Deliverable D5.1

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1 Executive Summary

This report focuses on the development of a set of methods and tools for teacher inquiry into students’ learning (TISL) supported by advanced learning technologies (ALTs) and the relationship between (1) teacher inquiry processes; and (2) schools’ strategic planning; (3) teachers’ professional development; and (4) teacher certification.

1.1 Teacher inquiry and advanced learning technologies

Schools and learners are making increasing use of ICTs. Teachers are being asked to appraise increasingly large and complex data about students’ learning for a wide range of purposes and stakeholders. However, effective use of ICTs in schools across Europe is patchy and levels of e-maturity vary widely. These trends, developments and expectations mean that teachers need to develop a deeper understanding of the role, purpose and value of data about students’ learning and ways in which advanced learning technologies can support this need.

Of particular importance is an increasing desire on the part of policymakers to evaluate students’ longitudinal learning, skills and competencies across multiple contexts, i.e. evaluating the rich, qualitative and typically formative data that emerges from students’ day-to-day learning practices as opposed to those which are tracked in a purely summative manner. Such shifts in policy, however, raise important issues for teachers and schools in terms of teacher autonomy, responsibility, flexibility of action, competency and quality, both in terms of the use and integration of ICTs and levels of assessment literacy, more particularly formative e-assessment literacy. TISL responds to these issues and needs by providing a set of methods (Section 4) and tools (Section 5), co-developed with teachers, to support teacher inquiry into students’ learning with a particular focus on teachers’ professional development (Sections 3, 4 and 6) and schools’ strategic planning goals (Section 6).

1.2 Aligning teacher inquiry with school’s strategic planning and teachers’ professional development

Too often, teachers’ professional development is delivered as a standalone activity divorced from the everyday concerns of teachers and/or the overarching strategic planning goals of school leaders. Where teachers do investigate their own practice, the outcomes from such activity are often regarded as trivial at the level of strategy and/or policy. TISL responds to this gap in educational dialogue by providing opportunities for teachers and schools to collaborate in the design and implementation of a set of planning tools and related methods which facilitate systemic, evidence-based teacher-led research that is aligned to schools’ strategic planning needs on three inter-related levels:

- the student level - where teachers focus on evidence-centred activity and assessment design (ECAAD);
- the teacher level – where the focus is on teachers’ inquiry into students’ learning (TISL); and
- the strategic level – where the focus is on strategic planning with ICTs in education (SPICE).

Two elements are key to the successful implementation of TISL in this context:

- The use and alignment of two planning tools (including a platform for communication and collaboration amongst stakeholders. These comprise an inquiry process planner at teacher level; and a strategy planner at school leader level. These are used, respectively, to promote and sustain teacher professional development as a driver for innovation and change at whole school level.
- The development of a systemic approach to teacher inquiry (TISL method, which draws on methods derived from teacher inquiry, teacher design research and context modelling based on the Ecology of Resources model) discussed in more detail in Section 4 of this deliverable; and of a corresponding systemic approach to strategic planning (SPICE method, which draws on the...
BSC/Baldrige approach to systems management and organisational change) which is discussed in more detail in Section 6 of this deliverable. Whilst each of these approaches may feed into teacher activity at the ECAAD level (e.g. in terms of assessment design) and vice versa, assessment within ECAAD focuses more closely on individual students’ whilst that at TISL/SPICE level focuses more on groups of students and on evaluating and enhancing the quality and/or effectiveness of teaching and learning through inquiry into data about students’ learning (see also section 3.2).

1.3 Developing methods and tools for teacher inquiry

A first iteration of the TISL approach to teachers’ technology-supported inquiry into students’ learning has been derived mainly from the literature. It comprises two layers: theoretical and empirical. Each layer is framed by 4 inter-related lenses for inquiry and action (Table 1).

<table>
<thead>
<tr>
<th>Theoretical Layer</th>
<th>Empirical Layer</th>
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<td>Action, Design, Context, Inquiry</td>
<td>Team, Method, Plan, Cycle</td>
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Table 1: Inter-related lenses for Inquiry and Action in TISL

Together, these provide a foundational structure for the kind of action-oriented, evidence-based, teacher-led research envisaged by TISL as an approach. Building on these foundational layers, this first iteration of TISL also provides a 10-step model (Table 2) for teacher-led inquiry and data-driven decision-making.

<table>
<thead>
<tr>
<th>5 steps for teacher inquiry</th>
<th>5 steps for data handling</th>
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<tr>
<td>• establishing a trigger</td>
<td>• identifying tools (ALTs) and potential data sources</td>
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<td>• choosing a lens (researcher or teacher-led)</td>
<td>• planning for data capture and data sharing</td>
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<td>• planning for and collecting evidence</td>
<td>• collaborative data analysis and interpretation</td>
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<td>• analysing practices</td>
<td>• evaluating data and reflecting on inquiry process</td>
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<tr>
<td>• enacting and adapting an action/innovation</td>
<td>• data-driven decision-making for innovating practice</td>
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Table 2: 10 steps to TISL (methods and tools)

In addition to identification of inquiry processes and methods, a set of related tools has been identified. These also comprise two types: tools which will be co-developed with participants; and tools which are readily available (see Section 5). Tools to be developed with participants relate to the planning of inquiry processes at teacher (TISL Planner) and school leader level (SPICE Planner). These focus, respectively, on teachers’ professional development as a driver for innovation and change and the alignment of these needs to school leaders’ strategic planning goals. Available tools which support these goals have been identified and include: generic collaboration tools (e.g. wikis, blogs, Google docs, Zoho, etc.), video analysis tools (e.g. EVA, VAT, etc.) and teacher e-portfolios. A dynamic list of emergent tools has been included as Appendix 1. The latter can be further developed and added to with teachers and schools over time.

