame in Figure 1). TISL, in turn, is embedded into school’s strategic planning of ICT alignment (SPICE; red frame in Figure 1) thereby orchestrating the schools’ development of learning and teaching with ICT. We see this structured embedding of classroom orchestration as an important feature of learning how to use ICT as supportive tool selection for 21st century learning. Figure 3 depicts the NEXT-TELL framework concerning classroom orchestration and cognitive density.

If cognitive density is “optimized” by ICT characteristics and their usage (which is subsumed under classroom orchestration), teachers’ are supported in adaptive teaching and students in learning - that is, instructional improvement. With regard to instructional improvement we assume that technology has the potential to inform a teacher about learning relevant student information via activity tracking (D3.4) and student modelling (D4.4), thereby increasing a teacher’s diagnostic power. We further assume that if teachers are informed more comprehensively about relevant students’ behavioural activities and competencies, the probability increases that they use this information and thereby can come to improved pedagogical decisions. Improved pedagogical decisions are seen as increases in adaptive teaching with elements of e-assessment for learning [Black, 1998; 2009; Pachler, 2009] and influences on temporal, content, and communicative densities. On the students’ side we assume that an optimization in instructional communication which takes place on the dimensions of temporal, content, and communicative density by teachers’ orchestration settings leads to a balanced increase in students’ engagement and metacognition as well as to a balanced setting of collaboration and individual work depending on what the tasks to be solved demand and what the learners need within a specific frame of time. If students’ second-order effects are influenced adequately students’ learning outcomes should increase.

In order to find out what an optimized cognitive density of a classroom means, it is necessary to collect information of the different density types and set them in relation with students learning progression/outcomes. Therefore, we have developed questionnaires that should help to collect data on teachers’ and students’ cognitive density.
Figure 4: NEXT-TELL framework of classroom orchestration and cognitive density
4 Scenario Development

Chapter 4 describes scenarios that are developed within NEXT-TELL in order to provide examples for teachers that show how cloud and Web 2.0 tools can be implemented in the classroom to support 21st century learning. As many of the teachers we have worked with over the last two years were not very familiar with the tools NEXT-TELL (e.g., GoogleDocs) considers as “deployment technology” which provides (raw) data on students’ learning, it is necessary to offer examples. The scenarios are more or less in development and might be adapted by teachers respectively. Assessment methods are part of the scenarios and need to be further developed in collaboration with WP2, WP3, and WP4. The facilitating scenario reported in D4.4 focuses on the assessment methods and is therefore not described at this stage in this chapter. Each scenario is developed in different ways, and thus, they differ with regard to how far they are developed and with which focus they were started. The chapter starts with an OpenSim scenario which resulted from earlier experiences in the project (see D6.3). The second scenario is about collaborative e-writing and was developed over two days working with some students. The third scenario is about implementing self-guided learning. Although this scenario is still in its beginnings, it already shows the complexity of self-guided learning which is a challenge for teachers to orchestrate in schools [Bohl, 2010].

4.1 OpenSim: The “Granny quest” in Chatterdale

First trials in Chatterdale with the „What happened to the Chatterdalers“-quest (see deliverable 6.3) lead by TALK had shown, that there is the danger to overwhelm students. Students have to cope with several issues:

- orientation in a virtual world (what is were?)
- handling the environment (walking, talking, flying)
- handling group-cooperation (including acoustical understanding what other group members say in a – maybe – noisy environment)
- the story itself (incl. drawing the correct conclusions from given hints)
- everything in English

Although some relief can be offered (e.g. let students sit next to each other and only use headphones when speaking to inworld actors), especially for younger students that have not much experience with online role-plays this can easily be too much.

Therefore we developed a new quest, that is much simpler – the „Granny quest“:

- A simple scavenger hunt style quest, where students are sent from one location to the next and get some hints at each location
- very simple and concrete hints – very little drawing conclusions necessary
- only one actor - the one at the final place who welcomes the students who have found their way and explains the background
- nevertheless, a compelling story: Granny’s heirs are on the hunt to find her house – because it will be given to the first who finds it

4.1.1 Description of the quest

Grandmother (Granny) had lived in the lighthouse. Students are sent from one location to the next and pick up hints. They should end up at the lighthouse and explain to the guardian there that they inherited it from their Granny. Those who get there first receive a "Certificate of ownership" and the Chatterdalian citizenship.

Hints at the locations are either given by avatars (actors) or stored in a red cube. If students click the cube, the texture with the hint is displayed. If actors are available, then they give (at least) the information that is written on the texture. The only special case (where always an actor is needed) is the guardian at the lighthouse.

Students are directed to the first location via the letter they are given (5 variations of the "N.B.").
This makes sure that they all start from different locations:

![Figure 5: Letter to the students](image)

Upon finding a hint, the students are sent to the next location, e.g.:

![Figure 6: Hint with next location](image)

If there is an actor available, then the actor will give the information. If not, the picture (as above) will be stored in an object and students have to click it to see the picture.

### 4.1.2 Next steps

The quest will be used with further classes of teachers who want to teach with immersive learning environments.
4.2 Collaborative eWriting: From Searching the Web to Generating Content

When realizing that many teachers are not familiar with using the internet or Web 2.0 tools in their classrooms, project partners TALK and KMRC started to develop a collaborative eWriting scenario. This scenario aims at making students competent in using the internet as one source which provides multiple documents (websites) that contain different information, different qualities of information as well as different representation types [e.g., Rouet, 2011]. Moreover, the scenario aims at using this information in order to generate content or learning artefacts (e.g., texts or presentations). Finally, the scenario is based on collaboration which includes idea and information sharing during collecting information as well as providing and considering feedback during and after generating content artefacts. The scenario is similar to a writing conference suggested by Harris [Harris, 1986] but adapted to technological development and collaborative activities.

A first version of the scenario was run with 10th graders (age 16 to 17) in an Austrian grammar school. The students could not join the trip to Ireland. The procedure and results are presented in the following.

4.2.1 Description of the scenario steps

In order to start the scenario tools were prepared and a teaching plan created.

Tools

(a) Dummy Gmail-accounts were created in Google in order to enable students to work with GDocs. The teacher (TALK) also created the Document in GDocs.

(b) Further accounts for these Gmail-accounts were created for the content curation tools or bookmarking tools storify (http://storify.com/) and diigo (http://www.diigo.com). Moreover, tutorials for these two latter tools were generated (screenshots with highlighting and explanations were saved in MS Powerpoint).

(c) Collaborative planning cards (paper) were prepared to write plannings steps down.

(d) It was checked whether MS Powerpoint run on the school’s computers. Microphones were organized.

Teaching Plan

The basic plan consisted of six subsequent steps which are explained in Table 3.

<table>
<thead>
<tr>
<th>Step</th>
<th>Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation</td>
<td>Teacher: “Hi, today I’ll help you with solving the task to create a text about Ireland - via collaborative eWriting. These days collaborative eWriting is a widely used professional working technique - thus something really relevant to YOU!”</td>
</tr>
</tbody>
</table>
| Setting the goal    | Teacher: “Now, ...
  - Your task is to collaboratively produce a text of 1-3 pages about Ireland.
  - You can choose what kind of text it is - only restriction: it MUST BE YOUR text. Copy/paste from the internet is strictly forbidden.
  - Some suggestions: advertisement for journey (text for flyer), essay, historical essay.
  - By the end of the day, your text will be submitted to your teacher.” |
### 4.2.2 First Results

In the following sub-sections, we will reuse the structure of the plan described above in order to describe what happened on these two days.

**Day 1**

On day 1 the pair of students chose the topic “a letter to the manager of a music label to present the student’s fictitious newly founded Irish rock-folk band “Guinessis” (hoping to get a contract with that label)”. Table 4 summarizes the results of day 1.

<table>
<thead>
<tr>
<th>Step</th>
<th>What happened</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation</td>
<td>Motivating the students was quite simple. They easily understood the relevance of using web-tools for work.</td>
</tr>
<tr>
<td>Setting the goal</td>
<td>Students were a bit amazed, that they should produce no more than 1-3 pages of text - together - the whole day. Later on they understood that the focus for the teacher was not on quantity but text quality - and that producing good quality is characteristic for good team work.</td>
</tr>
</tbody>
</table>
| Planning        | The students used the cards to brainstorm their ideas, but relatively quickly agreed on the topic of the music label. As the quality criteria for the text seemed to be especially important for them, they wrote them on an own card (and referred to it later). The process (after having found the topic) was quite straight-forward (they put it on one card):  
  * define in details who they are (band biography etc.)  
  * research about existing labels  
  * write the letter  
  There was nothing to discuss or improve on this plan. |
| Tools           | The students decided to use only diigo and Google-doc. They haven’t used either of them before. |
The students worked very autonomously and didn’t need much help. For researching existing labels, diigo proved to be very helpful, however, the students did not make much use of diigo’s annotation features (e.g., highlighting or writing comments or using tags). Figure 7 is a screenshot of the bookmarked websites in diigo.

In Google-doc, they didn’t use too many comments, but worked directly in the text. In the following screenshot the history of the document is displayed at the right hand side:
Step | What happened
--- | ---
Reflection | The students filled in the cognitive density questionnaire S2 that was provided online (see section 3.2.2). The students stated that they learned something about writing applications, searching the internet and using new internet tools, as well as about collaboration. Furthermore, they found the planning phase helpful for their process. They agreed that their text improved through collaboration and that working together was easy for them. However, they differed with regard to how focused they worked. Whereas one student rated that he had worked rather focused, the other one had not (this student had to write a test after the session). The students found it easy to work with the tools and complained a bit that the time they had to accomplish the work was too long for them (5 hours). The last result was astonishing for the teacher, because in the end she had to make the students hurry up in order to finalize their work.

| Table 4: Results of day 1 |

In conclusion, the unit went very well. The students enjoyed the creative aspect of their work, which is highlighted by the ingenious name, they chose for their band: “Guinessis”. As they were real musicians, it was easy for them to picture themselves into their chosen role. Collaboration between the students went smoothly, frictionless and spiced by emotional debates about their style of music. They mastered diigo and Google-docs very well, although they stayed with the basic features. It was good to have the whole day (5 hours), although 4 hours would have been enough as well (see students’ questionnaire ratings).

Day 2
For Day 2 we decided to stay with diigo, as some more diigo practice (advanced features) would reveal more real diigo-value to the students. The general idea to let students pick a topic on their own and also decide what exactly to produce proved to foster creativity and motivation. Hence, we kept it. Table 5 summarizes the results of day 2.

Step | What happened
--- | ---
Motivation | Students’ motivation was no problem, although some students had already been there yesterday.
Setting the goal | Setting the goal was also well understood by the students.
Planning | This day, the planning process went slightly different, as it took the students longer to find their project. They used the cards again, but it didn’t help them much. Finally they agreed on a “sound and light show” about Ireland. The process they came up with was:

- brainstorm topics and ideas how to visualise them
- research (search pictures and music) to the selected topics
- bring results together in Microsoft Powerpoint (insert pictures and music, record text)

Tools | As students were already familiar with the basics of diigo, only some more advanced features were shown to them.
<table>
<thead>
<tr>
<th>Step</th>
<th>What happened</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research &amp; Production</td>
<td>Students generated a slideshow which lasted 2 minutes and 30 seconds. The following pictures are examples of their slides.</td>
</tr>
<tr>
<td>Reflection</td>
<td>The students filled in the questionnaire S2 that was provided online by KMRC (see section 3.2.2). Students answers were very similar to the day before (see above). However, this time all students were focused during work. This was especially true because recording the audio files with their text and integrating them into MS Powerpoint was rather difficult for the students and they needed teacher’s explanation and technical knowledge to accomplish their goal.</td>
</tr>
</tbody>
</table>

Table 5: Results of day 2

Like on day one, the result was very impressive. The students did a great job in finding pictures that visualised the issues they wanted to address. Furthermore, they created compelling spoken texts to the pictures thereby providing opportunities for teachers to assess their pronunciation. The whole show was accompanied by some Irish music, only occasionally interrupted by the spoken text.

Again, the students collaborated nicely, mastered the tools and were motivated and engaged.

4.2.3 Conclusions and next steps

The English teacher of the students was very surprised by the activities and the artefacts produced by his students. However, it was difficult for the teacher to assess students’ collaboration based for example on the history function of GoogleDocs. He was especially impressed by the student’s creativity. Students were only asked to generate content that is somehow related to Ireland. Whereas one pair of students took this chance to incorporate their hobby (music band) into the assignment, the other pair generated a presentation about their picture of Ireland which contained current music bands but also festivals. The trials showed, that students picked up the technological challenges easily and get into productive work quickly. Nevertheless, students seem to need more guidance with regard to advanced bookmarking features. The students liked to work in pairs and had the feeling that their output was enhanced by collaboration. As the technological (only Web-tools and Microsoft Powerpoint was used) and organisational effort of this scenario is very low (compared for example with OpenSim), we think that it is worth to elaborate it. The scenario needs further development with regard to assessment issues targeted. These issues need to be developed in collaboration with WP3 (activity tracking) and WP4 (data visualisation).

4.3 Self-Guidance: Learning in the 21st Century Classroom

KMRC is currently developing a NEXT-TELL implementation scenario to foster self-guided learning competencies in the 21st century classroom.
Due to the technical revolution, knowledge is changing fast and the ability to identify knowledge gaps and actively approach these gaps becomes more and more important. It is necessary to become a lifelong learner - a learner who has the capacity to learn and who has competencies in communication and collaboration as well as in knowledge creation [Tan, 2011].

4.3.1 Self-Guidance

Self-guided learning (which can be understood as an umbrella term for often synonymously used terms like self-regulated learning, self-directed learning or self-determined learning) can be seen as a competence that is essential for becoming such a lifelong learner [Dynan, 2008] because it combines skills, capacities and dispositions that are necessary for participating in a socially and culturally diverse world [Tan, 2011].

Schools should not just prepare students for jobs but also help them to be responsible citizens of a democracy. This is possible if students learn to think critically, be creative, develop personal goals and learning goals, communicate these, collaborate with others in order to achieve those goals and to reflect upon the whole process. In short: A school needs to prepare its students to become 21st century lifelong learners. Thus, students are well prepared for learning needs and challenges beyond their formal education [Dynan, 2008].

The idea of self-guided learning has a long tradition back to Humboldt’s educational ideals which connects to a humanistic pedagogy and psychology: the human being as a constitutive, interpreting, self-reflecting and self-developing subject in a learning process [Greif, 1993].

Self-guided learning, as we understand it, is splitted into:

- **planning** of learning by asking appropriate questions to identify learning needs, learning goals, resources and tools as well as to guide the learning,
- **enacting** the plan by using the identified resources and tools
- **revising** the learning which is based on specific needs and ends up in modifications and adjustments of the learning
- **reflecting upon and rethinking** the plan by questioning the assumptions and ideas which led to the initial questions in step 1 [Knowles, 1975; Dynan, 2008].

It is often described as a cyclical process. In NEXT-TELL’s point of view it should not only be understood as a cycle but more like a spiral which grows bigger because every completion of the “cycle” represents progress and improvement.

Self-guided learning is not just the process but also the outcome of the process [Biel, 2011] and it combines different skills and competencies which are known as 21st century skills - i.e., critical thinking, collaboration, communication, creativity [P21, 2012]. Therefore, we decided to create a scenario to foster these different skills and competencies.

Due to the fact that it is not trivial to foster a self-guided learning, the scenario is designed in a way that it can be divided into several sub-scenarios which aims to facilitate different aspects of self-guided learning. Although we will recommend to run the whole scenario, it will also be possible to choose parts of it with minor adaptations to implement it into the curriculum (e.g., if a teacher thinks that his/her students should increase their competence of reflection he/she can run that specific part of the scenario to facilitate the reflection competency within his/her students).

4.3.2 Description of the scenario steps

The scenario is planned as a long-term project-based learning approach (current it is intended for a timespan of around 6 weeks) in which some of the existing NEXT-TELL tools and methods are included. We came to the opinion that it might be easier for teachers to use our tools and methods attached to a specific operational context. Students should get familiarized with the concept of self-guided learning as well as the tools which should be used during the scenario and be assisted step-by-step to increase different competencies and sub-skills of a self-guided learning.

Table 11 provides a rough overview of the scenario. It will be further developed in cooperation with teachers to guarantee a practical implementation.
<table>
<thead>
<tr>
<th>activity</th>
<th>steps</th>
<th>assessed competencies</th>
<th>tools</th>
</tr>
</thead>
</table>
| Familiarization with scenario  | • familiarizing students with scenario and concept of self-guided learning  
• familiarizing students with tools that should be used during scenario |                                                | ECAAD, LucidChart      
OLM Mahara/Moodle gDocs   |
| Negotiation of goals and intended outcomes | • negotiating learning topic  
• planning of learning process and learning goals  
• negotiating assessment criteria between teacher and student  
• giving feedback to each other (teacher and peers)  
• documenting negotiated assessment criteria | • setting learning goals  
• planning learning process  
• collaborating with others | ECAAD, LucidChart     
OLM               |
| Revision of plans (if necessary) | • reflecting on given feedback  
• revising learning plans and learning goals if necessary (documenting changes)  
• adaptation of planned strategies if necessary (depending on feedback of teacher and peers) | • setting learning goals  
• planning learning process  
• reflecting learning process | ECAAD, LucidChart     
OLM Mahara/Moodle gDocs   |
| Enactment of plans             | • enacting learning plans (in focus groups)  
• documenting learning progression  
• documenting reflection processes  
• giving feedback to each other (teacher and peers) | • monitoring learning process  
• reflecting learning process  
• collaborating with others | Mahara/Moodle gDocs OLM     |
| Revision of plans (of necessary) | • reflecting on given feedback  
• revising learning plans if necessary (documenting changes)  
• adaptation of planned strategies if necessary (depending on feedback of teacher and peers) | • monitoring learning process  
• planning learning process  
• reflecting learning process  
• collaborating with others | ECAAD, LucidChart     
Mahara/Moodle gDocs OLM     |
D6.4  
Report on RDS 2

<table>
<thead>
<tr>
<th>activity</th>
<th>steps</th>
<th>assessed competencies</th>
<th>tools</th>
</tr>
</thead>
</table>
| Presentation of learning outcomes | • presenting learning artefacts to whole class  
|                                   | • receiving feedback                      | • (negotiated assessment)              | Mahara |
|                                   | • being assessed by negotiated criteria    |                                        |        |

Table 11: Overview of the different activities and steps of the self-guided learning scenario

4.3.3 Competencies and next steps

The competencies have been split into the following subscales with further sub-competencies [Getha-Taylor, 2008; Jenert, 2008; Wirth, 2008; Van den Boom, 2004; Pintrich, 2002; Zimmerman, 2002; Winne, 1996; Butler, 1995]. These competencies will be included in the NEXT-TELL Open Learner Model (see WP4). The assessment methods for these competencies are currently under development.

Setting learning goals

- identify what needs to be learnt
- setting the frame of learning goals
- commit to learning goals

Planning the learning process

- identify what needs to be learnt according to learning goals
- identify learning resources
- choose appropriate learning strategy
- setting frame of planning process

Monitoring the learning process

- check if content/tasks/material is understood
- evaluate whether executed learning activity correspond with planned strategy
- evaluate whether learning activity correspond with learning goal
- evaluate whether learning strategy is appropriate for learning task
- evaluate whether time frame is still applicable
- adapt learning plan (if necessary)

Reflecting the learning process

- identification of level of reflection process
- description: what has been done
- analysis: how has it been done
- evaluation: what will come next

Collaborating with others

- Showing initiative
- Seeking for information
- Teamwork and cooperation
- Team leadership
- Giving feedback
5 Formative e-Assessment: Studying and Developing for Technology-Rich Classrooms

Section 5 presents four studies conducted during the second half of the second project year. The studies focus on formative e-assessment, though each of them in a different scenario comprising different subjects (STEM vs. TESL), technologies (commercial networked graphing calculators, division tool in development, OpenSim), and steps within the formative e-assessment cycle (implementation or deployment, negotiation). Three of the studies report results from observations in classrooms, one study was a participatory design workshop. Whereas study 1 and 2 have in common that they were run in mathematics classrooms, study 1 and 3 have in common that they analysed the observations from the perspective of the orchestration metaphor. The workshop study focused on teachers’ experiences with and opinions about technology as well as their feedback to the NEXT-TELL tools Repertory Grids for Formative Assessment (RGFA) and the Communication and Negotiation Tool (CoNeTo).

5.1 Mathematics with Classroom Network Technology

<table>
<thead>
<tr>
<th>Category</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study format</td>
<td>Ethnographical observations</td>
</tr>
<tr>
<td>Aims</td>
<td>• Analysing how formative assessment looks like in the technology-rich maths classroom</td>
</tr>
<tr>
<td></td>
<td>• Developing routines with regard to formative assessment</td>
</tr>
<tr>
<td></td>
<td>• Developing ideas how to connect NEXT-TELL’s OLM to the network system in use</td>
</tr>
<tr>
<td>Output</td>
<td>• 3 models on how teachers practiced formative assessment during lessons</td>
</tr>
<tr>
<td></td>
<td>• 1 routine for assessing students’ misconceptions formatively</td>
</tr>
<tr>
<td>Country</td>
<td>The Netherlands</td>
</tr>
<tr>
<td>School type</td>
<td>Secondary School offering European Baccalaureate</td>
</tr>
<tr>
<td>Participants</td>
<td>3 STEM teachers (Mathematics), 5 classes, 48 students</td>
</tr>
</tbody>
</table>

Table 6: Study portrait

5.1.1 Abstract

Technology-rich classrooms in STEM will increase in the future. For mathematics, networked graphing calculator systems are developed. Teachers are promised that these technologies will help them increase students’ learning in mathematics because the technologies should support students’ understanding and teachers’ formative assessment. However, networked classroom systems are complex technologies and implementing them in beneficial ways in the classroom needs to be developed over time. In order to find out how teachers implement these technologies from the perspective of formative assessment we observed five mathematics classrooms (four with and one without a networked graphing calculator system). The teachers were not yet very familiar with the system. Although the system supported teachers in getting a comprehensive overview on how students actually solved the problems, many functionalities which would increase a systematic way of formative assessment were not yet used by the teachers (e.g., ePortfolio). We elaborated a teacher’s approach to solve students’ typical errors (misconceptions) by modelling a respective pattern. In next steps, we need to clarify how NEXT-TELL can support teachers’ in formative assessment and
finding out how they can inquiry their own teaching with the system and its influence on students’ learning (see TISL).

5.1.2 Introduction

When researching and developing formative assessment for learning at school, NEXT-TELL is interested in how to support technology-rich classrooms with further developments on formative e-assessment. Classroom network technologies which enable technology-mediated communication and classroom participation integrated into face-to-face instructions (e.g., clicker systems, networked graphing calculators) build an interesting entrance point because they allow for rich data output. The common feature of classroom network technologies is that they allow the teacher to see what the student is doing on his/her computer or technological device. The teacher can observe this on a computer screen, however, more important, (s)he can also show this view on a digital (white)board. Beyond this basic functionality there are other functionalities which should support instruction. Because some mathematics teachers participating in NEXT-TELL teach with the Ti-Nspire™ Navigator™ Software by Texas Instruments (funded by NEXT-TELL), we will briefly describe the functionalities offered by this system [Texas Instruments, 2011] and how they are related to cognitive density. The Ti-Nspire™ Navigator™ Software offers:

- **Lesson Bundle**: It allows teachers to bundle several files. Each bundle can contain different files. As teachers can use this for preparing which contents they want to send to which students it is connected with the diversity aspect of content density.

- **Sending Files**: It allows teachers to send files (also bundles) from their computer to the students’ calculator. This transfer functionality allows parallelism but also selection of students and thus is related to communicative and temporal density. Moreover, students can send files back to the teacher.

- **Pausing Class**: It pauses the calculator, and thereby allows the teacher to stop all students working with the calculator at once. Pause activity can be used to orchestrate activity synchronization as part of communicative and temporal density.

- **Screen Capture**: It allows showing students’ calculator screens on a digital whiteboard. It allows the teacher but also students to see easily what each student is doing on his/her calculator. This functionality is thought to enhance the teacher’s diagnostic power. Furthermore, the screens can be saved.

- **Live Presenter**: It allows to select one student with his/her calculator on the digital whiteboard. The key press history can be shown and the actions on the screen can be saved as video file.

- **Review with Quick Poll**: It allows teachers to send polls to students. A poll can be made to ask for a) multiple choice, b) open response, c) equations, and d) coordinate points and lists. The students answers can be shown (anonymously) at the digital whiteboard. Using a poll is related to communicative and temporal as well as content density. Moreover, it is thought to might enhance teachers’ diagnostic power and students’ metacognition.

- **Portfolio with Class analysis**: Teachers can also integrate questions/polls in students files. Students’ responses are saved and can be displayed to the teacher in different formats. This functionality is thought to enhance teachers’ diagnostic power and decision making.

According to Clark-Wilson, these functionalities support formative assessment procedures in the classroom [Clark-Wilson, 2008; 2009].

Despite an increase in research on such tools [Penuel, 2005], however, DeBarger and colleagues noticed that there is not much research on how teachers can use such tools supportively in order to enhance learning [DeBarger, 2010]. Hence, lots of research focuses on which technology functionalities teachers use [e.g., Clark-Wilson, 2009] or how teachers orchestrate networked classroom technologies. This research led to the description of different orchestration types [e.g., Drijvers, 2010]. Drijvers and colleagues distinguish six orchestration types or better patterns which are related with teachers’ use of the system’s functionalities:

- **Technical-demo**: The teacher demonstrates a tool technique.
- **Explain-the-screen**: The teacher explains what is demonstrated on the digital board (screen). The explanations include mathematical content.
- **Discuss-the-screen**: The teacher involves the students in a whole-class discussion. Contrary to the explain-the-screen pattern, the focus lies on students’ explanation of the results.
- **Link-screen-board**: The teacher stresses the relationship between what is shown on the digital board (screen) and it is related to conventional mathematics on paper or analogue board in order to support the translation from one to the other representation [Billington, 2009].
- **Spot-and-show**: During preparation the teacher can select students’ work that is interesting to discuss about. During the lesson the teacher can show this specific work and discuss it in class.
- **Sherpa-at-work**: A student presents his/her work with the technology or to carry out the actions that the teacher requests.

The description of the six orchestration patterns reveal that “explain-the-screen” and “discuss-the-screen” use the screen/digital whiteboard in a very similar way. The distinction of the patterns results from how the teacher guides the discussion. The same is true for the patterns “spot-and-show” and “sherpa-at-work” which basically differ with regard to whether the student has already done the task (e.g., homework) or whether (s)he is doing it during the lesson.

In contrast to researchers analyzing teachers’ ways of orchestration other researchers focus on developing so called teaching patterns or routines which are designed to serve as a template which teachers can use for their specific topics [DeBarger, 2010]. We assume that NEXT-TELL offers a promising way for analysing how classroom network technologies are implemented into face-to-face classroom instructions and how to improve its implementations by means of its comprehensive framework comprising formative assessment, cognitive density, and classroom orchestration. The first study in investigating and developing formative e-assessment for classroom network technologies is described in more details below.

One aim of the study was to investigate how teachers use a networked graphing calculator system like the TI-Nspire™ Navigator™ Software offered by Texas Instruments from the perspective of formative assessment, the orchestration metaphor and cognitive density framework. Contrary to the above-mentioned studies on networked graphing calculators, NEXT-TELL starts investigating how teachers use such a system in the wild, that is, how teachers use it so far without special instructions for content and instructional design from researchers [cf. Drijvers, 2010 and Clark-Wilson, 2008; 2009]. Building on this information, developments concerning routines are suggested. The further aims of NEXT-TELL are to investigate (1) whether and how the orchestration of (networked) graphing calculators enhances students competences in Mathematics and (2) whether and how data from the TI-system can be used beyond the possibilities in the TI-system for the idea of formative e-assessment in NEXT-TELL.

### 5.1.3 Methods

**Participants**

Two researchers from the KMRC visited five Mathematics classrooms (grades 4, 5, 6, and 7) with altogether 48 students of three teachers in a European School. The teachers had taught with TI-Nspire™ Navigator™ Software for about five months and with the TI graphing calculators for about 18 months. In order to keep teachers’ anonymity as high as possible, we name the teachers in the text Teacher 1, 2, and 3, whenever it is necessary to distinguish between them, otherwise we just write teacher. Whereas one of the teachers had a teaching experience of about 16 years, the two others had teaching experience of about 37 to 40 years. All three teachers were male. According to the European School system, each teacher held his lessons in his mother tongue. Hence, one of the teachers taught in French, the second in English, and the third in Dutch. Most of the students in each class but not all had the same mother tongue like the teacher. The teachers were not familiar with practicing formative assessment explicitly. When we introduced NEXT-TELL to them the teachers liked the idea of formative assessment but also admitted that they are used to summative assessment procedures.
Procedure

We followed the ethnographical approach and collected various data and impressions of the teachers during several face-to-face and technology-mediated communication. We met the teachers three times face-to-face: (1) at a workshop on the TI-Nspire™ Navigator™ Software where we got to know each other, (2) at a plenary meeting where we introduced the project to two of them and talked about formative assessment as well as their teaching situation with graphing calculators, and (3) at the school visit enduring two days. In-between the latter two meetings and afterwards we had e-mail and skype contact with mainly one of the teachers (the contact person) in order to organize our visit, provide further information, and discuss about their experiences and interests as well as the results. The data that are described below are the results of five classroom observations. The five classroom observations took place on two days. The teachers had selected the classes.

Data Gathering

In accordance with the ethnographical method and with the permission of the teachers we made field notes during our class visits and audiotaped the sessions when we met with them separately. Moreover, we reflected on our observations individually and together.

Data Analyses

For analysing the data we went through our field notes and individual reflections. We listened to the audiotaped sessions where we discussed our experiences from the observations with the teachers. Furthermore, we discussed our experiences several times from the perspectives of formative assessment, classroom orchestration as well as cognitive density. We then “transcribed” our field notes into the models of NEXT-TELL’s ECAAD-Planner and focused on the incidents which seem to be the most important from the NEXT-TELL perspective. This was done by partially applying the reflection procedure of the ALACT model ourselves [Korthagen, 1999]. We came up with the following table (see Figure 12) to reflect in seven steps on our observations and move on to develop new ideas for implementing the TI-system.

<table>
<thead>
<tr>
<th>Looking back</th>
<th>Looking back</th>
<th>Diagnosing</th>
<th>Interpreting</th>
<th>Finding Rationale</th>
<th>Creating alternatives</th>
<th>Finding strengths and weaknesses of ICT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher's Activity</td>
<td>Students' Activity</td>
<td>Cognitive Density</td>
<td>Researchers' Hypotheses</td>
<td>Theoretical background</td>
<td>Possible Consequences for using TI Navigator</td>
<td>Function of TI usage</td>
</tr>
<tr>
<td>Used Quick Poll with 4 possible solutions for a task</td>
<td>students who voted for highest rated solution were engaged when asked to present solution; analog whiteboard was used for solving the “wrong solution”</td>
<td>Communicative Density rather high; Cognitive Density likewise; timely feedback for teacher through poll</td>
<td>Quick Poll was used to assess students’ misconceptions.</td>
<td>Assessment for Learning</td>
<td>According to Assessment for Learning one might make another Quick Poll to test whether the misconceptions were solved (this needs materials to be prepared and more explanation if students still have misconceptions).</td>
<td>enabling Assessment for Learning; the teacher &amp; students get detailed overview of his students’ knowledge level (misconceptions). TI allows for preparation</td>
</tr>
</tbody>
</table>

Figure 12: Screenshot from the reflection table to analyse the observations.

5.1.4 Results: 3 Examples

We describe three specific examples showing how two teachers used the TI-system for formative assessment compared to a non-TI-system classroom.

Example 1: Assessing Students’ Understanding without Technology

Class descriptions: 11 students in grade 5 of secondary education
Topic: Probabilities
Resources: graphing calculators, digital whiteboard, school book
The first example on classroom assessment is from a lesson in which students could use the TI-calculators and school book but in which there was no TI-Nspire™ Navigator™ Software run by the teacher. We chose this example because it demonstrates a “comprehensive” class assessment without technology. Once in the lesson, the teacher assessed or asked each student for his answer without having all students made use the calculator and without the network system. When sharing our experiences with the teacher afterwards, we were informed that the class contained many at-risk-students with regard to Mathematics. Therefore, the teacher is happy if the students use the graphing calculator but he does not want to force them, because the risk would be too high that these students gave up totally. Before we detail the comprehensive assessment method without technology, we shortly describe the interaction pattern and assessment method used for the other problems.

The overall interaction routine of this lesson was that the teacher asked students to solve a problem. The problems were either read aloud from the mathematics school book or the teacher generated the task which fit to the students. The teacher asked for the answers but emphasized at four times that he was much more interested in how the students solved the tasks. During the time students calculated, the teacher often walked around and had a look at some calculators. When students were more or less finished with solving a task, one or two students said the answer. When there were several wrong answers the teacher asked for the solution procedure or explained it himself (partly with writing down the procedure at the analogue whiteboard). Figure 13 shows the lesson visualised as learning progression map generated in NEXT-TELL’s ECAAD-planner.

Figure 13: Learning progression model of the example lesson 1 without network technology
Subsequent to explaining a problem’s answer by means of the probability tree, the teacher asked for the result of the problem “What is the probability that two of you (so, two out of eleven) have birthday at the same month?” (about 15 minutes after the beginning of the lesson). All students seemed to be highly interested in finding out the right solution. Most of them, but not all, used the calculator to solve the problem. After about three minutes, the teacher did not ask the whole class at once and then let one or two students answer but he asked all students subsequently (one after the other) for his/her answer. A student just said his/her answer, then the next student followed already and the teacher forced the speed a bit. Figure 14 visualises the assessment method model generated in the NEXT-TELL ECAAD planner. The students as well as the teacher seemed to enjoy this type of assessment. This class assessment took about 30 to 60 seconds altogether. Each answer was long enough for the teacher to detect greater deviations from the solution he expected. Only once, the teacher stopped at one student who gave a totally different answer than the students before. The teacher wanted to know what she did and she tried to explain but the teacher did not understand her explanation. In order not to interrupt the assessment-procedure for too long, he went on with asking for the results from the others. Subsequently, the teacher wrote down the result on the analogue whiteboard. He did not return back to the student’s difficulty, probably because it was not possible for him to understand in a more or less appropriate amount of time how the student had tried to solve the problem. Although the procedure was a very quick test for the teacher of how well his students had understood the task and gave him a transient overview, it was probably much too quick for the students to reach the same overview as the teacher. Furthermore, it was probably much too quick for the students to understand their knowledge level or learning progression. Moreover, to provide the correct answer (and not an estimation) the teacher solved the task himself and partly on the board, partly in the head and according to the researchers estimation also in a rather quick manner which not all students could probably follow. Subsequent to the result discussion the next task followed. This time the teacher asked for the solution procedure only.