1.4 TISL: technology-supported teacher inquiry in practice

The methods and tools for teacher inquiry identified in this first iteration will be evaluated and further co-developed with teachers and schools. Exemplar use case scenarios have been identified (Section 4) in the areas of STEM and TESL (language learning).
2 Introduction

2.1 Purpose of this Document

The purpose of this document (D5.1) is the provision of a preliminary (v1) set of methods and specifications for TISL components. An overview of (1) what teachers need in order to inquire into students’ learning is provided together with (2) a preliminary specification of requirements relating to methods and tools which teachers and school leaders can use to support the implementation of TISL in schools. (3) A method for implementing the TISL approach as a form of teacher-led professional development aligned with schools’ strategic planning is also presented, alongside (4) a related method for researcher-led facilitation of the TISL approach to teachers’ inquiry into students’ learning.

2.2 Scope of this Document

This deliverable focuses on the development of the TISL inquiry methodology. It reports on an initial needs analysis and requirements specification for a set of methods and tools pertinent to the implementation of the TISL approach. Findings are drawn from a preliminary review of the literature and a comparative review of school systems in partner countries (AT, DE, DK, NO and UK) conducted amongst participating project partners. Where available, data from initial informal dialogue with schools in partner countries (AT, DE, DK, NO and UK) is also used to inform the wider findings from the literature.

Collaborative contributions from project partners are also provided – as preliminary indicators of the ongoing development of methods and tools relating to the TISL approach to teacher inquiry which will be followed up in later deliverables.

This deliverable (D5.1) does NOT include a detailed report on the specific development of NEXT-TELL tools, i.e. the TISL Inquiry Process Planner and/or the SPICE Strategy Planner, insofar as the more specific development of these tools is dependent on data which will not be generated until both the baseline studies and requirements analysis phases of the project have been completed. However, commentary on initial prototyping is provided and, where relevant, cross-referenced to related Work Package deliverables (e.g. D2.1, D3.1, D4.1, D6.1 and D7.1)

2.3 Status of this Document

This document is the final version.

2.4 Related Documents

Before, or in conjunction with, this document it is recommended that the reader be familiar with the following documents (see also Appendices to D5.1):

Related Deliverables: D2.1, D3.1, D4.1

Appendices:
1. List of generic collaboration tools
2. Case studies illustrating exemplar use cases from the existing teacher inquiry literature
3. Overview of CbKST approach to teacher certification

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3 State-of-the-art in Teacher Inquiry

NEXT-TELL aims to provide schools with three inter-related methodologies (ECAAD, TISL and SPICE) and related software to support adaptive teaching, personalised learning and the development of 21st century skills. Combined, these three elements characterise the teacher’s role in three specific but inter-related ways – as a strategic, professional, practitioner. With this in mind, TISL aims to support teachers and school leaders in integrating advanced learning technologies (ALTs) into existing practices relating to (1) teachers’ learning about students’ learning, (2) teacher professional development, and (3) the alignment of these to the strategic planning goals of school leaders. At the core of TISL is the notion of teachers as innovators and designers in technology-rich, adaptive teaching and learning environments.

3.1 Rationale for TISL as an approach

Schools, nationally and internationally, are making increasingly extensive use of ICTs to support teaching, learning and student assessment. The range and variety of technologies available and the variable contexts within which these are and can be used is raising many questions for schools and educational policy makers around the use of ICTs in schools and the implications of these tools for traditional forms of teaching, learning and assessment (Sainsbury, 2009, Balanskat, 2005, Pedro and Scheuermann, 2010).

Furthermore, teachers are increasingly being called upon to interpret and appraise large amounts of data about students’ learning, for a wide range and variety of purposes (OECD, 2005, DfE, 2010). Whilst ICTs have done much to support the more routinised aspects of record-keeping, monitoring and assessment and have begun to offer capacity for data-sharing between teachers, parents, learners and other stakeholders, this capacity and the richer, more formative aspects of students’ technology-enhanced learning data have remained difficult to operationalise, capture and evaluate (Pedro and Scheuermann, 2010).

A recent report (Balanskat et al., 2007) on the impact and use of ICT in schools across 27 EU countries confirms that schools’ effective engagement with ICTs is patchy and that there exist considerable differences in levels of e-maturity within and between countries. At the same time, the existence of these ICT resources is raising expectations for increased and improved communication about students’ learning (DCSF/Becta, 2008, Jewitt et al., 2010, Luckin et al., 2008). Kozma, for example, in a 2009 report on 21st century skills argues:

Existing models of assessment are typically at odds with the high-level skills, knowledge, attitudes and characteristics of self-directed and collaborative learning that are increasingly important for our global economy and fast changing world. New assessments are needed that engage students in the use of technology and digital resources and the application of a deep understanding of subject knowledge to solve complex, real world tasks and create new ideas, content, and knowledge. (Kozma, 2009)

Daly et al. (2009), meanwhile, argue that the continued gap between investment in ICT and the effective engagement of students and teachers in its use has significant implications for teaching, learning and assessment as well as on teachers’ professional practice and schools’ strategic planning.
3.1.1  
**TISL in the context of technology-enhanced teaching, learning and assessment**

TISL picks up on the emergent needs identified above through the development of a set of methods and tools that support teachers’ engagement with advanced learning technologies. At its core is a focus on teachers’ use of student data to promote innovation and change. Innovative practice, here, is conceived as a form of teacher-led professional development aligned to schools’ strategic planning goals. TISL addresses issues raised in the literature by providing teachers (and, through them, their schools, students and wider communities) with:

- Exposure to advanced learning, and Web 2.0, technologies
- Software support for real-time appraisal and assessment of students’ learning
- Increased assessment literacy and the participatory design of innovative e-assessment models through teacher-led research
- Team-oriented teacher learning about students’ learning

TISL, with its focus on technology-supported teacher inquiry into students’ learning, holds the following aspects to be of particular importance:

- teacher-led research in the development of effective e-assessment models
- teacher assessment literacy and certification
- the alignment of the preceding elements to schools’ strategic planning as a sustainable form of teacher professional development

3.2  
**Aligning strategic planning with teachers’ professional development**

In contrast to ECAAD (see D2.1) TISL does not focus on the assessment design of students’ learning – rather it aims to engage teachers in developing a deeper understanding of the role, purpose and value of student data at both strategic and classroom level, i.e. in relation to their own professional growth as teacher practitioners and in the alignment of their professional development activity with schools’ strategic planning goals as a tool for sustained innovation and change.

The use of student data in TISL can be viewed through three disparate, but closely inter-related, lenses on assessment practices, their role and purpose. For example, in a 2009 report on national testing across Europe (Parveva et al., 2009) three purposes for assessment were identified:

- **Summative** (assessment of learning) – summarising the achievement of individual pupils at the end of a school year or key stage
- **Formative** (assessment for learning) – focusing on the day-to-day learning needs of individual pupils and adapting teaching accordingly
- **Evaluative** (assessment of education quality) – used as an indicator of individual school/teacher performance in terms of education quality and the effective application of policies and practice

However, whilst the report highlights the role of summative and evaluative assessment, it emphasises that the core form of assessment, and that which is most commonly used, is *continuous assessment*, i.e. the ongoing monitoring and tracking of students’ learning progress – which may incorporate all or any mix of the above-mentioned purposes. TISL, then, responds to emerging needs for the development of evidence-based evaluation and inquiry into the role, purpose and value of student assessment data by providing a robust set of methods and tools designed to support teacher-led approaches to innovation, adaptive teaching and learning, and the related integration of advanced learning technologies into existing educational systems. These methods and tools are described in greater detail in Sections 4 to 7 of this deliverable.
3.3 Teacher quality and school improvement

New directions and innovative practice in assessment can involve devolving greater autonomy to teachers and schools (Desurmont et al., 2008). For example, in a recent white paper “The Importance of Teaching” (DfE, 2010) the UK government outlined plans for a comprehensive review of the English education system. At the heart of this review lay concerns with the standing (potential or actual) of the English education system compared to its international counterparts (DfE, 2010, Parveva et al., 2009, Oates, 2010). The report (DfE, 2010) focused on the need to improve teacher quality through increased localisation of training, professional development opportunities, and school improvement; and the harnessing of detailed performance data for ease of comparison of school effectiveness. It recommends that teachers be encouraged to work together “with other teachers to develop effective practice” (DfE, 2010) and that they should be free to “use their professionalism and expertise to support all children to progress” (Ibid., p 42). These developments mark a shift in UK educational policy perspectives that TISL seeks to address alongside its primary focus on students’ learning, teachers’ professional development and school leaders’ strategic planning. Such shifts, however, raise other issues for teachers and schools.

A recent report (Desurmont et al., 2008) which examined levels of teacher autonomy and responsibility across Europe found that whilst increased levels of autonomy allowed teachers greater flexibility of action, this was coupled with increased responsibility for outcomes. Elements considered important for comparing the relationship between increased autonomy/accountability included:

- Political context
- Educational system (curriculum, teaching methods, pupil assessment)
- Teacher professionalism and professional development
- Teacher participation in educational reforms and innovations
- Teacher time and required duties
- Accountability and incentives

These are important contextual issues with potential impact in the development, design and implementation of TISL as an approach to teacher professional development and teacher certification. With increased responsibility comes a greater need for teacher professionalism and appropriate rubrics/models for assessing teacher competencies. These needs will be met in TISL through the development of the TISL Platform, Planner, and related methods and tools (see Sections 4 and 5); a Strategy Planner for school leaders (see Section 6 on SPICE); and a set of methods and tools for teacher certification (see Section 7).

3.4 Fostering teachers’ professional development

Freebody et al. (2008) suggest that the notion of teachers as innovators is crucial to successful change management in schools.

Teachers need to be able to create and adapt their instructional practices, to use robust methods of systematic inquiry, to engage in knowledge-building dialogues with professional instructional designers and university researchers, and to contribute to advances in their specialist knowledge domains. In other words, teachers need to work as innovators who design and create new pedagogical practices, as researchers who inquire into and assess their innovations, and as knowledge builders who contribute to accumulating the knowledge of their professional community. (Freebody et al., 2008)

They suggest that schools should see themselves as innovation networks (Fullan, 2004) and that, in order for this to happen, teachers need to be encouraged and supported in their engagement in action for change through a process of systematic inquiry into their own practices, thus enabling schools to capture and benefit from the emergent innovations that arise in and through the everyday practice of teachers as they respond to
specific issues arising in the local context (Ibid, p67). TISL supports a systemic approach to teacher inquiry by seeking to align teachers’ learning about students’ learning (TISL) to strategic planning with ICTs at whole school level (SPICE) and to the assessment and activity design of students’ technology-supported learning at classroom level (ECAAD). Through the implementation of TISL methods (see Section 4) teachers bring these components together in and through an exploration of their own and others’ practices in an iterative, evidence-based cycle of teacher-led research supported by TISL tools, i.e. TISL Platform, Planner and related teacher e-Portfolios (see Section 5).