Figure 14: Assessment method model “Comprehensive classroom assessment”

Figure 14 shows the sequential character and transience of the assessment method which could had been overcome only by writing down the answer of each student on the analogue whiteboard. Compared to this
example, the following two examples show some strengths of networked technology in the Mathematics classroom.

Example 2: Continuous Monitoring and Feedback

_class descriptions:_ 3 students in grade 7 and 1 from grade 5 of secondary education (final school year)
_topic:_ Curve sketching
_resources:_ Computer for teacher, TI-Navigator Software, TI-calculators, digital whiteboard, analogue whiteboard, task sheets

The second example was a lesson with only four students. Subsequent to connecting calculators to the system and task assignments, the students started to work on the assignments. Each student worked on his/her own. The teacher carefully watched his students and walked from student to student to provide help. The teacher continuously went from student to student. The individual support dialogues between teacher and student lasted between 30 seconds and 2 minutes. Only twice the teacher put a question to the whole class to get an answer for the respective student. Whenever all students had solved a task, the teacher walked to the digital whiteboard where the solutions of the four students were visualised. The teacher shortly checked the solutions, then he “discussed-the-screen”, and mostly “explained-the-screen” - often one solution after the other (see Figure 15). In some cases he wrote down the result on the analogue whiteboard. In another case, he highlighted the important aspect of the student’s solution on the digital whiteboard. As students used different representations (formula vs. graphs), there were four different representations on the digital whiteboard. The teacher sometimes compared the representations, however, this was not done systematically. During sharing our experiences from our observations with the teacher afterwards, he told that he was happy to work with graphing calculators, because they allow students to choose which type of representation they want to work with to solve a problem.

Figure 15 shows the learning progression model of the lesson. The respective assessment method model is visualised in Figure 16.
Teacher 2 did not use specific functionalities of the TI-Navigator Software during that lesson. He also used a rather typical way of dominating the lesson when he explained students’ solutions. However, the fact that students’ solutions were visualised on the digital whiteboard supported him to go into details of each solution and to compare solutions and the type of mathematical representation students used to solve the problems.

![Diagram of assessment method model “Continuous assessment”]

**Figure 16: Assessment method model “Continuous assessment”**

**Example 3: Assessing (and Resolving) Students’ Misconceptions by Means of a Poll**

*Class descriptions:* 20 students in grade 4 of secondary education  
*Topic:* Pi  
*Resources:* Computer for teacher, TI-Navigator Software, TI-calculators, digital whiteboard, analogue whiteboard, task booklet

The third example describes the activities we observed when one of the teachers formatively assessed whether his 4th grade students had understood a concept in the topic about Pi or whether they had made typical errors which might be interpreted as a misconception concerning the calculation of a type of mathematical procedure [Merenluoto, 2004; Tirosh, 2004; Vosniadou, 2004]. The students had to use the TI-calculator and the teacher used TI-Nspire™ Navigator™ Software to do a poll. Because we assume that finding out students typical errors
and misconceptions and resolving them is an important but critical part in teaching Mathematics, we developed this issue further from the perspective of classroom routines (see below). Figure 17 depicts the learning progression model generated in NEXT-TELL's ECAAD modeller which focuses on this instructional phase only, although the lesson consisted of other phases before (e.g., discussion of last Math test). Each of the boxes in the model can be further elaborated by defining which activities, resources etc. are needed to enact that step during a lesson. For example, the first box labelled “Teacher provides task for misconception” can be elaborated by defining which tasks the teacher selected and how (s)he wants to introduce the following activities. The second box shows that the students had to solve a task on their own with the calculator. The third box labelled “Poll 1: Misconception” was elaborated. The respective assessment method model is depicted in Figure 19. It clearly shows the parallelity of collecting data (compared to the assessment method model of the lesson without the TI-Navigator system) and shortly how the TI-system processes the data.

Figure 17: Learning progression map of example lesson 3 with network system

Figure 18: Learning activity model “Resolving misconceptions”
We concentrate on the elaboration of box 4 labelled “Resolving misconception at class level” which is an elaborated description of the activities we observed (see Figure 18) after the teacher had asked the students to solve a task and to vote which of the poll’s answers was theirs. The following steps were:

- **Learning progression model**: Subsequent to collecting students’ answers the teacher showed the results of the poll on the digital board. Figure 19 shows the assessment method underlying the poll. One answer was voted by seven students. Two other answers were voted by five students respectively, and one answer was only given by three students.

- **Learning activity model**: The teacher asked which students had given the answer that was voted most often. He asked one of the students to write down his procedure on the analogue whiteboard.

- After the student was finished, the teacher provided the information that although this answer was voted by most of the students, that answer was wrong.

- The teacher asked further which students had voted for the answer with the three votes. This was the correct answer. He asked whether these students could explain why the answer on the analogue whiteboard was wrong.

- Two students explained what was wrong with the answer on the board.

- Subsequently, the teacher asked why the other answers were wrong and students explained why the other two answers were wrong. Subsequent to the last explanation the lesson was over.

As the verbal description shows, the discussion of the incorrect and correct solution followed the Initiate-Response-Evaluate pattern led by the teacher which is a very prevailing communication pattern in classrooms. The teacher did not use the digital whiteboard to demonstrate or let students discuss the errors and solutions. Hence, the teacher did not use the “discuss-the-screen” pattern. Moreover, the teacher used the poll function of the TI-system once in order to assess students’ typical errors (or misconceptions) in order to make them aware of their errors and learn the correct solution. Therefore, this part of the lesson can be called a formative assessment instruction undertaken in the classroom to resolve typical errors and/or misconceptions. The procedure contained individual work (solving task at first and then sending poll) which demanded all students to engage in the task at first as well as classroom collaboration because the discussion of resolving typical errors was done with the whole class.

![Figure 19: Assessment method model “Poll 1: Misconception”](image-url)
5.1.5 Development: Routines for Assessing and Changing Misconceptions

As one aim of the collaboration with the teachers is to support them in finding beneficial orchestration patterns with regard to the TI-system, we not only analysed their implementation of the technology but also started with the development of alternative implementation scenarios (fourth step according to the ALACT model and sixth step in our analyzing table).

We assume in line with DeBarger and colleagues that it is useful to develop patterns or routines for teaching with technology [DeBarger, 2010]. Building on the observations made during the lessons (see above), the transcriptions of the teachings into the ECAAD modeller, and on different literature, we elaborated the teacher’s approach of using a poll for formatively assessing students’ misconceptions / typical errors and the subsequent classroom orchestration. The elaboration is the first version of a routine or pattern which is modelled in order to show the possible adaptive parts of it. Compared to our observations, the changes focus mainly on temporal density (especially transience) by using the analogue and digital whiteboard at the same time for demonstrating the incorrect as well as the correct solution but also on content density by providing feedback on students’ short-term learning progression after a second poll (and its comparison with the results of the first one). The communication density is kept similar because after the poll the discussion is also done with the whole class. Three more students are additionally involved to exert the step-by-step procedure either on the analogue whiteboard or on their calculators that are screen-captured on the digital whiteboard.

Figure 20: Learning progression map suggested for dealing with misconceptions
- **Learning progression model** (Figure 20): The teacher does a poll to get an overview of students’ understanding and misconceptions. Figure 19 shows the assessment method underlying the poll.

- According to the distribution of the solutions the teacher decides how (s)he proceeds with handling the misconception (in our worked-out example the majority of the students has the same misconception).

- **Learning activity model** (see Figure 21): The teacher selects four students. Two of them solve the problem with the calculator which is demonstrated on the digital whiteboard (so called “sherpa-at-work” pattern), whereas the other two students write down the solution steps on the analogue whiteboard. Thereby the transience of the calculator is circumvented. Moreover, the teacher can direct the focus of the procedure to the differences between mathematics on paper (analogue whiteboard) and with technology. This would enhance the “link-screen-board” pattern.

- The students are asked to compare the steps and discuss the differences with regard to their mathematical meaning. Furthermore, the teacher can mix the “discuss-the-screen” pattern with “explain-the-screen” depending on students’ understanding.

- **Learning progression model**: Subsequent to the demonstrations and discussions the students are asked to solve a problem of the same type on their own and the teacher sends a second poll to test students’ understanding. The teacher shows students’ answers on the digital screen to show and reflect with them the results. Ideally, the result of the first poll is compared with the result of the second poll. The second poll does not need to be in the same lesson but can also be used for the next lesson or when discussing the following homework. Discussing the results of the first and second poll should enhance students’ metacognition concerning their learning progression.

---

**Figure 21: Learning activity model “Majority WITH Misconception”**
5.1.6 Conclusions and Next Steps

Our observations of five classes with a networked graphing calculator system showed that the usage of the networked system and the usage of the calculators alone can be manifold. Which functionalities of the technology were used depended on the teacher.

We selected three examples in order to demonstrate how formative assessment during teaching in one-to-one classrooms can look like. The positive aspects of networked classroom technology are obvious. The TI-Nspire™ Navigator™ software allows teachers to see what each student is doing with the calculator. This supported the teacher to explain students’ solution compared to the lesson without the networked system where the teacher did not know what the students actually calculated. However, the digital whiteboard is not watched the whole time by students or teachers. If there are more than eight or ten calculator screens to display on the whiteboard, the size of each screen representation becomes rather small for students. Furthermore, it does not seem that natural for younger students to work with the digital whiteboard for explanations but rather it seems that they prefer the calculators as concrete objects.

When analysing the observations from the perspective of formative assessment and based on the ALACT model, we observed how one of the teachers used a poll in order to get an overview of his students and to clarify misconceptions or typical errors. Although we think that this was a good way to use the poll, we used this example in order to demonstrate how classroom network technology can be more exploited from the perspectives of formative assessment and cognitive density.

Our next steps will be to clarify with the teachers how to investigate whether and how the usage of the TI-system and calculators influence theirs students learning. Moreover, in order to implement formative e-assessment teachers would need to start collecting and saving students’ data within the system. If students’ data are collected, NEXT-TELL can develop a solution to send the data into an OLM (see WP4).

5.2 Using the Division Practice Tool Sonic Divider in the Mathematics Classroom

<table>
<thead>
<tr>
<th>Category</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study format</td>
<td>Observations, questionnaires</td>
</tr>
<tr>
<td>Aims</td>
<td>• Supporting students in their learning as well as increasing depth of knowledge by using a specific ICT tool</td>
</tr>
<tr>
<td></td>
<td>• Supporting teachers in teaching and assessing of a specific teaching activity in the classroom by using the Sonic Divider</td>
</tr>
<tr>
<td></td>
<td>• Developing ideas for refinement of division tool</td>
</tr>
<tr>
<td>Output</td>
<td>• Fruitful feedback for project partners on formative e-assessment</td>
</tr>
<tr>
<td>Country</td>
<td>Austria</td>
</tr>
<tr>
<td>School type</td>
<td>Primary School</td>
</tr>
<tr>
<td>Participants</td>
<td>1 STEM teacher (Mathematics), 1 class, 20 students</td>
</tr>
</tbody>
</table>

Table 7: Study Portrait

5.2.1 Abstract

In this report, the cooperative work between the KPH Praxisschule Graz and NEXT-TELL, in particular TUG, is described. The aim of this collaboration was two-fold: (1) Supporting pupils in their learning as well as increasing their depth of knowledge by using a specific ICT tool; and (2) Supporting teachers in their teaching and assessing of a concrete teaching activity in the classroom by using a specific ICT tool. Based on the guide scenario ‘Division with a single divisor’ a division practicing tool, was developed and then embedded and
applied in the classroom. This report describes on the one hand the developmental process of this tool and on the other hand the experiences made by teachers while using it.

5.2.2 Introduction

In 2011, TUG held a 2-day workshop in Bad Waltersdorf with the main purpose to disseminate the project and its fundamental ideas, in particular formative assessment. From this workshop close cooperation with interested teachers and schools resulted which allows for directly involving teachers and their experiences in the NEXT-TELL research project. In the following sections, first a general overview of the educational purposes of primary schools in Austria should be given. After that, the cooperative work with one of these schools, a primary school located in Graz (Styria, Austria) should be described in more detail.

Schools providing general education: Primary schools

In Austria, primary schools (Volksschulen) have the main purpose to provide all pupils with the same elementary education. A particular focus is placed on the social integration of children with specific needs. The primary level lasts four years and is subdivided into 2 sublevels. The first two years are considered as a unit (elementary level I) where all children automatically proceed to the second year, irrespective of the assessment of their performance. From the third year onwards a foreign language is taught, but without assessment of the pupil's performance. This basic and well-balanced general education is supposed to foster children's social, emotional, intellectual and physical skills and abilities. Taking into consideration the individual educational needs and capacities, the primary school has to fulfil the following tasks in order to establish the basis for successful learning in the secondary schools: i) encourage and develop pupils' enjoyment of learning, their skills, and interests; ii) strengthen their self-confidence in their own abilities and potential; iii) build and improve their social skills, especially their ability to communicate and to express themselves to others; iv) evolve and impact basic knowledge, skills, abilities, and attitudes that help them learn elementary cultural techniques including the child-adapted use of modern information and communication technologies; v) gradually advance their attitudes to learning and work; and vi) guide them towards an independent and goal oriented learning.

Praxisschule KPH Graz

In Austria, teachers were trained for compulsory schools (e.g., primary schools) by the University colleges of teacher educations. In so-called training or practical schools (Praxisschule) future teachers can gain practical teaching experience. Furthermore many teachers are directly involved in research and the development of innovative practice (e.g., new methods of teaching and learning). One of such a school is the KPH Praxisschule Graz (see figure 22), a primary school that is an integral part of the University College of Education of the RC Diocese of Graz (Kirchliche Pädagogische Hochschule Graz). Its profile and pedagogical aims can be described as child-centered, inclusive, holistic and open to the world. The pedagogical ambition behind is to support children's individual ways of learning and to see them as a starting-point of pedagogical efforts. This orientation serves as basis for setting new accents in teacher training that foresees the practical use and usefulness. Thus the main aim is to better prepare teachers to face the needs and the challenges of heterogeneous groups of learners. In the KPH Graz the concept of heterogeneous classes (regarding pupils' age in each form) are adopted and put into practice. Additionally special attention is being paid to the social integration and education of children with specific needs and a need for special support. In addition to the current practice of social and pedagogical care, if needed, specific concepts for those people will be developed.
The KPH-Praxisschule Graz mainly follows the Jenaplan-approach\(^2\), a progressive teaching method which includes the following central ideas: i) concept of community life (i.e. “life community school”) where the school is rooted in the local community rather than being an isolated institution; ii) promoting pupils’ autonomy in their learning through self-discovery; and iii) formative and verbal assessment which takes into account the child’s overall development and personality. Due to the application of this method and approach, the KPH Praxisschule Graz is able to respond to the 21\(^{st}\) century learning challenges by applying the following aspects: mixed age groups, individualisation of the learning and the evaluation process, integration of students with minor physical challenges and/or learning difficulties, and a student-teacher relationship which is characterised by warmth, sympathy, empathy and confidence. The project NEXT-TELL picks up on these ideas focusing particularly in the support of individual learning as well as in promoting formative assessment processes and the related teaching with smart planning, assessment and teaching technologies.

With this in mind, the cooperative work between the KPH Praxisschule Graz and NEXT-TELL, in particular TUG, pursued the following two main goals:

- Supporting pupils in their learning as well as in increasing their depth of knowledge by using a specific ICT tool
- Supporting teachers in their teaching and assessing of a concrete teaching activity in the classroom by using a specific ICT tool.

Together with the principal of the school as well as a very engaged teacher, we decided to use the domain ‘Division with a single divisor’ as a first example and guide scenario. Division is an important operation concept which is related to the concepts of addition, subtraction and multiplication. The relation of these operational concepts allows that one can be understood through the exploration of another. In a society where such concepts are used frequently in everyday life within varying situations, learning and understanding these operation concepts are crucial as well as beneficial for students.

5.2.3 Competencies and Tool Development

In the following section, the working steps which are necessary to achieve both of the goals, mentioned in the section above, relating to our example and guide scenario were described in more detail.

---

\(^1\) http://kphgraz.at/kps.html
\(^2\) http://www.schome.ac.uk/wiki/Jenaplan
Skill Structure Specification

In total 35 skills were identified that seem to be sufficiently strong to describe the domain “Division with a single divisor” (see table 8). The single skills which were identified mainly refer to and describe the single steps which are necessary to successfully solve the division task. In a second step these skills were analysed regarding prerequisite relations among them which is illustrated in figure 23. In a further step, in total 71 division problems were constructed which can be allocated to one out of four different degrees of difficulty (ranging from 1 ‘easy’ to 4 ‘difficult’). This was followed by assigning underlying skills (those which were defined before) to each single problem. Additionally, a specific rule was defined including a set of such skills that are necessary for being able to generally solve division problems. Table 9 presents examples for division problems for each level of difficulty, their underlying skills, as well as the respective skill-rule.