The integration of school leaders’ strategic planning with ICTs in education (SPICE) with teachers’ professional development and students’ learning is key to the successful implementation of TISL. Legitimisation of the teacher inquiry process at the strategic level contributes to teachers’ ownership of the inquiry process and supports the development of an innovation cycle around use of ICTs in education that is authentic to all layers of the local context and to contiguous educational contexts and society more generally. It involves a collegiate commitment to improving teaching and learning as an integral, emergent and evolving activity which, in contemporary society, necessarily includes the effective integration of advanced learning technologies (ALTs) into existing educational systems. Means et al. (1993), for example, have identified six common features for successful innovation with technologies in school systems:

- Strong leaders
- Supported teacher time for planning, collaboration and reporting on technology use/developments
- A critical mass of teachers involved in technology activity
- A high degree of collaboration among teachers
- Readily available access to technologies and technical support
- Instructional vision and a rationale linking this vision to technology use

It is important to emphasise that the review of the relevant literature suggests that technology-supported teacher inquiry into students’ learning is a complex and transdisciplinary approach to teacher research which draws upon techniques, methods and expertise from a wide, and often disparate, range of contexts. Against this background, the use of teacher inquiry methods to support teachers’ technology-supported evaluation of students’ learning offers an apt and sustainable opportunity for shaping teacher participation in educational policy and schools’ strategic planning and in supporting integration of advanced learning technologies in existing school systems.

### 3.5 Teacher inquiry into students’ learning

In order to more ably contextualise the teacher inquiry process and its fit with TISL as an approach with the NEXT-TELL project, the following questions were used to negotiate the wide-ranging literature in this area.

1. What is teacher inquiry?
2. What is the history/context of this approach to research?
3. How is teacher inquiry defined?
4. What are the key characteristics of teacher inquiry as a method?
5. What are the benefits/limitations of teacher inquiry?
6. What tools/methods have been used in implementing teacher inquiry?
7. How does the teacher inquiry approach work in practice?
8. How does the teacher inquiry approach fit with the NEXT-TELL and TISL?

#### 3.5.1 What is teacher inquiry?

Teacher inquiry, as an approach to research, began around the late 1980s (Cochran-Smith and Lytle, 1999), although it has its origins in much earlier work, e.g. that of Dewey, who as early as 1933 was already expounding on the benefits of teachers’ reflective practice (Rich and Hannafin, 2008). Others have described the approach as having its origins in action research, critical inquiry and teacher research (Lytle and Cochran-
Smith, 1994). Ritchie (2006) attributes an insider’s perspective to teacher inquiry, aligning the approach to teachers conducting their own research, in real classrooms and school settings, and focusing on local issues which may or may not be generalisable to wider contexts. Dana & Yendol-Hoppey (2008), meanwhile, describe teacher inquiry as a vehicle for teachers, whereby not only are they enabled to “unravel the complexity of the profession” but also to “raise the teachers’ voice in discussions of educational reform”. Rust (2009), however, marks teacher inquiry as a challenge to the academy, insofar as this insider focus and the manner in which questions are posed and data are collected, analysed and evaluated raises questions for traditional (academic) notions about validity, objectivity and reliability in research settings. These perspectives from the literature reflect some key characteristics of teacher inquiry that are relevant for the development of TISL insofar as teacher-led research is perceived to:

- be action-oriented, critical and reflective
- offer an insider view of real classrooms, school settings and local contexts
- give teachers a voice in educational reform
- challenge traditional academic practices
- engender debate around notions of validity

### 3.5.2 How is teacher inquiry defined?

Teacher inquiry has been defined as:

- a bridge connecting research, practice and education policy (Rust, 2009)
- an important and practical way to engage teachers as consumers of research (Rust, 2009)
- a way of engaging teachers in researching their own practice so as to shape practice, as designers of their own professional development, and as informants to scholars and policymakers regarding critical issues in the field of education (Rust, 2009)
- practitioner inquiry that involves systematic, intentional, self-critical inquiry about one’s own work (Cochran-Smith and Lytle, 1999)

Across the literature, key characteristics that may contribute to a broadly conceptualised definition of teacher inquiry thus include the notion that it is: systematic, intentional, contextual, self-critical, practical, action-oriented, planned, evidence-based, evaluative, and shared. Further, it encourages teachers to adopt an inquiry stance (Cochran-Smith and Lytle, 2009) contributes to teacher professional development (Dawson, 2007), informs policy and research, shapes practice and promotes school-based innovation, change (Rust, 2009) and teacher autonomy (Castle, 2006).

### 3.5.3 What is the history/context of the teacher inquiry approach to research?

The characteristics of teacher inquiry are explored by Dana & Yendol-Hoppey (2008). They locate the origins of teacher research in three educational research traditions (Table 3) identified as: process-product, qualitative-interpretative and teacher inquiry. They argue that the first two represent an “outsider” perspective which has, in the past, tended to dominate school-based research, whilst the latter “insider” perspective - which may offer valuable and potentially more meaningful insights - has been limited by traditions of knowledge-building as defined by the academy.

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Process-Product</th>
<th>Qualitative or Interpretative</th>
<th>Teacher Inquiry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher as technician</td>
<td>Teacher as story character</td>
<td>Teacher as story teller</td>
<td></td>
</tr>
<tr>
<td>Researcher</td>
<td>Outsider</td>
<td>Outsider</td>
<td>Insider</td>
</tr>
<tr>
<td>Process</td>
<td>Linear</td>
<td>Discursive</td>
<td>Cyclical</td>
</tr>
<tr>
<td>Question Source</td>
<td>Researcher</td>
<td>Researcher</td>
<td>Teacher</td>
</tr>
</tbody>
</table>
3.5.4 What are the key characteristics of teacher inquiry as a method?

Teacher inquiry is characterised by a number of common features around identifying, framing, planning and enacting an inquiry into teaching practice. In line with its definition as systemic, intentional and contextual, it adopts a definite, planned, purposeful and action-oriented stance. The review of the literature confirmed these common features. Table 4, for example, compares three articles which reveal five steps in a common approach to teacher inquiry as a process:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishing a trigger/lens</td>
<td>Pose a question or ‘wondering’</td>
<td>Reflect on problem</td>
</tr>
<tr>
<td>Planning for and collecting data</td>
<td>Collect data</td>
<td>Formulate question</td>
</tr>
<tr>
<td>Analysis and interpretation</td>
<td>Analyse data and literature</td>
<td>Collect, analyse, interpret data</td>
</tr>
<tr>
<td>Develop and enact solution(s)</td>
<td>Make changes in practice</td>
<td>Make changes to practice</td>
</tr>
<tr>
<td>Disseminate findings</td>
<td>Share findings with others</td>
<td>Share results</td>
</tr>
</tbody>
</table>

Table 4: Cross-case comparison of characteristics of teacher inquiry methods

Implemented as a series of steps, these features provide a useful starting point for the development of TISL as a set of methods and of teacher inquiry processes in relation thereto (see Section 4). For example, the literature suggests that formulation of a question is key to the teacher inquiry process and that this is rooted in practice (Rust, 2009). For this reason, Cobb et al. (2003) argue that teacher research “speaks to teachers with an authenticity that many teachers find absent from research on or about teachers because in teacher research, teachers recognise themselves and their settings.” The ability to generate their own research questions, then, gives teachers a sense of ownership in the research and encourages them to implement changes derived from their inquiries. Teacher ownership and teacher-led research activity in particular are key features of TISL as an approach.

3.5.5 What are the benefits/limitations of teacher inquiry?

Dana and Yendol-Hoppey (2008) suggest the benefits of teacher inquiry are that:

- the theories and knowledge it generates are grounded in the realities of educational practice
- teachers become collaborators in educational research by investigating their own problems
• teachers are more likely to facilitate change based on the knowledge they themselves create
• teachers ask questions outsiders may not deem relevant
• teachers may discern patterns that outsiders cannot see
• it focuses on teachers’ concerns
• it engages teachers in the design, collection and interpretation of data
• it provides the impetus for teachers to find solutions to their own questions
• it creates an inquiry stance towards teaching
• it supports questioning of one’s own practice and so becomes an integral part of teachers’ professional growth and of teaching culture
• it provides for non-traditional approaches to staff and school development
• it can lead to meaningful change for students
• it enables teachers to support, with evidence, the decisions they make as educators and to advocate for authentic educational change

Teacher inquiry also, however, brings with it some key limitations (Rust, 2009, Dawson, 2007, Rich and Hannafin, 2008, Ellis and Castle, 2010)

• changing mindsets about ways in which research should be conducted
• ensuring research rigour and validity of evidence base
• training/orientation to tools and methods
• support for teachers professional growth at school and policy level
• variation of school systems and potentially low levels of generalisability
• lack of motivation, time; impact of existing workload

This suggests that implementation of TISL as a set of methods and tools to support teacher inquiry into students’ learning with ICTs is a complex activity that requires effective design principles and an ongoing awareness of context. In TISL, these benefits and limitations are addressed through the inclusion of key characteristics around the notion of teacher design research and ecological models of context drawn from the existing theoretical literature on participatory design (see Section 4).

3.5.6 What tools/methods have been used in implementing teacher inquiry?

Teacher inquiry has been applied to many research areas over the last three decades, covering a range of subjects and teacher-oriented practices and employing a wide range of tools and methods. Rust (2009), for example, suggests that teacher inquiry is embedded in the everyday practices and timeframes of teachers’ lives in classrooms and, thus, teachers:

[...] have a readily available toolkit, including: classroom maps, anecdotal records, time-sampled observations, samples of student work, drawings and photographs, audio and video recordings, interviews, conversations, surveys, and teacher’s journals, which can be used, over time, to answer questions about practice. (Rust, 2009)

Daly et al. (2009) meanwhile, in their study of teacher CPD (continuing professional development) with ICTs, argue from a technology perspective where, they suggest:

[...] teachers need to use social software such as blogging and podcasting to support inquiry into their practice and ... need to learn how to work with Web 2.0 and integrate technologies into their everyday lives. (Daly et al., 2009)

This view of the need for greater and more effective teacher engagement with ICTs is upheld by a recent OECD report on students’ technology use and its impact on educational performance, as evidenced in PISA (Pedro, 2009), suggesting that educational policy implications pointed to a need to:
raise awareness among educators, parents and policy makers about the consequences of the increasing ICT familiarity of students
identify and foster the development of 21st Century skills and competences.
address the second digital divide around competences and skills in ICT use
adopt holistic policy approaches to ICT in education
adapt school learning environments as computer ratios reduce and the availability of digital learning resources grows
promote an increase in computer use at school and experimental research on its effects

Kozma et al. (2009) also emphasise the links between technology-supported teaching, learning and assessment with ICTs and the development of 21st century skills and competencies. Similarly, the Partnership for 21st Century Skills (P21-Skills, 2007) point to the tight inter-relationships between (1) Curriculum and Instruction; (2) Professional Development; (3) 21st Century Learning Environments and ICTs, lifelong learning and innovation skills (Fig. 1).