<table>
<thead>
<tr>
<th>No.</th>
<th>Abbr.</th>
<th>Short Description</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mu2R</td>
<td>101 for 2</td>
<td>1x2; 2x2; 3x2,..</td>
</tr>
<tr>
<td>2</td>
<td>Mu3R</td>
<td>101 for 3</td>
<td>1x3; 2x3, 3x3,..</td>
</tr>
<tr>
<td>3</td>
<td>Mu4R</td>
<td>101 for 4</td>
<td>1x4; 2x4, 3x4,..</td>
</tr>
<tr>
<td>4</td>
<td>Mu5R</td>
<td>101 for 5</td>
<td>1x5; 2x5, 3x5,..</td>
</tr>
<tr>
<td>5</td>
<td>Mu6R</td>
<td>101 for 6</td>
<td>1x6; 2x6, 3x6,..</td>
</tr>
<tr>
<td>6</td>
<td>Mu7R</td>
<td>101 for 7</td>
<td>1x7; 2x7, 3x7,..</td>
</tr>
<tr>
<td>7</td>
<td>Mu8R</td>
<td>101 for 8</td>
<td>1x8; 2x8, 3x8,..</td>
</tr>
<tr>
<td>8</td>
<td>Mu9R</td>
<td>101 for 9</td>
<td>1x9; 2x9, 3x9,..</td>
</tr>
<tr>
<td>9</td>
<td>In2</td>
<td>2 goes in</td>
<td>e.g. 12:2=? → 2 goes in 12 = 6 times</td>
</tr>
<tr>
<td>10</td>
<td>In3</td>
<td>3 goes in</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>In4</td>
<td>4 goes in</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>In5</td>
<td>5 goes in</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>In6</td>
<td>6 goes in</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>In7</td>
<td>7 goes in</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>In8</td>
<td>8 goes in</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>In9</td>
<td>9 goes in</td>
<td></td>
</tr>
</tbody>
</table>

‘Goes in/ is in’ rule for the number space 100

Inverse task (adding up)
## Table 8: List of skills

<table>
<thead>
<tr>
<th>No.</th>
<th>Abbr.</th>
<th>Short Description</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Um2R</td>
<td>101 for 2</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Um3R</td>
<td>101 for 3</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Um4R</td>
<td>101 for 4</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Um5R</td>
<td>101 for 5</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Um6R</td>
<td>101 for 6</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Um7R</td>
<td>101 for 7</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Um8R</td>
<td>101 for 8</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Um9R</td>
<td>101 for 9</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Add1</td>
<td>Written addition proc.</td>
<td>To be able to master the addition</td>
</tr>
<tr>
<td>26</td>
<td>Sub1</td>
<td>Written subtraction proc.</td>
<td>To be able to master the subtraction</td>
</tr>
<tr>
<td>27</td>
<td>KrZR1000</td>
<td>Mental arithmetics in the number space 1000</td>
<td>To be able to master the mental arithmetic in the number range up to 1000</td>
</tr>
<tr>
<td>28</td>
<td>Or100</td>
<td>Secure orientation in the number range up to 100</td>
<td>Safe orientation in the number range up to 100</td>
</tr>
<tr>
<td>29</td>
<td>SwgSw</td>
<td>Digit space appropriate writing</td>
<td>To be able to correctly spelling single steps of calculation</td>
</tr>
<tr>
<td>30</td>
<td>AlgStr</td>
<td>Sequence of written division</td>
<td>Knowledge of the single steps of calculation</td>
</tr>
<tr>
<td>31</td>
<td>Div1in1</td>
<td>1st step of calculation: Division step 1</td>
<td>Divisor 1 in 1</td>
</tr>
<tr>
<td>32</td>
<td>Multerg</td>
<td>2nd step of calculation: Division step 2</td>
<td>101 and adding</td>
</tr>
<tr>
<td>33</td>
<td>herhol</td>
<td>3rd step of calculation: Division step 3</td>
<td>Spelling (&quot;bringing down&quot;)</td>
</tr>
<tr>
<td>34</td>
<td>iGvorst</td>
<td>Identification of the digit space of the result in advance</td>
<td>Knowledge of the basic concept of division</td>
</tr>
<tr>
<td>35</td>
<td>Übrech</td>
<td>Roughresult estimation</td>
<td>Applying the rough calculation</td>
</tr>
<tr>
<td>36</td>
<td>Erg</td>
<td>Adding and completing</td>
<td>e.g. 13:2=? 2 goes in 13 6 times with a remainder of 1</td>
</tr>
</tbody>
</table>

**Figure 23: Prerequisite relation for the skills of the domain 'Division with a single divisor'**
Problems | Difficulty | Skills | Rule for each division problem
--- | --- | --- | ---
442 : 2 = | 1 | 1;9 | 25,28,29,30,31,32,33,34,35,36
639 : 3 = | 1 | 2;10 | 25,28,29,30,31,32,33,34,35,36
993 : 3 = | 1 | 2;10 | 25,28,29,30,31,32,33,34,35,36
369 : 3 = | 1 | 2;10 | 25,28,29,30,31,32,33,34,35,36
426 : 3 = | 2 | 2;10 | 25,28,29,30,31,32,33,34,35,36
928 : 4 = | 2 | 3;11 | 25,28,29,30,31,32,33,34,35,36
775 : 5 = | 2 | 4;12 | 25,28,29,30,31,32,33,34,35,36
738 : 6 = | 2 | 5;13 | 25,28,29,30,31,32,33,34,35,36
836 : 7 = | 3 | 6;14 | 25,28,29,30,31,32,33,34,35,36
999 : 8 = | 3 | 7;15 | 25,28,29,30,31,32,33,34,35,36
865 : 4 = | 3 | 3;11 | 25,28,29,30,31,32,33,34,35,36
681 : 5 = | 3 | 4;12 | 25,28,29,30,31,32,33,34,35,36
302 : 4 = | 4 | 2;10;36 | 25,28,29,30,31,32,33,34,35,36
608 : 3 = | 4 | 2;10;36 | 25,28,29,30,31,32,33,34,35,36
407 : 3 = | 4 | 2;10;36 | 25,28,29,30,31,32,33,34,35,36
804 : 6 = | 4 | 5;13;36 | 25,28,29,30,31,32,33,34,35,36

Table 9: examples for division problems for each level of difficulty, their underlying skills, as well as the respective skill-rule

**Sonic Divider**

For the realisation of this guide scenario in the real classroom a specific learning tool, the so-called *Sonic Divider*, was designed by TUG. The general idea of *Sonic Divider*, a division rehearsal tool, is two-fold. On the one hand it is a learning tool with the main purpose to support pupils in deepening their knowledge of the division operation. In this sense the tool enables pupils to apply and to practice all single steps of calculation, the so-called division algorithms which are necessary to successfully solve a division problem (cf. figure 24). Additionally to the training function, the tool gives pupils concrete and constructive feedback on their performance by demonstrating those areas where further work and training is needed. Apart from pupils, also teachers can benefit from using *Sonic Divider* in their classroom. The tool can be additionally used to other traditional teaching materials on the one hand. On the other, it supports teachers in their formative assessment by giving a precisely accurate performance protocol and visualisation for each pupil. This enables the teacher to detect individual problems. In further consequence, the teacher is able to take into account the child’s individual abilities as well as learning difficulties.

A detailed description of this division rehearsal tool can be found in D2.4 and D2.8.
Procedure: Sonic Divider in the classroom

To investigate the impact Sonic Divider may have on learning and teaching, we conducted a classroom study at the KPH Praxisschule Graz. Over a period of two weeks, Sonic Divider was embedded in the teaching and learning activities of one school class, the so-called Sonnen-Klasse (Sun-Class). The Sonnen-Klasse is an integrative school class comprising 20 children of different age groups assigned to the third and fourth grade. As the Sonic Divider is a rehearsal tool, we decided in our investigation to primarily focus on teachers’ experiences with the tool and its usage. The survey that is used to gather information on this issue is developed by TUG and covers the following four aspects: ease of use, usefulness, opinion on the visualisation- and feedback-function, and general feedback on the tool and its functionalities (e.g., user satisfaction). In addition to questions where a Likert scale of 1-5 (with 5 having the best value) for the response is used, each aspect is complemented by open questions, allowing to get additional, more detailed, qualitative feedback. This comprehensive data collected is used to derive ideas for further improvement and refinement of the division tool.
5.2.4 Results

The experiences with the tool Sonic Divider resulted to be very good. Teachers’ general opinion on the tool is very positive: they are satisfied with both the tool in general and the particular functionalities that are offered to them such as design, interface, feedback and visualisation. Characteristics of tool such as its ease of use, its goal orientation as well as its stimulative nature were particularly emphasized. A closer look at teachers’ perceived usefulness of the tool for both pupils and teachers also shows a high level of user satisfaction. This is also motivated by the fact that teachers assume Sonic Divider as being a good supplement to traditional teaching methods. It supports the formative assessment process by providing a precise protocol of students’ performances, their (division-) abilities and weaknesses in solving division operations. Feedback given to students is appreciated as being easily comprehensible as well as helpful. Visualisations of students’ individual results and performances given to the teacher are also judged as being comprehensible and helpful for the further (formative) assessment process.

5.2.5 Conclusions and Next Steps

The outcomes of the survey on teachers’ experiences with the Sonic Divider and its usage indicate a high satisfaction with both the tool and its particular functionalities and features. These results are not a surprise since there was a strong collaboration with teachers during the tool development process resulting in a tool that is more or less geared to the needs of them. There is, however, certainly considerable room for further improvement of the tool.

So far, Sonic Divider is based on the domain of the operation division in its easiest way, meaning always having a single digit number and fraction which do not have any remainder. In a next step, the domain and its underlying skill structure might be extended in order to also support the solving process of more complex division calculations. The most impressing feature of the Sonic Divider is its feedback mechanism which allows for providing students formative, competence-based feedback in real-time. Displayed in form of a smiley and a text block, the feedback refers not only to the correctness or incorrectness of an action but also to the underlying skills. Thereby the system is capable to identify such skills which are available and which are lacking. In a further step this function might also be used to give direct recommendations (e.g. by providing a link to a specific learning-worksheet) For instance, the student is able to perform calculations with even numbers very well but at the same time has problems with the number 7. The system points this out and provides a link to a learning-worksheet at once, where the student can repeat and practice arithmetic problems with number 7.

The first version of Sonic Divider was used and assessed in one classroom. For further studies, it would be desirable to have an extended sample of teachers and pupils who consequently will allow for more room for interpretation of the obtained results. Furthermore, the use of standardized questionnaires would be advisable and desirable since it provides the advantage of a sound assessment on a certain evaluation parameter (e.g., user acceptance, usability), and the possibility to compare evaluation results even with other studies (especially in case of usability it seems interesting to get an idea how the own system can be ranked in usability compared to other learning tools).
### 5.3 Orchestrating and Assessing Second Language Learning in OpenSim

<table>
<thead>
<tr>
<th>Category</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Study format</strong></td>
<td>Observations, interviews</td>
</tr>
<tr>
<td><strong>Aims</strong></td>
<td>• Supporting teacher in orchestrating OpenSim scenarios</td>
</tr>
<tr>
<td></td>
<td>• Supporting teachers in assessing what’s going on in OpenSim</td>
</tr>
<tr>
<td><strong>Output</strong></td>
<td>• Fruitful ideas for refining OpenSim scenarios</td>
</tr>
<tr>
<td></td>
<td>• Data tracking to develop automated assessment</td>
</tr>
<tr>
<td><strong>Countries</strong></td>
<td>Italy &amp; Austria</td>
</tr>
<tr>
<td><strong>School type</strong></td>
<td>Secondary School</td>
</tr>
<tr>
<td><strong>Participants</strong></td>
<td>2 SL teacher (German/Italian), 2 classes, 30 students (18 Italians, 12 Austrians)</td>
</tr>
</tbody>
</table>

**Table 10: Study portrait**

#### 5.3.1 Introduction

In early summer 2012, the second cycle of developing school lesson scenarios with immersive learning environments within schools’ contexts took place. (The first cycle of these scenarios is discussed in D6.3). The scenarios focused on secondary language acquisition (similar to TESL) with international character in immersive learning environments (OpenSimulator).

The hypothesis in the learning scenario design is, that more individualization and more practice of the secondary language benefits the competencies asked in the curriculum. Now, if you let students work with these scenarios something interesting happens:

Students get engaged and the teacher disengages. From a teacher’s point of view it can be relaxing because the approach is student centred. However, depending on teacher’s teaching style it can also be stressing, because the teacher will lose the overview about what’s going on as soon as students start in OpenSim. Then, every student is on his individual learning path.

*Figure 25: Picture of the Italian-Austrian tandem class in summer term 2012*
5.3.2 Results: Teacher

Teaching Role

The approach of this classroom study changes the role of the teacher. A lot of effort is going in preparing and analysing the classroom session. To justify this effort a reuse of the design work needs to be ensured. The benefit is, that the teacher is hands-free in class. He or she can focus to support students in need.

All lessons should be connected. The efforts required to prepare such a learning scenario cannot be justified, if it is a one-time only event. On the other hand, not every lesson needs to use immersive learning environments. On the contrary, with the Austrian - Italian tandem we used the full stack of NEXT-TELL classroom tools, from GoogleDocs to Moodle and Facebook to the OpenSim space.

As an interface to the ECAAD planning a Google spreadsheet was used because this is very similar to the format teachers are used to.

Hence, teachers working with OpenSim need to plan and document before. This means that teachers are forced to decide specific decisions before the actual teaching. During the OpenSim session the ad-hoc decision-making is less possible than in traditional classrooms.

Nevertheless, the teacher liked the OpenSim scenario, because according to her view the scenario offered her students a good way to find their individual learning paths without her:

*Especially in language education there is a lot of offerings in collaborating cross-border. Involving a partner-class and learn with each other and from each other is a way that every pupil can find his/her own way to learn language.* (translated by TALK)

Competencies and Assessment

Part of the learning scenario design is to create a context in the virtual space and timeline, which means that it makes sense to be present in certain places in a certain sequence. Students following these sequences could be assumed competent in applying the curriculum competencies which are addressed by the learning scenario design. These sequences don’t need to be linear and identical for each student, we did design different roles and an asymmetric engagement for the students. This way we are able to allow more freedom and motivation for the individual student - it is also a prerequisite that the students can find an individual learning path.

The data analysing of this online behaviour can be automated and implemented near real-time. The drawback is, that they need to be explicitly modelled when the learning design is done. The analysis is not very flexible in respect of last minute changes or shortcuts. Anyhow this kind of feedback was well received by all participants and intuitively visualized by the design of the stage for the learning scenario.

To supplement this automated feedback, peer feedback and native-speaker feedback augmented the quality of the interactions of the students. This allowed a more qualitative approach to assess the individual learner’s competencies. In a simple version it is a method similar to a like-button where in context of place and timeline-position the actions of the learner could be commented. In a more extended version a short questionnaire was triggered to reflect on the latest interaction. This approach is very flexible and powerful, because one can collect a big number of short qualitative assessments, which can be processed statistically, as discussed in D2.8 with the ProNiFa tool.

From Activities to Engagement

As discussed in D2.8 we created some assessment methods to provide some overview to the teacher about who is engaged and who is dropping out. This is done by analysing the activities in the virtual learning space. The procedure can be automated and in real time, pointing the teacher in the direction of those students who need support or encouragement. According to the cognitive density framework, this assessment method links first-order effects to interpretations of second-order effects. Further development is needed to investigate the impact of visualising such data to the teacher to increase his/her diagnostic power.
5.3.3 Results: Students

Self-control

Aspects of students’ self-control have been implicitly integrated into the learning scenario. As the objectives were very much related to applying competencies in a “real” practical environment, the success was immediately obvious for the student. If one needed to communicate with a specific person to advance in the learning sequence - well the student immediately saw if he got to the right places.

Besides the implicit feedback all information assessed were written in the chatlog and will be moved to the student’s learning diary and OLM. Thus it is possible for each student to look and analyse about his or her own performance.

Requirements to Collaboration

The collaboration and communication requirements are pretty high. A lot of things are going on in parallel with all the students doing things in the same time. In the same time there are language- and cultural barriers to overcome in international learning groups like we did in our classroom tests. But then overcoming these challenges is the aim of a second language class in the first place.

5.3.4 Conclusions and Next Steps

If teachers are motivated to learn how to handle OpenSim and run units which include OpenSim lessons but also lessons with other technologies, OpenSim is a technology which seems to motivate students because the immersive environment enables students to work independently and collaboratively. OpenSim environments like Chatterdale offer students enough freedom within specific boundaries (e.g., places in Chatterdale and tasks to be solved). Further classroom implementations are planned in order to further develop OpenSim scenarios and the automatized assessment of activities.

5.4 Participatory Design Workshop Report

<table>
<thead>
<tr>
<th>Category</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study format</td>
<td>Participatory design workshop</td>
</tr>
</tbody>
</table>
| Aims         | • Inquiring the current perceptions, practices, and challenges with teaching, teaching with technology, formative assessment, and technology enhanced formative assessment  
• Introducing the NEXT-TELL project (including hands-on training) and working on Repertory Grids for Formative Assessment (RGFA) & Communication and Negotiation Tool (CoNeTo) |
| Output       | • Feedback for developing RGFA & CoNeTo                                                                                                         |
| Country      | Denmark                                                                                                                                          |
| School type  | University College                                                                                                                              |
| Participants | 8 university college teachers                                                                                                                   |

Table 11: Study Portrait

5.4.1 Introduction

A participatory design workshop was conducted with 8 teachers from a University College in Roskilde, Denmark. The workshop was run in the middle of August. Thus, the data are not yet analysed in detail and will
be reported by WP4 at a later time. The results will be fed into the development of RGFA and CoNeTo. For the current version of RGFA and CoNeTo see D4.4.