In a 2006 report, meanwhile, the Smart State Council on Education and Skills for the State of Queensland (Smart State Council, 2006) suggested that 21st century learners need (amongst other things) to be:

- literate and numerate
- globally aware
- critical thinkers and problem solvers
- confident and self-managing
- creative and productive users of technologies
- team players and collaborators
- lifelong learners
3.5.7 How does the teacher inquiry approach work in practice?

The review of the literature provided many examples of teacher inquiry that focused on the use of technology and/or the development of a systematic approach to teacher-led research. A selection of these is provided in Appendix 2, brief details – by way of overview are, meanwhile, provided in Table 5 below:

<table>
<thead>
<tr>
<th>Source</th>
<th>Focus</th>
<th>Tool</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dawson, K. (2007) The Role of Teacher Inquiry in Helping Prospective Teachers Untangle the Complexities of Technology Use in Classrooms, Journal of Computing in Teacher Education, 24, 1, 5-12</td>
<td>Teacher-led inquiry supported by researcher-led methods</td>
<td>Generic technology tools to support data capture and analysis, - teacher reflection</td>
</tr>
<tr>
<td>5</td>
<td>Smith, H., Underwood, J., Walker, K. Fitzpatrick, G., Luckin, R., Benford, S., Good, J. and Rowland, D. (2007), Web 2.0 for schools e-Science: A hands-on approach</td>
<td>Participatory e-Science Teachers as learners and researchers Co-designing web-based learning activities</td>
<td>Generic tools - Web 2.0 (Flickr, blogs, Skype) - Virtual Experts forum (website)</td>
</tr>
<tr>
<td>7</td>
<td>Dawson, K. (2007) The Role of Teacher Inquiry in Helping Prospective Teachers Untangle the Complexities of Technology Use in Classrooms, Journal of Computing in Teacher Education, 24, 1, 5-12</td>
<td>Teacher Inquiry with ICTs (see also 1 above) - pre-service teacher - use of journal for reflection on research process</td>
<td>Teacher-selected tools - digital microscope - Internet - Word processor - Digital camera/camcorder</td>
</tr>
<tr>
<td>8</td>
<td>Tucker, W. (2010) Putting Data into Practice: Lessons from New York City, Education Sector Reports, Washington, DC</td>
<td>Strategic Planning (Data-Driven Decision Making) - learner-focused - professional development</td>
<td>Bespoke Data-Sharing System - training - issues: interoperability, etc. - tracking learning</td>
</tr>
</tbody>
</table>
Table 5: Example use cases for TISL type scenarios

Findings from these exemplar studies suggest that the following are important characteristics to be considered in planning for TISL type use cases:

- A clear understanding of the inter-relationships between teachers, researchers and designers; acknowledging the potential impact of crossing boundaries between insider and outside knowledge; and identifying ways of negotiating differences in understanding, purposes and goals
- Recognition of the mutual inter-relationships between study (teacher-led activity) and meta-study (researcher-led activity) in the development and application of inquiry methods and tools
- Recognising the need, and planning for, participant orientation to tools and/or methods
- Recognising the implications of teacher agency and finding a balance between teachers’ application of the inquiry process and the co-development of this process by teachers, researchers and tool designers
- Understanding the difference between provision of tools to support inquiry (in general) and the provision of a ‘set’ of tools and methods for designing and supporting teacher inquiry.

These studies point to a shift, over time, in emphasis away from researcher-centred studies to teacher-centred approaches. At the same time, the literature reveals that this shift has been accompanied by a move towards a more design-centred approach to teacher inquiry and the generation of inquiry methods that will support and guide teachers and enable them to participate in evidence-centred and evidence-based decision-making. It is this turn towards evidence-centred design that TISL aims to support, through the development of an inquiry methodology, incorporating a set of methods and related tools (see Sections 4 and 5).

3.5.8 How do existing perspectives on teacher inquiry fit with TISL?

As indicated at the start of this review, TISL is a research approach that aims to identify and develop a set of tools and methods that facilitate teachers’ learning about students’ learning with and through the use of digital technologies. A core focus of the approach is the effective use of student data to support real-time adaptive teaching and learning in the classroom, as well as teachers’ professional growth as innovative practitioners, in particular, in the areas of assessment literacy and adaptive teaching and learning in technology-rich environments. Based on these premises, and on findings from the existing teacher inquiry literature, we propose a preliminary definition of TISL, as follows:

TISL Definition:

TISL is a systematic, intentional, design-oriented approach to teachers’ technology-supported inquiry into students’ learning. It focuses on the development and use of formative e-assessment methods using advanced learning technologies (digital tools) to capture, analyse, interpret, share and evaluate student data. In so doing, it aims to contribute to the development of teacher professionalism and school improvement through a focus on teacher-centred, practice-based, evidence-oriented research activity. The outcome of this activity is intended to bridge the communication gap between teachers, learners, parents, policymakers, school leaders and administrators and the wider community.
In this respect, TISL builds on the existing literature on teacher inquiry, and technology-enhanced learning more generally, through an in-depth focus on the *principled* design of appropriate tools and methods for teachers’ learning about students’ learning and to an enhanced awareness and understanding of teaching and learning in technology-rich learning contexts (Luckin, 2010).
4 TISL Method

Teacher inquiry is the systematic, intentional, self-critical, planned investigation into one’s own teaching practice. (Dana and Yendol-Hoppey, 2008)

One of the key challenges levied against teacher inquiry as a research approach lies in the validity or generalisability of its findings; how to justify results and how to move from the specifics of the local context to the generality of the wider community within which this ‘movement for change’ can have its place (Rust, 2009).

The challenge here lies in the transformation of teachers’ personal knowledge into professional knowledge. It is this challenge that teacher design and participatory design research methods aim to tackle.