5.4.2 Results of Group Exercise on Technology Enhanced Teaching and Learning

Practices
The teachers group discussed a variety of issues related to their current pedagogical practices and organizational context.

- The loss of face-to-face meetings and personal contact with students
- Scaffolding and scripting for individuals vs. small groups was challenging
- Transfer to actual classroom teaching from teacher training
- Technology use creates a distributed classroom with persistent resources & activities
- Concern for the socialization of students and growing individualism in the Danish cultural context

Technology Use
Regarding current technology use, the following were mentioned

- Organizational necessity to integrate technology
- Social media tools such as wikis and blogs
- Digital artifacts such as podcasts
- Didactical rationale to integrate technology
- Didactical matter to integrate technology
- No formal course module on technology enhanced learning but ICT courses are offered by the IT Department
- Peer-to-Peer training and support by teachers on TEL

Students
Regarding the students, the following issues were mentioned

- Greater diversity in terms of students’ competencies
- New technologies are sometimes a barrier to teachers
- Technology overuse in the classroom
- Need to take breaks from technology

Formative Assessment: Methods and Tools
The major concern expressed by teachers was the delay in providing formative assessment to students ranging from 2-3 days in the course management systems for digital reports to 14-days for physical reports. The following formative assessment methods and tools were mentioned by the teachers:

- Cmap for keywords and connections
- Intermediate product evaluations for Math
- Oral presentations
- Surveys
- Multiple-choice questions

5.4.3 Results about NEXT-TELL’s Methods and Tools

Repertory Grids for Formative Assessment (RGFA)
Teachers were paired into dyads and created one repertory grid exercise each. Questions raised were related to the design of the repertory grid exercises and the need for customized prompts to serve as scaffolds.
Teachers gave positive feedback on the teaching analytics solution integrated into RGFA and the two research prototypes. Design changes requested were to make the teaching analytics functionality available under “My Analytics” tab on the web interface.

**Communication and Negotiation Tool (CoNeTo)**

Teachers were presented the original usage scenarios for CoNeTo. Teachers discussed several additional usage scenarios for CoNeTo, suggested usability changes to the interface, and requested new features.

### 5.4.4 Conclusions and Next Steps

Several new pedagogical purposes for RGFA exercises and CoNeTo were discussed. The teachers group committed to create an implementation plan for using NEXT-TELL methods and tools in their classrooms in fall 2012. The teachers group expressed interest in holding a joint workshop with the NEXT-TELL partner teachers in Bergen, Norway to discuss technology enhanced formative assessment in teaching English as a second language.
6 Teachers’ Inquiry into Students’ Learning: Studying and Supporting Teachers’ Professional Development

Section 6 presents the detailed results of a TISL workshop conducted in the first half of the second project year in Norway (see D6.3) and the summarized results of teachers’ TISL activities in two schools in England. The aim of the Norwegian study was to get into contact with teachers on that topic and to find out whether and how they currently investigate (without a NEXT-TELL TISL training) how their teaching influences students’ learning. The aim of the research in England was to evaluate the use of the TISL Method (see D5.1 – D5.4) by teachers conducting research in their classrooms. This research should inform the software design of the Next-Tell infrastructure.

6.1 First Steps Towards TISL in Norway

<table>
<thead>
<tr>
<th>Category</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study format</td>
<td>3 focus groups</td>
</tr>
<tr>
<td>Aims</td>
<td>• Analysing how teachers investigate student learning in order to develop and change their teaching&lt;br&gt;• Developing ideas on how to implement the TISL method (see D5.1) at a Norwegian school</td>
</tr>
<tr>
<td>Output</td>
<td>• 3 models on how teachers collect, document, analyse, and share data on student learning for professional development&lt;br&gt;• Knowledge on how Norwegian teachers investigate student learning in order to develop and change their teaching</td>
</tr>
</tbody>
</table>

Table 12: Study Portrait

6.1.1 Abstract

A study of how 10 teachers reflect on different aspects of teacher inquiry into student learning (TISL) has been carried out. The teachers were divided into three focus groups, based on their teaching subject - Science (STEM) or English (English). Prompted by questions the teachers discussed why and how they collect, analyse, share data on student learning for professional development. They also discussed how they document student data and if they further develop teaching based on the findings, and the role technology played in this work. Data from the focus groups showed that the teachers do collect and share data in order for them to develop their teaching practises or exchanged experiences, in addition to help student develop. However, teachers admit they do not have routines for documenting these changes in a unified, systematic, and structured way. Our conclusion is that there does not seem to be a shared understanding or a common method for collecting, sharing, documenting, analysing and using data on student learning for further professional development as a teacher.

6.1.2 Introduction

The motivation for this study is to determine if teachers could make use of the TISL Method [Clark, 2011, D5.1] to conduct research for professional development in their own classrooms. As a first step, a background study of how teachers investigate student learning in order to develop and change their teaching was carried out.
Focus Group Method

Focus groups are a research method, where data is produced by group interaction concerning a theme chosen by the researcher [Morgan, 1997]. Focus groups are a good method to gain insight and an overview of common experiences, attitudes and aspects in environments where people interact. Focus groups provide rich data and at the same time do not produce too much data for later analyses [Malterud, 2012].

There is no single right way to do focus groups [Morgan 2010], but a focus group is not the same as a group interview. Semi structured group interviews do contain a great degree of interaction between the interviewer and the participants in sense of direct questions and answers, as in a personal interview. This is in relation to a focus group, where there is much more interaction between the participants [Halkier, 2002]. The processes in focus groups can start with the researchers questions and other concrete inputs [Halkier, 2002].

While the focus group method is good for producing data on common understandings, it is less suited for producing data on individual understandings of a person’s life world [Bloor, 2001]. This is due to the social control that may appear in a focus group, hindering the expression of different personal experiences and perspectives [Halkier 2002]. Malterud [2012] stresses that the researcher should be careful to use “correct” stories as representative for the group, as the stories might be a result of strategic communication, and not representative of the group.

One of the researchers has experience with teaching in lower and upper secondary schools, while the other researcher has experience with teaching at the university level. In a reflexive view this gives the researchers knowledge about the field of study, from a teachers perspective. Malterrud [2012] explains the necessity to be close to the participants’ experiences, though not being too close. To have such an experience is absolutely a benefit in the study, since the researcher would know much of the terminology. Though as Malterud [2012] explains it is necessary to have field knowledge, the experience should not be too alike since this could lead to the notion of becoming field blind. This could result in not getting the data you would need, because the researcher is too much into the field to be able to ask the curious questions that will give good data.

There are two important roles when conducting a focus group, the moderator and the secretary. The moderator should ask the questions and keep the conversation going. The aspect of flow in the interaction is one of the most beneficial aspects of using focus group as a method. Puchta and Potter [2004] explain how the moderator will have the roll to keep this flow and direct the discussion towards a goal. The secretary should produce field notes and write down different aspects, like who is talking, and how is the atmosphere during the discussion [Puchta, 2004].

6.1.3 Methods

Participants

Ten teachers from an Upper Secondary School in Bergen, Norway participated in the focus group study. There were both STEM and TISL teachers, male and female and teachers with long experience and those with short experience. Table 13 gives an overview of the participants.

<table>
<thead>
<tr>
<th>Group</th>
<th>Teaching subject</th>
<th>Teaching experience</th>
<th>Students age</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-1</td>
<td>STEM (Mathematics, natural science, Gymnastics)</td>
<td>1 year</td>
<td>16</td>
<td>Male</td>
</tr>
<tr>
<td>S-1</td>
<td>STEM (Natural science, Biology, Chemistry, Economy)</td>
<td>16 years</td>
<td>15-19</td>
<td>Male</td>
</tr>
<tr>
<td>S-1</td>
<td>STEM (Mathematics, natural science)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-2</td>
<td>STEM (Mathematics, natural science, Gymnastics)</td>
<td>29 years</td>
<td>16-19</td>
<td>Female</td>
</tr>
<tr>
<td>S-2</td>
<td>STEM (Mathematics, natural science)</td>
<td>4 Years</td>
<td>16-19</td>
<td>Female</td>
</tr>
<tr>
<td>S-2</td>
<td>STEM (Geography, natural science)</td>
<td>23 years</td>
<td>16-19</td>
<td>Female</td>
</tr>
</tbody>
</table>
Table 13: Participants of study (Bergen, Norway)

<table>
<thead>
<tr>
<th>Group</th>
<th>Teaching subject</th>
<th>Teaching experience</th>
<th>Students age</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-1</td>
<td>(TESL) English, Norwegian</td>
<td>15 years</td>
<td>16-17</td>
<td>Female</td>
</tr>
<tr>
<td>E-1</td>
<td>(TESL) English</td>
<td>No information</td>
<td>15-18</td>
<td>Female</td>
</tr>
<tr>
<td>E-1</td>
<td>(TESL) English</td>
<td>No information</td>
<td>15-18</td>
<td>Female</td>
</tr>
<tr>
<td>E-1</td>
<td>(TESL) English, Norwegian</td>
<td>6 months</td>
<td>15-18</td>
<td>Female</td>
</tr>
</tbody>
</table>

The teachers were asked to divide themselves into three groups, the only criterion was to have English (TESL) teachers in one group and science (STEM) teachers split between the other two groups. The STEM teachers organised themselves into the two groups resulting in one group of female and one group of male STEM teachers. Thus, the groups comprised four TESL teachers (E-1) and three male STEM teachers (S-1) and three female STEM teachers in the last group (S-2).

Procedure

The session began with a presentation of the idea of research on own teaching practice and a description of the four stages of the teacher inquiry into student learning (TISL) method developed in Next-Tell. The four stages comprise: collecting data; analysing data; sharing data; and, further developing teaching and assessment based on data.

After the presentation the teachers were presented a series of 8 questions, one at a time, related to TISL and were asked to discuss, within their group, each question for 5 minutes. These questions related to the TISL method are:

1. Do you collect data on student learning? Why (not), and how?
2. Do you analyse data on student learning? Why (not), and how?
3. Do you share data on student learning? Why (not), and how?
4. What do you do with collected, analysed and shared data? Why (not), and how?
5. How do you further develop teaching based on collected, analysed and shared data? Why (not), and how?
6. How do you document the collected, analysed and shared data? Why (not), and how?
7. Is technology used to document, analyse and share data? Why (not), and how?
8. Is modelling used to plan teaching? Why (not), and how?

After the last question the teachers were asked to draw a model of their teaching inquiry based on their discussion.

Data collection

During the focus group a number of data collection methods were employed including observation, field notes, digital sound recordings and teachers modelling. The digital sound recordings made up the majority of the data material resulting in 91.45 min (S-1), 64.25 (S-2; they forgot to turn on the recording during the final modelling activity) and 94.32 (E-1). The digital sound recordings were transcribed (in Norwegian) and quotes from excerpts used in this report have been translated to English by the researchers.

Although the focus group method is criticised for being superficial, it was found to be very useful in this study. It produced information about teachers experiences related to TISL. While the study did not follow the recommended recipe of one focus group at a time [Malterud, 2010], this did not prove to be a problem. The introduction was given to the teachers at the same time, then each question was projected onto a whiteboard and they were told to discuss it for 5 minutes before being presented the next question. One group moved to a second room to discuss, returning to the main room each time a new question was presented. The moderator (researcher) did not sit together with the groups, but mingled between the groups answering questions if there
was something the participants were wondering about. The secretary (the other researcher) took field notes, but also moved between the groups. The atmosphere in the groups was very good and the discussion had a good flow for all the groups. The experience showed that this was a fruitful way of doing the focus groups. The experience showed that teachers needed somewhere between five and ten minutes to discuss each question. If they were not ready to get move on to a new question they were given a few more minutes to finish their discussion. The short time, however, made the discussion very effective and there seemed to be an expected “causality/flow” in the questions, since some of the groups anticipated what to be the next question would be, and it almost became a sport.

Analysis
Each of the questions discussed in the focus groups will be addressed in turn in this section.
As Malterud [2012] recommends, we have not presented the data for the participants after the analysis. She explains how participants often tend to have too much to say about their statements. Either they will change their statements, adjust them or don’t like how “they sound”.

6.1.4 Results
The results are structured according to the questions asked to the teachers.

Q1: Collecting data on student learning
The first group of science teachers (S-1) explains how they have collected student assessment results and their own feedback to students for several years. One of the teachers explains, “I have collected written tests for many years, and then gone back to look at those to adapt teaching in terms of weaker students.” (S-1). This is done in order to have input to and develop new teaching practices, particularly in relation to weaker students. Another teacher in this group elaborates this:

- I download all the answers, so they are saved with my comments on the computer. This is the benefit of things being digital. It is very easy to save a large number of documents. Beyond that I would like to have a better system for the assessment. Earlier I have systematized this using ItsLearning, it’s a nice system. When I give feedback, I do it as a task submission (in ItsLearning), whether the student has submitted or not. I create a task on ItsLearning and then they get feedback there, whether they delivered or not, because then I can easily synchronise it with the SkoleArena (school management system), which is required. In addition students can easily find their assessed work. I usually have a copy for myself on the computer (S-1).

ItsLearning is the Learner Management System (LMS) at this school, while SkoleArena is a management system for teachers to document assessment, remarks, and student attendance at school. S-2, being science teachers, explain how collecting data on student learning has been something they have always done in various ways, and how collecting data on student learning is part of the process of planning their teaching. One teacher explains how she collects data on student learning situations in order to adapt her teaching to different learning strategies as we see from this discussion between the teachers (S-2):

- To collect data on student learning is done in different ways
- We do it all the time
- Continuously
- It brings the situation that you change your course. And you change the way you organize the teaching.
- When you see if things work, not work, you change it so that it works. Or, makes it possible for students to use different learning strategies

The teachers further elaborate the practise of collecting data:

- One thing is that we collect data when they have had tests, group work and projects, etc. Then we get an idea of what they know. Another thing, I am thinking also, is that we ask, how did you learn this best? Was it best when we did this or that? It’s quite interesting for us to know. For it could be a very big difference between the groups.
As you know, you get an impression of your group or students, including single students, what works or not.

I have collected much data, in order to ask questions to get them active, or create situations to make it easy to talk.

We get an incredible amount of information about the students. Yes, both written and orally in class. The classroom I mean. So you get lots of information.

This discussion illustrates how these teachers not only collect data, but collect data to enable them to change and revise their teaching. In addition there is an extreme amount of assessment material to collect, both from submitted assessment, and from classroom assessment situations. Collecting data gives them a possibility to get an overview of best practice. Also E-1, the English teacher, discussed how they revise teaching plans and their teaching based on what is happening in the classroom. As an example, in a discussion E-1 mentions how they regularly exchange experiences, based on collected data. They are, though, unsure if and how to they collect data and how to tie this to teaching situations as to which ideas that worked and the results of those ideas.

Q2: Analysing data on student learning

The second question discussed by the teachers is if they analyse the data on student learning. From the first question on collecting student data we know that they do collect data in order to change or develop new teaching practises, or exchanged experiences. When it comes to the analysing of these data, S-1 explains that this varies and depends on what type of data and assessment situation they are collecting:

- It varies with the types of data we collect. And the assessment situation. In some assessment situations I give my students grades, and then the assessment criteria and the conditions are given in advance. While in other situations, I give them only the low, medium or high achievement criteria. So how do we analyse it, depends on the assessment situation we use. It is clear that the easiest way to analyse data is when you collect grades. And I see at these first year students, when we assess their first test (...). So I see that they are quite confused about how to handle this. And then I offer them oral guidance as well as written feedback. The first times I push them, that they shall all have an oral guidance after I have given the written response, because then you can go in and see: what will it take for you to get 5? (...)

This teacher explains how some assessment methods are easier to analyse than others. Still, he finds that it is the combination of different feedback and guidance methods that is best when having analysed data, and the possibility to give individualised guidance for the individual student based on the development they find in the assessed material.

While S-1 is discussing how they use collected data to give student feedback, S-2 discusses another aspect of analysing student data. They discuss how analysed data on student learning and teaching may help you as a teacher to change your teaching. This is done in order to improve the plans for teaching. All three S-2 teachers discuss how important this is, though admitting to not documenting these changes. If it turns out that many students fail in an assessment situation, the data gives the teacher information to teach this theme once more, or remember this aspect for next time it will be taught. E-1 explains how they use data to compare results from one situation to the other, similar to what the first science group explained.

- I think immediately to break down and look at the different individual goals, the criteria and see which of those they achieve. And then take this the next time and “Oh, there they were weak, there they scored high” and look at something that stands out and take it to the next step, to analysis. Instead of just giving grades.
• I think that we miss some tools, in a way. Because I sit and assess Norwegian, and correct verbs ... colour code wrong verbs in the text. I think that it could have been interesting to look statistically if this has improved, in the spring, or in third grade. It would be interesting to see if it might give different results in different classes according to different ways of teaching. So I think that the type of analysing tools, as they have in other professions, to obtain such information, we don’t have (E-1).

This interesting discussion shows how one of the teachers stress that there is little analysis of their own teaching, based on data on student learning, and analysing best practise. Though the teacher thinks that this could be an interesting way of analysing her data, she does not have a tool for analysing data on how learning is affected by different ways of teaching.