NEXT-TELL builds on these earlier teacher inquiry models and responds to these challenges by extending the principles of teacher design research (Bannan-Ritland, 2008) – itself a variant of teacher inquiry to include a focus on technology-supported teaching, learning and assessment as drivers for innovation. It also draws on an enhanced method for the modelling of learner contexts which sees the classroom as a learner-centric, technology-rich ecology of resources (Luckin, 2010). Finally, through the development and use of the TISL method and related tools, e.g. the TISL Planner, teacher e-Portfolios, TISL collaboration platform and other generic tools, it provides a toolkit for evidence-based, teacher-led research as a means of generating robust inquiry processes which enhance opportunities for validating, generalising and justifying the results of teacher research as a driver for innovation and change.

4.1 Developing a method for technology-supported teacher inquiry (TISL)

This section outlines a first iteration of a possible model for a TISL approach to teachers’ inquiry supported by advanced learning technologies (ALTs). The model has mainly been derived from the literature and from informal discussions with teachers. It has two key layers, (1) a four-fold theoretical lens focusing on action, design, context and inquiry processes (outer layer) – Fig. 2) drawn from the literature on teacher research; and (2) a practice-oriented reconfiguration of these 4 perspectives that focuses on teacher teams, inquiry methods as an approach to teacher inquiry and teacher professional development, teaching and learning contexts and the notion of inquiry cycles as an iterative process for TISL-type teacher inquiry with ALTs (inner core – Fig. 2).

The outer (theoretical) layer provides a multi-layered lens reflecting the complex situations within which teacher inquiry methods may be understood and effected and draws on the literature relating to action
research, teacher design research, context modelling and teacher inquiry research. The inner (empirical) layer translates this multi-layered lens into a set of methods that may provide opportunities for teacher-led TISL activity. TISL methods will, therefore, involve (1) the use of teacher teams, (2) a teacher-led inquiry process, (3) the systematic planning and documenting of this teacher-led inquiry activity using a dedicated planning tool (TISL planner), and (4) a method for this activity which requires teachers to engage in iterative cycles of inquiry. The notion of TISL as action implies that the research/inquiry process will be teacher-oriented and teacher-led. The notion of design implies a systemic method that takes a holistic approach to the complex nature of educational systems. The notion of context implies that planning should take into account this holistic approach to systemic activity and educational complexity, viewing these as an ecology of available resources. The notion of inquiry implies a cyclical process of defining and refining research aims and objectives.

Thus, whilst teachers’ action research and teacher inquiry research are well established research paradigms, TISL aims to go beyond these by drawing on participatory and iterative research models which focus on notions of design and context at a deeper, more systemic, level of inquiry, i.e. by drawing on: (1) Teacher Design Research (Bannan-Ritland, 2008); and (2) the Ecology of Resources model of learning context (Luckin, 2010).

4.1.1 Design-Based Research

Design-based research (Wang and Hannafin, 2005, Brown, 1992, Collins et al., 2004) focused on the need, in educational settings, for researchers to engage with real-world scenarios and the people enacting them to cooperatively and collaboratively analyse, design, develop and implement educational innovations in an iterative manner that is sensitive to local contexts (Wang and Hannafin, 2005).

According to Shavelson et al., (2003) the strengths of design-based research lie in:

... testing theories in the crucible of practice; in working collegially with practitioners, co-constructing knowledge; in confronting everyday classroom, school, and community problems that influence teaching and learning and adapting instruction to these conditions; in recognizing the limits of theory; and in capturing the specifics of practice and the potential advantages from iteratively adapting and sharpening theory in its context (Shavelson et al., 2003).

Collaboration between teachers in TISL should lead to better integration between theory and practice. Participants work together to try to achieve an optimal design, reviewing and refining options by observing their use in practice and each contributing to the decision-making process and to iterative adaptations to the developing design. For this reason, it is important that users of the TISL method and tools see themselves as partners in a broader design process and that each is able to adopt a spirit of co-inquiry, in which all members of the design process are contributors to the research goals.

4.1.2 Teacher Design Research

Teacher Design Research (TDR) focuses on developing teachers’ expertise as adaptive innovators through long-term involvement in iterative design research and a process of guided professional development (Bannan-Ritland, 2008). A key feature of this approach is that teachers’ learning comes from their own experiences rather than from outside experts per se. In this way:

Teacher design research then becomes a context for inquiry that meaningfully provokes teachers to restructure their core ideas, beliefs, and practices (Bannan-Ritland, 2008).

This can be described as a means of re-envisioning teachers’ professional development needs by enabling teachers to move beyond existing routines and to reconceptualise their practice in a process of context-oriented continuous innovation which allows teachers to construct their own meanings of change processes, both individually and collectively. From this perspective, problem definition begins with teachers themselves and the design process encourages the articulation, through dialogue, of teacher beliefs and practices in the form of a shared community of inquiry. A key characteristic of this approach is that:
Teachers are treated as design researchers actively involved in contributing to a conceptual design, and the power of the context of their classrooms is recognized as fundamental to design and research activities. (Bannan-Ritland, 2008)

The issue of context is, however, “not an element to be trivialized” (Barab and Squire, 2004). Fishman et al., (2004), for example, argue that classroom contexts are severely impacted by other systemic constraints and that teachers’ practice and professional development needs must be considered against the wider contexts of school culture, capacity and strategic management needs.

TISL expands on Teacher Design Research through the provision of a method (this section) and tool support (see Section 5) for teacher-led research that focuses on teachers’ inquiry into students’ learning and the alignment of teacher professional development with schools’ strategic planning (see SPICE, Section 6) in and for technology-rich teaching and learning environments. Negotiation of these complex pedagogical spaces is supported by a second, participatory, design method which focuses on modelling of learner contexts: the Ecology of Resources (Luckin, 2010).