Q3: Sharing of student data

On the question of sharing data the S-1 teachers discussed how they share data with the students in order for the students to develop.

• We share with students so they can develop, and we share with ourselves to develop our teaching. The problem is often that when we are assessing, the topic is over. And usually you do not have time to take a topic twice in one year. So you really need more than just summative assessment (S-1).

In addition, they share data with colleagues in order to develop their own teaching. The problem with teaching science has to do with too many topics in too little time. This results in a problem of adjusting teaching based on student data, as they have no time to teach the same topic twice. S-2 brings up another issue related to sharing, explaining how important it is to collaborate or share data on student learning cross-levels and cross-schools.

• I share with others if we have professional issues. We work together.
• We share in subject meetings, we share in class meetings and it is very important to share. Also about the student, showing that we actually care for the learner, and we want them to learn and deal with any problems.
• (…)
• Find, share if you find, discover and see that some students use learning strategies better than others. Better ways to learn than others. So it is clear that when you meet, I share my experiences. That functions really well right? (S-2).

The sharing of data is especially important if students have learning problems. One example could be if a teacher notices that a student uses one learning strategy better than others. Shared information can be on class level, that is to share experience on best practice teaching/plans, but also cross-schools. The teachers tell how such sharing of experience also is done between teachers at different schools. E-1 also explained how they share data on student learning when there is little learning progression, but differs from the first two groups, as they also elaborate how this kind of sharing is not structured into a system.

• We do that; we share with students and with each other.
• And with main teacher sometimes.
• It’s often when learning is progressing slowly is the case.
• It is not very much structure in the sharing, except for the subject teacher cooperation.
• (…)
• If we think of the individual learner and in the case where we have a learning problem, then it is to talk with other teachers. How do the student do in other disciplines? It is to help the student, and get to know how they learn best, if it does not work in different ways. They can identify some problems and, if they (the students) have problems in our subjects, they may do it very well in other subjects. So then it is language that is the problem, or is it learning in general, or where is the problem? (E-1).

Having meetings based around teaching-subject, the teachers meet, plan, and share experience or talk to colleagues on how individual students do in other disciplines. Data on student learning is shared with the student first to inform on the current state, second to inform on what it takes to move forward, third to document, and forth to see how the teachers themselves are doing in relation to other classes. One of the
newly educated teachers explains that she has the impression that their school is very structured. This impression is something she gets from talking to teachers working in other schools. She has the impression that her colleagues are very good at sharing experience and planning together. Though she also knows that some teachers find that there may be too many meetings, she herself, as new, is happy to get the opportunity to share with those who have more experience.

Q4: What to do with collected analysed and shared data

The S-1 teachers explain how they use data to design and adjust their own teaching in addition to giving student feedback. One teacher explains how such data is a good tool to correct or change the way teaching is carried out, especially if you teach the same subject for several years. This is done by developing the basic plan for teaching, using student data.

- We use the data to give students feedback, to provide summative assessment. And then we use it to design our own teaching, correcting some of the teaching. Especially for students who are weak, then I feel there has been a good tool to correct or modify the teaching. You do this best, I think, if you have one subject over several years. That one is sort of a base. Running the same program several times and then develop the program, and not inventing the wheel all over each time. It’s quickly see if there is a student who has misunderstood. If you can see that there is a connection and many students who are struggling, it is something you take with you and if I find that I might need to focus a little more on that next year, or maybe then teach it over again. And when there is a misconception common to all the students, I take it as a sign that it’s something I’ve gone through in a way that was wrong. And then “Ann Mari” does not have students with that misconception in her class, and she has rehearsed this (with her students), while I have only gone quick through it. And then you see that there is a systematic difference in her class and my class, on the basis of how we teach. And I have seen this several times, that there are systematic differences in the various classes, depending on the teachers and what they have emphasized.

- So we found that we correct the teaching.

- And for the long-term that you change presentations and in what order you present the material. In the short run, go through the test immediately after it is taken, and correct: this was a common mistake; do not do this next time, to the entire class. What is typical after a test is self-assessment.

- I think we can do much better to reflect on own teaching and to use it (assessment) more for that (reflect on own teaching), because I think that it seldom is. And then it is better if the data is organized in terms of what knowledge we are interested in, and there we have a long way to go. I also think we who are newly educated, that maybe after a few years it is easier to see how we can change it. (S-1).

By looking at student data the teachers see if there are several students struggling with the same problem, or a misconception is held by many students. In this case the teacher explains that this should be taken as a sign that something has been taught in the wrong way. In this case the teachers can see if there is something they have to repeat now, or focus on for the next teaching year. By comparing data on student learning with colleagues, one teacher explains how he can see systematic differences between classes, based on how the subject is taught. Such systematic differences in different classes, depending on how teachers teach and what they have emphasized in their teaching is something he has observed several times. Based on these observations the teaching, in long term, are corrected as for example, how to present and in which order the material is presented. In the shorter term the findings from the assessment are presented in class, focusing on common mistakes. Another teacher explains how he believes that teachers should become much better at reflecting on their own teaching and to use assessment results more in the sense of how to change teaching practices. He emphasises that there is little focus, and a long path to go, considering organising student data in relation to what knowledge one is interested in, for further development of teaching. S-2 explained how to use data about students for example to get teachers, teaching the same subject, to work more coordinated in order to learn and to improve teaching. The teachers find their school, though, to be very good at doing this. S-2 also explained how they share best practice to make things better through the data they have collected.

- It’s to improve the subject, and that everyone should benefit of what we are doing. Is not it?

- Absolutely.
• (...)
• And improve yourself. Yes of course. And get a wider range of reading strategies for students to learn. And what I think is perhaps the best part is that I dare to use other things. That I dare to make it maybe in a slightly different way.
• (...)
• It can work in my class, then you do it, and it does not work in the class. So why does it not?
• Yes, why does not it? What is different? It’s quite the exiting to see. For there are two, I have two classes in science, and there is no way I can use the same methods in the different classes. They are too different.
• (...)
• It’s very nice to take part in what others have got to work. And then you can test, ok this did not work, maybe I can try it this way, or we can try that.
• (...)
• The arrangements do you think?
• Yes. For all science teachers.
• As we can put both in and out thing. So we change all the time.
• So if we have made an arrangement we will add it in there; Having examples that work, having things that works, so you can go and pick out and use. Then you can add what you have found to work. We can add, as part of this we have made now (S-2).

Another aspect of using data is to be brave enough to try out new things, and to do things differently. Data can also be used to get feedback from the students. Through sharing of experiences the teachers can see that something work in one class but not in another. Using collected data may lead to questions like "Why doesn’t it work, and what makes it different?" One of the teachers in S-2 explains how she experiences this difference with two of her own classes. The same method does not always work in all classes because classes are different. She found one class to be very verbal, and they did better when they got more practical exercises. She explains how she has used a lot of time to figure out how she can solve this and what might motivate them.

One of the teachers in E-1, also refers to “the mystery” of why something works in one class, but not the other. The English teachers (E-1) mention how they share experiences and discuss best practice and what students learn from different activities. Again, stressed by one of the teachers, is that the use and collecting of data from student assessment and connecting it to best practice, is very unstructured. “I must say that I do it a little unstructured. Some collected as documents, some gathered there, and some things that worked, might noted down”. (E-1).

Q5: Develop teaching based on collected, analysed and shared data

As mentioned one of the S-1 teachers explains how he started to combine oral and written feedback in student assessment. However, he finds there is too little time in his daily work for further developing his teaching. This is something another teacher agreed with, and the time to further develop teaching by using collected and analysed data is very limited.

• I think that at some schools, this has low priority. That the teacher uses the feedback himself. The everyday life at the school is to think in the present, and on what happens going forward, and then it's a bit difficult for teachers to find time to sit down and find out what to do ... You've got some ideas, but that you really set to work ...
• I typically like to do it during Christmas and summer holidays. It's a dilemma all teachers face, whether they have time for it. It's a problem for the society that, it has "invested" in the school, but what is really invested? (S-1)

Another teacher in the group tells about a project in Brazil where teachers take videos of their teaching and discuss teaching in small groups, working systematically on their teaching practice and student learning strategies. The teachers further discuss how development not only is based on analysing and sharing data from
students' learning, but is also a guiding tool for teachers. Data is used to adapt teaching to the group of students. Doing this they further develop and make things their own way, because each class is different. All the teachers point out how important it is, not only to copy teaching methods from other teachers, but to make these methods their own and develop ownership of it. The S-2 teachers discussed how developed teaching and activities that work perfect in one group, do not necessarily work in other groups. By using findings, like grading results you see that you have to adapt the teaching to the student group.

- The teaching, the development is not only based on analysing and sharing data on the basis of students' learning, but it is guiding tool that we have to relate to.
- (...) We use it in a way (assessment). We use it to customize the class or the group of students we have. We develop and make it a bit more our way. It is what we have said. Each class is not the same.
- It’s exactly the same, we like the pool of various teaching arrangements. We have talked about it before. It’s the different kind of PowerPoint presentations. It’s not only to use it from the pool. Because it does not quite fit me in a way.
- No, it’s true. You must have a relationship to it. (S-2)

The dynamics in the student groups are often completely different regarding the use of different teaching techniques in the different groups. Further development is doomed to failure if teachers don’t pay attention to this and develop their own teaching.

The E-1 teachers also discuss how developing as teachers is based on sharing of data. In order to make education better for next year, and to become more aware of how one teaches data must be shared. Further development of teaching is based on data from the students, even if this is done in an unstructured manner and even used in other subjects.

- Yes we do (develop). Unstructured. However you learn, for example this English group discussion we had. I did see what did not work (...) So I have taken that further when I taught in social science. (...) And I could see what the students would benefit from. (E-1).

Further, the teacher mentions how they, together with colleagues, reuse teaching plans from previous years, and change according to what they want differently this year. Collaboration between colleagues works as a forum for further development based on experiences with students learning.

- We do the things this year that are similar to what we did last year (...) precisely because we have been looking for things that we want to change. So it (team collaboration) acts as a forum for further development based on experiences we have, concerning students' learning. It is a mix of what students like, what we felt they learned from it, and what they feel they learned from it. (E-1).

Changing teaching plans is based on a mix of what they found students to like, what the student felt they learned from it, and what the teacher believes that the students learned from it. In addition the teachers added that students' evaluation of the teaching processes was a good source for further developing, reflecting and sharing with other teachers.

**Q6: How and why document the collected, analysed and shared data?**

One of the S-1 teachers is quite clear on why he documents student data. This is done in order for him to develop his teaching next time or next year, and though many teachers still use a lot of time to document student learning, technology makes is easier than before. Another S-1 teacher even finds that he does not use much time on this, because he found a way of getting this done automatically:

- Many teachers use a lot of time to document things. However the digital bit has made it a little easier.
- Yes, I do not use very much time to document, I feel, and it’s partly because I have made this automatic ... I can automatically sync data from the system that the students and I use, and the system that we are required to use for documentation. It happens, in a way, in the background. I do not need to sit for hours and put the grades into SkoleArena anymore, as long as I put them on It’s Learning (S-1).

This teacher uses tools that he finds very useful. He can document a lot of student data without spending much time, because he automatically sync data from the system that he and his students use, with the system he is required to use for documentation. Though one teacher in S-1 explains this, the ladies in S-2 explain that
written documentation is done in different ways though also using SkoleArena (administrative program), and it’s learning for documenting learning strategies, methods and teaching plans. However, much of the documentation totally relies on own practise. For example the documentation in SkoleArena is not tied to which learning activities that is suitable for a weak class. However, when one finds something that to be used, the teachers re-plan it to suit their group's requirements.

- It’s in my head.
- We document
- We share and document it. We share with someone we are talking to.
- However, we document many things. If it is written documentation we got that in many forms. SkoleArena? It’s learning?
- Do you document how you collect and analyse data? That is more strategies, methods
- If that is it. It’s both. We document everything. Don’t we?
- Yes!
- Do we only document teaching plans? We mentioned that now. That is to document something. Teaching, we do. Most certainly it is.
- What is not documented is perhaps what lessons that are suited the weak class...
- And then we see if there is anything we can use. Or change it, so it fit exactly the group we have. There and then. Is not that what we do?
- Yes
- One must get to know the group first. It will be different for each group one gets, so it will not always be much use to document how that arrangement went on.
- I understand
- Because when it comes a new class you have to do a re-evaluation of what worked there (S-2).

This conversation may show that there is no clear understanding of what is documented and how it is documented. The teachers are quite clear that documentation is done in order to change teaching, to develop teaching and be able to direct a learning strategy towards a student. However, the documentation is not done in a harmonised way. The E-1 teachers describe documentation as something they do. The question is whether they do it enough? Or if they should do it more, and if this is something on which they should use their resources? Another question they ask is what they should prioritise? One of the teachers believes that teaching should not be too instrumentalised, though mentioning that documentation can be more systematic to have a positive effect on student learning:

- But in that way, it will not be documented such sharing between colleagues. It manifests itself in the change of plans, in that way it may be documented, but we do not directly write down “Today I told Maria” about...”. (E-1).

This sharing between colleagues is not documented, but is manifested in changes in teaching. Teachers explaining what happens in class are indirect evidence of collected, analyses and shared data.

Q7: Different ways of how technology is used to document, analyse and share data.

The S-2 teachers explain how grades are recorded in SkoleArena (a school management system), in addition to what is kept in ItsLearning (LMS). ItsLearning also works as a pool to store teaching material and enables the teachers to find and use what they need:

- I’ve got my own spreadsheets as I have for my own part, and it is something one has in ItsLearning. So concerning grades etc. that is in SkoleArena.
- (...) We use ItsLearning, we use OneNote. We use GoogleDocs. Wikis, we have not used that much.
- No not wikis, we have not used that much. It’s fun though. What I think is so stupid with this GoogleDocs is that you must choose something that you think is...(interrupted)
• Also like Facebook and stuff. I have not been good at using that.
• We have created Facebook ... a NGV geography Facebook (not searchable). (S-2)

Many different tools such as Google Docs, Wikis (though this group have not used it, we have documentation from other teachers that they use it) and Facebook are used to document and share data about student learning in this group of teachers. In S-1 one of the science teachers explains more thoroughly how he keep track of the assessment situations and keeps student assessment data in Access (a database management system). He describes himself to be quite knowledgeable in this program making it easy to manipulate the data.

• I can enter data into a lot of different tables in the database program, Access, and then afterwards I can arrange it and retrieve data in different ways, as I want. That’s what I have now, I have a system where I record the data on one form, and then I print reports for students on the PDF from the computer system, which are arranged in a special way. The main point however, is that I register it in Access, I can very easily change how data is presented. It is much easier to do in Access than Excel (S-1).

Information is recorded in Access in different tables. Enabling him to easily manage how data is accessed for later. Organizing and extracting my be done differently depending on what he wants to have knowledge about, but the data is recorded in a form that easily enables him to print out reports in PDF.

The E-1 teachers explain how technology is used to provide comments to the student such as in process writing, using Google Docs, and then the comments are then documented.

• To share, then we also have it in Google Docs, especially now when we have used process writing. They have received direct feedback in Google Docs, so there will be a mix of everything. It documents what the student does, the feedback provided by their peers, that they can use the feedback to further develop the text. In addition, it is used for collaboration.
• (...) It is then what you say, that the teaching is changed and planned on the basis of sharing experiences related to (the student’s) learning. However (student’s) learning is not, so much, shared that way. This is more done in team meetings, I think (E-1).

Q8: Is modelling used to plan teaching? Why (not), and how?

Visualising teaching is not common among the teachers in our groups. The S-1 teachers think that it would be useful to get access to something that could visualise their teaching plans, in addition to what they are working with, which currently is basically text. S-1 is interested in being able to visualise how they teach presented for example as a flowchart with the following phases: presentation, discussion, individual activities, and finally multiple-choice questions:

• And then there is perhaps writing a flow chart, I do not know, it is a way to visualize, a flow chart for your assessment. I have not done that.
• It would have been appropriate to have access to something like that. That we can visualize what we are working with, there are quite a lot of text and words.
• Well it is absolutely something we should have, for example if you want to visualise: how I teach you? How do I teach? Then I could make a flowchart, it might been a fairly linear flow chart, but let’s say that the flow chart looks as follows: presentation, discussion, written exercises, and finally multiple choice questions, flowchart (S-1).

One of the teachers in S-2 explains how she thinks in models when she plans the structure of class and her teaching:

• So you can say that it is a type of model for the construction of a lesson. Sometimes I do it that way. I’m presenting my tasks. Other times I will do it in a different way having group work. And then you follow a kind of a model for teaching. (S-2)

In E-3 they mention that they use models of previous teaching to plan new teaching:

• We enjoy the benefits of cooperation with the others who have tried it before. “We did it that way with groups such and such in the classroom, or taking a group out, but it did not work, it worked well but it
“worked better...” In that sense it is used to plan teaching. Then it becomes more ... models of previous arrangements that are being used.

- (... ) We had this discussion in English, and now I have a model of how I did it last time, and can use it over again this time, but with some modifications from last lesson. And I have used this to plan what I should do now. And changed it in terms of what did not work last time, and what might work better this time. That's all I have, I do not have many models to choose from, for I have not built up on experience (E-1)

The teachers were asked to model their teaching and how they use data for further developing their teaching. The models are presented in figures 26-28.

S-1:

The group explains their model, see figure 26, to be a very unscientific research model since there is no time to be researchers. They identified 6 steps:

1. Collecting information about new students,
2. Activity for knowledge - teach
3. Change in teaching
4. Seeing the results of the assessment afterwards and compare with students' grades afterwards
5. Show colleagues
6. Share and adjust instruction

![Figure 26: S-1 model](image)

S-2:

This group forgot to turn on the recorder while they were drawing the model shown in figure 27, so we do not have an explanation of this model. This model is very thorough. Starting with how teachers collaborate on curriculum goals, and the process (one for the teacher and another for the student) towards student learning outcome (the competence goals), resulting in further development of the teaching.
E-1:

1. Starting in the team planning the theme and a look at competence goals.
2. Return to the team and plan instruction and assessment.
3. Teach students in order for them to learn and gain an understanding of the themes, based on competence.
4. Consider students’ knowledge and skills towards level of achievement.
5. Sharing of data with colleagues, spontaneously, individually or across disciplines.
6. Teaching-subject meetings for sharing experiences

6.1.5 Summary and Conclusions

Data from the focus groups shows that the teachers do collect and share data in order to develop their teaching practices or exchanged experiences to help students develop. However, they admit that they do not document these changes in a unified, systematic and structured way. Furthermore, there does not seem to be a shared understanding or a common method for collecting, sharing and using data on student learning for
further professional development of the teacher. Assessment data and observations are used to adapt teaching to the group of students. By doing so they further develop and make their teaching their own way, however, as each class is different. Sharing of teaching methods happens though the learning management system, but this kind of sharing it is not in a unified structure. In the discussions, the teachers were also unsure if and how they collected data and tied this to teaching situations as to what ideas that worked and the results of those ideas. The teachers further discussed how professional development not only is based on analysing and sharing data from students' learning, but is also a tool for teachers to adapt the teaching to the different the groups of students. However, there does not seem to be a consistent practise on how to the collect, analyse and use data on student learning in order to systematically change practise. One of the teachers explained how he believed that teachers should become much better at reflecting on their own teaching and to use assessment results more in the sense of how to change teaching practices. Use and collecting of data from student assessment, connecting it to best practice is very unstructured. There is little analysis of their own teaching, based on data on student learning, and analysing best practise. Teachers should become much better at reflecting on their own teaching and to use assessment results more in the sense of how to change teaching practices. There is little focus, and a long way to go when organising student data in relation to what knowledge one is interested in using for further development of teaching. Use and collecting of data from student assessment, connecting it to best practice is very unstructured.

6.2 Teachers conducting TISL in England

<table>
<thead>
<tr>
<th>Category</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study formats</td>
<td>Focus groups, interviews</td>
</tr>
</tbody>
</table>
| Aims       | • Evaluating how teachers get along with the TISL method  
             • Finding strengths and pitfalls when teachers investigate their own teachings |
| Output     | • Insights into difficulties of the method and teachers’ ways of interpreting their studies’ results |
| Country    | England                                         |
| School type | 2 Secondary Schools                             |
| Participants | 50 teachers (7 in WS), 50 classes           |

Table 14: Study portrait

6.2.1 Abstract

A series of studies were conducted, comprising 8 engagements, with teachers in two secondary schools in the UK during Project Months 16-22. Teachers at both schools were asked to employ the TISL method to conduct research within their student populations. A total of 21 teachers used the TISL method in their 21 classes. Focus groups and group interviews were employed to collect data. The details of this research are presented in D5.3. Here, we report a brief overview of the research and key findings that lead to recommendations for teacher-led design studies in the next section.

6.2.2 Introduction: The Research Context

The aim of the TISL research in the UK has been to evaluate the use of the TISL Method\(^3\) by teachers conducting research in their classrooms, with the overall goal of informing the software design of the NEXT-TELL

\(^3\) For a full description of the TISL Method, refer to deliverable D5.1.
infrastructure. Of the two schools we engaged, one of the schools is an Academy School, Thomas Deacon Academy (TDA), and the second, ACS-Cobham International School, is a private school which is composed of primarily expat students and uses a US-based curriculum.

An academy may receive additional support from personal or corporate sponsors, either financially or in kind. They must meet the National Curriculum core subject requirements and are subject to UK government inspection regimes. They are self-governing and most are constituted as registered charities or operated by other educational charities. Most are secondary schools for pupils aged 11 to 16. By contrast, International schools may define their own curricula independent of the UK National Curriculum and cater mainly to students who are not nationals of the UK, such as the children of the staff of international businesses, international organizations, foreign embassies, missions, or missionary programs. These two school were selected because of their relationships with the institute of education and because they represent substantially different learning institutions (and thus, learning environments) in terms of economic resources, teacher autonomy, number of students, socio-economic status of students, and their countries of origin. It was expected that this widely varied sample in terms of the school environment might uncover different problems using the TISL method in quite different learning contexts.

6.2.3 Method

NEXT-TELL researchers in the UK established relationships with 8 schools who were invited to attend a preliminary TISL "summer workshop", lasting 1 day. From this cohort, one teacher in each of two schools (TDA and ACS) was recruited to conduct TISL studies. These two teachers designed TISL studies that were later undertaken by a total of 50 teachers (see table 15). In preparation, NEXT-TELL researchers convened TISL training sessions at both schools. Subsequently, research was carried out at both schools, in 3 engagements each (summarised below). Research data were collected in the form of audio recordings of group interviews and discussions, online forms containing teacher-defined TISL plans, teacher-produced supplementary materials, and online comments made using an audio annotation system.

We also conducted post-TISL semi-structured debriefing interviews, both individually and in groups. NEXT-TELL researchers maintained close contact with R1 and R2, to support their design and execution of their TISL plans. Suggestions were made as to data collection method, online technologies to be used, how to refine the research question, and to some degree, how to interpret the data. The teachers then executed their TISL plans, occasionally requesting support from the NEXT-TELL researchers via email and phone.

<table>
<thead>
<tr>
<th>School</th>
<th>Teachers in TISL training</th>
<th>Teachers planning TISL studies</th>
<th>Teachers running TISL studies</th>
<th>Teachers in post-TISL debriefing</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACS</td>
<td>1</td>
<td>1</td>
<td>49</td>
<td>20, 6*</td>
</tr>
<tr>
<td>TDA</td>
<td>6</td>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 15: Number of participants in the UK TISL cohorts.

* conducted in two sessions

We now focus on and summarise the two TISL plans created by two teachers and executed by 21 teachers at both schools, before drawing conclusions from the experiences of both cohorts of respondents.

6.2.4 Results: ACS-Cobham International School (ACS):

This research was conducted over three engagements of approximately three hours each. The primary contact at ACS was Respondent 1 (R1), who is a teacher of Computing and ICT. Six teachers participated in a TISL training session at ACS. These cohorts were introduced to the TISL method and were shown how to use a paper-based TISL planner worksheets. They used these, working in pairs, to propose possible TISL research

*4 www.soundcloud.com*
plans within their classrooms. They then transferred these plans to an online version of the TISL planner (a simplified version of the TISL planner that is under development) that had been prepared by NEXT-TELL researchers using Google Forms. At the time of writing, of the six teachers engaged at ACS, only one teacher (R1) has been able to carry out her TISL plan, summarised below.

**TISL Plan at ACS**

R1 is a computing teacher, who teaches Java programming and ICT skills. Her TISL plan was to investigate how Java Programming students perform on an online version of a quiz that has previously been administered on paper (see table 16). The quiz is part of her formative assessment and is on the subject of specific Java Programming skills. Her TISL plan was to create an online version of the paper quiz, and ask her students to complete the quiz. She then planned to analyse the results of the quiz as compared to paper versions taken by the same students several months prior, and to elicit comments from her students about their preferences (paper versus online). She augmented this analysis with qualitative data in the form of informal discussions with students about their experiences taking the online test. R1 carried out the TISL research with her students during Project Month 17.

| Subject: | Computer Science: Java Programming |
| Topic: | Basics of Java programming, multiple-choice questions |

<table>
<thead>
<tr>
<th>1: Establishing a trigger</th>
<th>2: Choosing a lens</th>
<th>3: Planning for and collecting evidence</th>
<th>4: Analysing practices</th>
<th>5: Enacting and adapting to innovation and change</th>
</tr>
</thead>
</table>

Student assessment in the course include: Lab work, mini projects, and reading assignments, which include MC questions. The reading assignments are assigned as classwork or homework. All of these assessment types involve working on a computer, except the reading assignment. Students don’t like current paper format used in reading assignments, which

POSSIBLE WAYS TO PROCEED IN ADDRESSING PROBLEM:
(a) Change format of reading assignment so it can be done on a computer.
(b) Conduct assessment in 2 steps: a. collaborative exercises, b. individual exercises

RESEARCH QUESTION: Do students prefer, and perform better in, online multiple-choice questions?

Google form for multiple-choice questioning + audio recordings of students' opinions.

RESEARCH METHOD:
(1) Create (in Google forms) and administer online assessment in class using multiple-choice questions previously assigned-April/May 2012.
(2) Compare scores to paper assessment scores - May 2012.
(3) Develop (in Google forms) and administer a second set of questions that students could do outside of class to provide ideas on how to develop a Java Programming app.

Feedback will be used in developing courses for next academic year. The app will randomly select multiple-choice questions for students to answer. If the incorrect answer is give, student will be prompted with a revision statement of the underlying concept.

Develop app to be used for revising concepts covered in the course.

---

5 http://support.google.com/docs/bin/answer.py?hl=en&answer=87809
includes multiple-choice questions for them to answer.

app-May 2012.

(4) Provide students with questions for small group discussion and recordings-May 2012.


RATIONALE: Stage-1 will address the research question. Stage-3 will help with planning and designing app.

There is also an idea that the app could be developed further to include collaborative activities and game-play so that the students could work with each other to solve problems or to compete to improve their skills.

<table>
<thead>
<tr>
<th>Table 16: TISL plan used by one ACS teacher, as captured using the online Google Form</th>
</tr>
</thead>
</table>

**NEXT-TELL TISL Data collected**

The data collected from ACS is comprised of:

1. Audio recordings of the TISL training and follow up sessions
2. TISL plans created by the teachers, as recorded on the TISL Planner Google Form

**6.2.5 Results: Thomas Deacon Academy (TDA):**

This research was conducted over three engagements of approximately 3-4 hours each. The primary contact at TDA is the head teacher of science, Respondent 2 (R2). R2 was trained in using the TISL method and online planner, and introduced to three methods for data collection: Google forms, online video annotation and audio recording annotation. He spontaneously created his own TISL training materials for his teaching subordinates, which explained and rationalised the use of TISL and which related this to on-going teaching activities within his subject area. He then enlisted 49 subordinate teachers to carry out a TISL plan. This research was carried out as a pilot study by R1 during Project Month 16 and on a larger scale during Project Months 18-19. Of this group of 49 subordinates, 16 teachers who completed the TISL study with their students were able to follow up with NEXT-TELL researchers in a group post-TISL debriefing.

R2 and his subordinates are science teachers employing problem-based learning (PBL) activities for 360 Year 8 science students. The topics cover a wide range of science subjects and include applied maths, physics and technology design. The teachers at TDA have undertaken a new approach to teaching that unifies the many
topical areas in one problem-based activity spanning one or two days. The teachers decided to use TISL to investigate whether their new pedagogic approach is effective in developing students’ Stage 4 skills\(^6\) and in supporting unified learning across several topical areas. R2 selected two of these PBL activities for study, using TISL.

The first activity, “STEM Materials”, was used as a TISL pilot at TDA and focused on the correct application of the Scientific Method to evaluate tensile strength of various materials. The second activity, “The Golden Ratio”, was on the topic of identifying examples of the golden ratio in everyday life. In both activities, students were asked to conduct post-hoc discussion groups of 4-5 participants, using a small set of questions prepared by R2, and devised according to TISL method (see table 17). These discussions were recorded by the students using portable audio recorders provided by NEXT-TELL. The audio recordings were then uploaded to SoundCloud, a commercial website which supports collaborative audition and annotation of sound files. A free “Professional” account was provided by SoundCloud to support the teacher-led studies. The TDA cohort of teachers then made annotations of the student discussion groups, identifying utterances related to how the students attained their learning objectives (see figure 29). Teachers were able to select from any of the recordings that had been made and to choose whether or not to make annotations on any given recording.

Subsequent to the teachers’ TISL studies, two individual interviews were convened with R2, and a group discussion was conducted in which R2 and 16 subordinates were interviewed as to their opinions about employing the TISL. A further small focus group was convened immediately afterwards to identify key benefits of using TISL.

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Establishing a trigger</td>
<td>2: Choosing a lens</td>
</tr>
<tr>
<td>3: Planning for and collecting evidence</td>
<td>4: Analysing practices</td>
</tr>
<tr>
<td>5: Enacting and adapting to innovation and change</td>
<td></td>
</tr>
<tr>
<td>We would like to establish a protocol for evaluating a Cross-curricular project using direct feedback from students (Sound bites) which will allow us to evaluate at the student level, the teacher level and management level. The use of direct evidence such as this will we hope allow us to award a level of achievement against pre-agreed criteria as well as</td>
<td>Key areas: Student skills can be assessed formatively</td>
</tr>
<tr>
<td>Use of technology to allow clear and relevant responses to the task given and assess the progress made by the student groups. The responses can also be used to assess the task itself and its effectiveness in delivering the learning opportunity</td>
<td>Method: Sound recorders to collect data from student groups</td>
</tr>
<tr>
<td>Sound cloud to store and allow access to these recordings</td>
<td>Staff to annotate these clips and discuss the learning and skills discussed</td>
</tr>
<tr>
<td>Staff to comment on and review the effectiveness of the process</td>
<td>Staff to use feedback to inform future projects</td>
</tr>
<tr>
<td>Clips have been reviewed and annotations made on some of these. Staff have listened to the comments and discussed these with a view to developing how they can be used to make assessment decisions. Senior management have listened to these and expressed interest in how this will develop. Work in progress</td>
<td>Develop stage 4 and designing a practical way of reviewing material and allowing students to revisit and review this material. Lots to do here still.</td>
</tr>
</tbody>
</table>

---

\(^6\) Stage 4 refers to a Key Stage in the UK National Curriculum.
Feedback on the effectiveness of the activity itself and evidence that the project is achieving its stated aims.

Students to revisit their recordings and to comment on how they have reached their learning objectives.

Senior management to look at the project outcomes and review evidential data here!

Table 17: TISL plan used by 49 TDA science teachers, as captured using the online Google Form.

7Na Golden Ratio Emma Alana Marco

Science Technology Maths 4 months ago

5 Comments Add a comment
4 typed comments and 1 regular comment

Mr D Trank at 0:27 4 months ago
If you had to assess scripts you could just assess them in the usual way without listening to the audio files. There has to be a better way of ensuring sensible behaviour. Warn them that they will be named and shamed perhaps??

Mr D Trank at 0:27 4 months ago
not taken seriously unfortunately

Mr D Trank at 0:27 4 months ago
Can we give negative events? I have the post right here...

Mr D Trank at 0:27 4 months ago
Such a shame these students abused the privilege.

Mr D Trank at 0:27 4 months ago
perhaps students should have their scripts assessed before they are allowed to move on to the recording stage.

Add a new comment
Want to add a typed comment instead? Use the blue bar in the SoundCloud Player.

Figure 29: Teachers’ annotations regarding students’ comments during post-hoc discussion groups.

NEXT-TELL TISL Data collected

The data collected from TDA is comprised of:

1. Audio recordings of the TISL training and follow up sessions
2. TISL plans created by the teachers as recorded on the TISL Planner Google Form
3. Data collected by teachers annotating audio recordings of their students’ retrospective discussions regarding a project-based learning activity

6.2.6 Summary and Discussion

Data analysis of the results from this work is still on-going at the time of writing. However, some preliminary results are reported in [Craft, 2012, D5.3] and it is possible to provide a general summary of the research findings here, highlighting the benefits and problems with the TISL plans carried out by the participants. These findings inform the guidelines and recommendations in section 7.
Generally, teachers were able to quickly understand the TISL method and to identify how it would be valuable for their practice. After about approximately two hours of explanation and a question-and-answer discussion, informants at both schools were able to use the online planner to attempt to capture their TISL research plans.

(R2 TDA): The planning process is almost intuitive, it almost works automatically in that way; and the planning I did...I went to a day's conference where we went through how to plan this thing. And to be honest, I enjoyed it but it was very obvious how it flowed to me.

... 

(R1 ACS): I think for me it has helped me sort of narrow down what it is I want to look at.

However, some teachers did encounter problems. Although teachers were able to articulate the kinds of questions they would like to study among their students, they found it challenging to propose ways of designing an effective research strategy to answer them. This bears some similarity to the way that research scientists must grapple with the challenge of designing an appropriate research plan. Effective research is the result of careful and creative study design, a skill which must be developed over time and with experience. Some teachers had difficulty in translating their questions about student learning into action plans for research. Although they had only about an hour to do this during the fieldwork, they were encouraged to update and refine their TISL plans over a period of several days. Yet, the task was unfamiliar and they were not accustomed to conceiving ways to answer questions through research in their own classrooms:

(NT Researcher): Quickly, since we only have a few minutes, can you guys tell me what’s the hardest part about this process?

(R3): Analysing it...for me.

(R4): I think coming up with a specific question was the hardest...coming up with that target question. I was all over the place. I have so many things that I want to answer I couldn’t focus on one thing.

(R5): Yes, there are too many.

(R3): Teaching is so complex that it is hard to disentangle things.

(R4): I don’t think it’s confusing, is just difficult to choose and to narrow it down. I have so many questions that I want to answer or somebody thinks that I would like to know... Having ten of me?

Notwithstanding these challenges, several plausible research plans were recorded. Two of these TISL plans were carried out (among 20 classes at TDA and by one teacher who executed her own plan at in one class ACS), and the TISL planner was seen as useful:

(R4): ...I think this is much more sustainable, a lot more teachers can do this sort of thing...TISL...and have evidence at the end of the year to show that they have actually learned something within their classroom about their own teaching.

... 

(R1): So that’s [the TISL planner] really helpful – it’s structured; and if you had to take this to the board, it’s structured. You don’t just say, oh she said...you know. So the student performed or preferred, and performed better in online multiple choices. So very simple. ... So we talked about a timescale. When would I do all of these things to try and keep it realistic? And I put in some times to get their recordings in May. I’ve just finished and analysed it.

Although teachers reported that their TISL research was effective at answering their questions, and they believed the research was valuable, there were some notable problems.

7 R1 and R2 are the lead teachers. R3, R4 and R5, are other teachers participating in group discussions.
In the case of TDA, the selected data collection method (audio recordings of students’ reflections about their experiences) was not very suitable to answer the TISL question posed. Yet, the teachers interpreted the data as confirming their own conclusions that their pedagogic approach was successful. The lead teacher, R2, conceived his TISL plan as a way of formatively assessing students to evaluate a protocol for a new pedagogic approach (see Table 17: 1. Establishing a trigger). However, student self-reports are likely to be an inadequate way to achieve this, as they involve students’ retrospective opinions about their learning experiences and are not a direct measurement of the learning activities under formative assessment. In this case, it would have been better to directly measure students’ learning behaviours, rather than to evaluate their retrospective opinions. It is interesting to note that when we raised this concern with the TDA teachers in a debriefing discussion after the conclusion of the study, they disagreed, and reported that their data revealed nuanced information about both students’ progress and learning experiences. While we agree this may be true, it appears to us that they were essentially using the recorded audio as an alternative means of supplementing their other summative assessments.

In the case of ACS, there was a significant potential research design flaw. In this study, R1 devised an online version of a previously administered paper test, which students had taken several months earlier. The instrument and questions were the same - only the means of administration was changed, in a repeated-measures study design. R1 compared the student scores and noted a substantial increase across items and aggregate scores:

(R1): They had to put in their name, and almost every question – the arrow means they got it right. Almost every question, almost everybody has done very well. So I know the average score is not 53 – it’s probably about in the 70s or even higher than that.

She interpreted the improved scores as an effect of the students’ having used an online version of the test. Her students positive feedback in post-test discussions confirmed her interpretation that as an assessment method and in terms of student experience, the online version of the test was superior to the paper version. But practice effects are a known problem with repeated-measures studies, which occur when subjects’ performance improves due to repeated exposure to stimuli.

Prior to R1 performing her study and in post-TISL debriefing, we highlighted the potential problem that the previously administered paper test would have conditioned her students, but R1 discounted this explanation of the improved test results, on the basis that students are provided support for finding the answers during both tests:

(R1): The same test they took in the first quarter.
(R4): On paper in the first quarter.
(R1): But would you have expected them to improve their scores anyway in that time? No, you wouldn’t.
(R1): Not necessarily, because I tell you what it is about these tests; these tests are meant to check their use of the language. So they know how to do these things; if I tell them to declare a variable and set the default at zero, they will know how to do that. But when I ask them, which one of the following is a valid Java state, they may not know which one is correct. They don’t connect the language to what they do. And that’s what these tests are supposed to do. In fact when I give them the one on paper, all they have to do is read it and I translate it...Everybody immediately went online and started finding it out...
(R4) So they do the research during the test.
(R1): Yes, exactly. So it’s not as if I’m trying to trick them or see what they remember; I’m just saying, I want you to make these connections.

Notwithstanding this explanation, we are not convinced that R1 was able to clearly isolate the causes of her students’ improvement in the online version of the test. In addition, the small student sample size (n=12) means that measures of statistical significance could not be employed. Although statistical inference is not generally among the aims of teacher-led design studies, they are a useful goal because they support generalizability. Furthermore, statistically rigorous data are likely to be seen by other teachers and key decision makers as more compelling than interpretive or qualitative results, regardless of whether the latter may be
have equal or greater value to the teacher. However, many teachers have only a modest level of experience with statistical data analysis.

Both of these examples point toward the difficulty in communicating the formalities of rigorous research to a naive cohort, even with a relatively simple method, such as TISL. Although the need for rigour is perhaps less crucial than it is for peer-reviewed scientific research, it is nonetheless important for teachers to conduct well-designed research if they are to derive meaningful conclusions from their work. It was clear that even with careful (though limited) guidance on the part of NEXT-TELL researchers, teachers experienced difficulty in designing a scheduling a research plan, selecting measures, executing rigorously, interpreting the collected data, and identifying alternative explanations. They were also clearly able to articulate these challenges, to identify that they need to be overcome, which they must do in order to derive value from teacher-led design studies:

(R2): We're not researchers; we don't sit in London University and research. We are teaching day after day after day, group after group. What do I need? I need a clear instruction sheet. Why am I doing this? Well the outcome is that we're looking at the way that this project... OK, fine. That's all they want to know.

In spite of these challenges, they reported that the results they obtained were valuable to them, and supported their judgements about their own teaching. Almost universally, the teachers said that they felt empowered, and that they were confident about the value of conducting research with their students. On the whole, the participants said they believed employing such studies could lead to improvement in their professional practice and better learning outcomes for their students.

Limitations and shortcomings of the research

This research and the findings must be seen in the light of the following limitations, which impact on the data collected, its interpretation and the recommendations made in the next section:

- Small cohort size (refer to Table 15, above)
- Limited teacher time to engage with the TISL method and to conduct research
- Small sample of TISL plans enacted (2).
- Difficulty attracting participation among practitioners
- Difficulty interpreting clearly the effects of TISL from the group interviews
- Teachers used a Google Form as a simplified TISL planner and did not use version 1 of the TISL planner in the NEXT-TELL infrastructure, and therefore can only offer limited suggestions for further improvements to it.
- UK centric sample
- Results not generalizable
7 Guidelines & Recommendations For The Teacher-Led Design Studies and use of TISL

In a previous deliverable [D5.1], we have conducted a literature review regarding teacher-led inquiry into student learning, and proposed a method for teachers to structure teacher-led design studies (TISL). We have also conducted research with teachers who have used the TISL method in their teaching environments, which is reported in this document and in [D5.3]. The data we have collected has suggested areas for improvement for the TISL method and has also revealed some of the challenges that teachers experience in undertaking teacher-led design studies.

On the basis of this research, we propose the following guidelines and recommendations:

7.1.1 Practical Guidelines for Researchers

- Keep the TISL method as simple as is practical and highlight potential research challenges.
- Avoid overloading teachers with research and do not oblige them to conduct research.
- Recognise that although they might be interested, teachers often are not provided with extra time to do research.
- Support teachers’ use of technology to conduct their research.
- Bear in mind that ambiguous results are also useful and do not reflect negatively on the teacher. Research often yields ambiguous results.
- Suggest what is their interest and how to enlighten them - options, limitations, clarifying specific context influencing the design.

7.1.2 Recommendations

The following six recommendations need to be considered when teachers should inquiry themselves. The recommendations are no recipe that can easily be run down step by step. Rather, they make clear that establishing the basis for TISL and working with teachers to inquire themselves is time-consuming effort. However, we think that the merit is worth investing the effort.

1. Provide research support

Teachers are not used to conceptualising research as part of their professional practice. It is not part of their CPD (continuing professional development). Therefore, research training and acculturation to research practice is essential for teachers to be able to learn these new skills and incorporate them into their work. Support from practicing researchers is important for providing teachers an understanding of how to engage in design studies using TISL (or any method). Researchers can also help teachers to select technologies to undertake their research and to share it with others.

As described here, NEXT-TELL researchers have successfully engaged teachers in using TISL to conduct their own studies. A mentoring relationship was demonstrated to be helpful in developing their own identity as a teacher-researcher. However, such support is not practical after the life of NEXT-TELL, and is not scalable to large numbers of teachers. Therefore, establishing or leveraging existing support networks for teachers is recommended (see Recommendation 4). Incentives should also be identified for researchers to engage with teachers and vice-versa. Another strategy would be to establish a network of teacher-researcher “champions” through a series of funded workshops. Teachers within such a network would advocate teacher-led design studies within their own communities. They would mediate and sustain this through the recommended support networks.

Teachers can also be supported by learning from both their colleagues and researchers in hands-on applied workshops. This was achieved, for example, by the Alpine Rendez-vous (ARV) series and the ASLD 2011 workshops, both funded by the STELLAR European Network of Excellence in TEL. Such workshops should focus on the ways that schools can work with researchers. Viable workshop topics include: building connections,
building networks, research techniques training, discussing results, methods, analysis, refining the research question(s).

2. Minimise impact on teacher time

In addition to training and acculturation to the idea of doing research, teachers need time to design the research, conduct it, reflect upon it, and act. Such time is in short supply. As reported elsewhere [see Cierniak, 2011, D6.2] teacher time, across schools and countries, is an extremely limited resource. Thus, it is extremely challenging for teachers to find any room incorporate Teacher-led design studies into their schedules. Moreover, there is a risk that a teacher might invest time in a study but uncover little of value (teachers might construct the research poorly or have problems in interpreting the data). Thus, undertaking studies can be seen as a risky endeavour with little immediate value offsetting the time cost. Compounding the perceived risk is that institutions, on the whole, do not place value on teachers conducting studies.

To mitigate these factors, templates of exemplar studies should be created. Also, examples of successful teacher-led design studies should be collected and shared with teachers. The templates and stories should describe studies which can be quickly implemented, and the value of which is clearly highlighted. This approach is similar to the current practice that teachers report in borrowing lesson plans from colleagues both in person, and from online communities. In addition, teacher-led design study methods (viz. TISL) should remain simple and practical, whilst supporting rigorous research (see Recommendation 6).

3. Secure buy-in from strategists and policy makers

The value of teacher-led design studies should be made obvious not only to teachers, but to education strategists, such as heads of schools and policymakers. Consequently, dissemination and profile-raising initiatives for these groups should be supported. This would include workshops and networking events targeted at strategists, which highlight the impact of teacher-led design studies on metrics that are important to this population.

This should lead to a cultural shift in which teacher-led design studies will be construed as an essential part of teachers’ professional practice. Goals and milestones for conducting such studies should be incorporated, optionally, into teachers continuing professional development (CPD) plans. It is stressed that if targets for studies are set, these should not be contingent upon the teachers’ producing results toward a particular outcome. The studies should be seen as a valuable activity in their own right. The outcomes of teacher led studies themselves, especially those that are ambiguous, should not be construed as a reflecting the quality of the practitioner’s teaching.

4. Provide online resources

Online resources such as use-cases, templates, reference materials should be made available to teachers. Teacher-researcher communities should be cultivated for sharing research plans/templates, interesting data, experiences, and community-based advice and guidance. Ideally, these resources will be situated within existing IT services (see Recommendation 5) that teachers already are familiar with and use regularly. These resources should be in the form of teacher-centred social networking site(s) or a dedicated website. These resources should also be made available using IT resources local and private to each school, district or region. This would address potential privacy and data protection concerns (in the case that student data would be shared in a open or semi-open forum).

5. Leverage existing IT services and online support networks

Teachers are already overloaded with a wide range of technologies and services to support their work. Teacher-led design studies should make use of existing IT tools and services with which they are familiar. Support in using these is often provided locally at the school by IT services and by existing teacher communities both online and offline. If they are to be adopted by schools, the design study tools developed by Next-Tell should be carefully integrated into existing IT systems, and adequate support provided in using them through training, online references, and online communities.
Creating new online communities from scratch is known to be difficult to do without substantial commitment of stewardship, time and resources. Expertise in teacher-led design studies should be provided in online forums and by the teacher-researcher champions identified in Recommendation 1. Networks of support for teachers in existing teacher networks should be leveraged. An example of this in the UK is the Times Education Supplement online teaching resources website. Teacher-researcher champions should seed these forums with relevant teacher led design study topics.

6. Continuously improve the teacher-led design approach/TISL Method

Creating a TISL can be challenging and time consuming. Several informants suggested the possibility of browsing through examples of teacher-led design studies to adopt or adapt for their own research. To support this, TISL/Research Templates should be incorporated into the NEXT-TELL infrastructure and should also be shared within support networks. Key technology tools which support data collection, analysis and sharing should be identified and linked to the templates.

Also, the current TISL method does not specify that a research question be defined. This is problematic because it does not provide a focus for the inquiry. High quality scientific research (in both quantitative and qualitative paradigms) is predicated on primary, secondary, and even tertiary research questions, which are clearly specified. These provide a basis from which the research can be executed and which the collected data can address. The TISL method should be changed to incorporate defining a research question.

In TISL, Planning for and collecting evidence are currently comprised in one step (3), but they are different activities. They should be separated into distinct steps and the activities that need to be carried out should be clarified.

Precise scheduling is not a requirement and is burdensome for teachers. The detail required by this step should be kept to a minimum. If it is possible to connect the NEXT-TELL software infrastructure to existing scheduling systems (e.g., Exchange, SharePoint, Google Calendar, iCal), this should be integrated into the software.

---

8 http://www.tes.co.uk/teaching-resources/
8 Conclusions

The work presented in this deliverable shows again that developing and establishing 21st century learning, formative e-assessment, and TISL in schools is a complex process. The following paragraphs detail the conclusions according to the sections respectively.

8.1 Conceptual Framework

In order to analyse and structure this complexity we have elaborated the cognitive density framework and linked it with the perspective of classroom orchestration over the last project year. Both frameworks will help to describe what is happening in technology-rich classrooms. The development of tools for tracking and measuring cognitive density has made good progress during Year 2. How these tools will inform researchers about and support teachers in adaptive teaching will be investigated during Year 3 and 4.

8.2 Scenario Development

The scenarios presented in section 4 concern important issues of 21st century learning. The scenarios will be developed further, tested in classrooms, and refined according to the results. They are good examples to show teachers less familiar with ICT how 21st century learning might look like. The competencies they aim at and the respective assessment patterns will be elaborated in collaboration with WP2, WP3, and WP4 in order to come up with runnable solutions for e-assessment, data tracking, and visualisation. Moreover, training materials will be developed in collaboration with WP7 in order to support teachers in implementing the scenarios.

8.3 Studying and Developing Formative e-Assessment

The studies in this deliverable demonstrated that technology per se cannot promise that formative e-assessment is practiced deliberately (see for example the study on networked graphing calculator technology in section 5.1). Rather, when cloud tools should be used for improving teaching and learning, good methods need to accompany these tools. Therefore, NEXT-TELL is developing and already revising different scenarios (see section 4) because it seems sufficient that it might be easier for teachers to use NEXT-TELL’s methods and tools attached to a specific operational context. Therefore, this approach might also help teachers later on in implementing own studies.

8.4 Teacher-led Design Studies

Teachers need to be able to inquire their own practices. The research findings presented in section 6 show good progress in supporting teachers in TISL. However, they also highlighted issues which need further research and development.

One can infer from the recommendations in section 6 that introducing TISL in schools, especially in addition with the focus of formative e-assessment, is effortful and time-consuming. Although NEXT-TELL acknowledges that teacher-led design studies are resource intensive for both sides, teachers and researchers, we support this method as one way for researching and developing education. The emancipatory approach underlying TISL is necessary, if we want to support teachers in educating students for the 21st century. The recommendations are a good agenda to rely on. Considering country-specific and other contextual factors is an important issue. In Year 3 and 4, the project partners will work further on involving teachers into active research. The knowledge gained so far by WP5 is important for all other project partners. We are aware that it is not possible to ask teachers to investigate themselves but let them alone with this task. The TISL workshop scheduled for the international meeting for school leaders at the next plenary meeting in September 2012, should support project partners in adopting and refining NEXT-TELL’s TISL method.
9 References


10 Glossary

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

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSCW</td>
<td>The document store used in NEXT-TELL used for storing internal documents</td>
</tr>
<tr>
<td>Document store</td>
<td>see BSCW</td>
</tr>
<tr>
<td>EuresTools</td>
<td>The reporting tool used in NEXT-TELL</td>
</tr>
<tr>
<td>PM</td>
<td>Person month</td>
</tr>
<tr>
<td>T</td>
<td>Task</td>
</tr>
<tr>
<td>WP</td>
<td>Work package</td>
</tr>
</tbody>
</table>

Partner Acronyms

<table>
<thead>
<tr>
<th>Partner</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>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 Centred Activity and Appraisal Design (builds on the ECD)</td>
</tr>
<tr>
<td>ECD</td>
<td>Evidence Centred 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>
</tbody>
</table>
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.

**RA** Requirement Analysis

**RDS** Researcher-led Design Study

**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

**NEXT-TELL partners responsible for generating tools and methods**

- **BOC-AT** ECAAD
- **TUG** ProNIFA and all modules
- **BOC-PL** SPICE
- **EXACT** Moodle
- **JRS/ EXACT** Google Docs and Google Spreadsheet
- **TALK** OpenSim
- **CBS** Rep5
- **JRS** EVE
- **EXACT** Mahara ePortfolio
- **BHAM** OLM

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.