4.1.3 The Ecology of Resources Model of Context

The Ecology of Resources Model (EoR) and design framework ¹ (Fig. 3) is a participatory design approach to inquiry in technology-rich teaching and learning contexts. It is grounded in a socio-cultural view of learning (Luckin, 2010) and provides a set of methods and conceptual tools for understanding, negotiating and visualising available resources within the learner’s learning context(s) as well as the inter-relationships of these resources. As such, it provides for the analysis of contexts as dynamic ecologies framed by the inter-connections between people (e.g. teachers and learners), things (e.g. curriculum and/or other artefacts) and their environment (e.g. physical, social, psychological).

¹ http://eorframework.pbworks.com
Developing an understanding of context and its relationship to learning and technology is core to the EoR model. A key purpose of the inclusion of this design framework as a supporting tool within TISL is to guide and support teachers understanding of the role and influence of technology-rich contexts on students’ learning. Context, here, is presented as a dynamic process associated with connections among people, things, locations and events, in a narrative that is driven by people’s affective motivations. Within TISL, this theoretical lens will support teachers in developing a wider contextual awareness of available resources and potential constraints in integrating advanced learning technologies with their everyday practices and with schools’ strategic planning needs.

Each of these two approaches: Teacher Design Research and the Ecology of Resources Model can be used to support participants (e.g. teachers, learners and other stakeholders) to move from a position of dialogue around design issues to a focused, guided, and systemic, engagement with design contexts and practices. In this way, the systemic approach of TDR and the contextual lens of EoR are used to support, capture and draw attention to the inherent complexities of teacher-led research as a supplementary contribution to the TISL method as a whole.

4.2 Developing a TISL method for teacher inquiry (Theoretical Layer)

The TISL approach to teacher inquiry envisaged by NEXT-TELL rests on four key premises:

- the integration of advanced learning technologies (ALTs) with teaching, learning and schools’ strategic planning
- the development of technology-supported teacher inquiry processes;
- the facilitation of evidence-based, teacher-led research
- a focus on assessment, innovation and development practices
These four premises are a reflection of both the aims and goals of TISL as expressed in WPS and of emergent patterns in teacher practices and theoretical perspectives on teacher research located in the existing literature.

Table 6 (see next page) provides a comparative overview of key features of teacher inquiry, teacher design research, and teacher-led research in technology-rich contexts drawn from a review of the literature. Alongside these (final column) a preliminary outline of characteristics important to the implementation of TISL as a method within the NEXT-TELL framework have been identified. These TISL features are based on common characteristics in the teacher inquiry process as identified from the literature (columns 1 to 3) and the stated goals of TISL within the NEXT-TELL project. Whilst it is clear that TISL benefits from this earlier work and its contribution to teacher professional development and the wider contexts of the research, educational and policy communities, the TISL model extends and builds on this prior art in some important ways. It provides:

- An increased emphasis on evidence-based, data-driven decision-making
- A sharp focus on the impact, role and implications of technology for data capture, analysis and visualisation as a support for innovation
- A focus on real-time adaptations in teaching and learning
- A focused view of teacher professional development centred on assessment literacy and technology-supported formative e-assessment in particular
- A holistic, systemic approach to teacher professionalism which integrates with students’ learning and schools’ wider strategic planning needs

<table>
<thead>
<tr>
<th>Teacher Inquiry (TI)</th>
<th>Teacher Design Research (TDR)</th>
<th>Ecology of Resources (EoR)</th>
<th>Teacher Inquiry into Students’ Learning (TISL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishing a trigger</td>
<td>Collaborative needs analysis</td>
<td>Brainstorm forms of assistance</td>
<td>Research orientation (methods and tools)</td>
</tr>
<tr>
<td>Brainstorming ‘passions’</td>
<td>Explicit articulation of current beliefs/practices</td>
<td>Specify a focus of attention</td>
<td>Collaborative needs analysis/contextual analysis</td>
</tr>
<tr>
<td>Choosing a lens</td>
<td>Select an area of study</td>
<td>Enacting change</td>
<td>Establishing a trigger</td>
</tr>
<tr>
<td></td>
<td>Align to state and national standards</td>
<td>Data interpretation</td>
<td>Articulation of current beliefs/practices</td>
</tr>
<tr>
<td></td>
<td>Data collection</td>
<td>Data analysi</td>
<td>Choosing an assessment-oriented lens</td>
</tr>
<tr>
<td></td>
<td>Data interpretation (iterate and refine)</td>
<td>Data collection</td>
<td>Framing purpose(s)</td>
</tr>
<tr>
<td></td>
<td>Data analysis</td>
<td>Dialogue/More Able Partner</td>
<td>Guiding/Support/Dialogue</td>
</tr>
<tr>
<td></td>
<td>Data collection</td>
<td>Data validation</td>
<td>Developing a plan of action</td>
</tr>
<tr>
<td></td>
<td>Data analysis</td>
<td></td>
<td>Data-driven decision-making</td>
</tr>
<tr>
<td></td>
<td>Data interpretation</td>
<td></td>
<td>Data collection/capture</td>
</tr>
<tr>
<td></td>
<td>(iterate and refine)</td>
<td></td>
<td>Data visualisation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Data and context analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Data interpretation (filters, influences, relations)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Data validation</td>
</tr>
<tr>
<td></td>
<td>Conceptual design and prototyping</td>
<td>Scaffolding and adjustment</td>
<td>Iterative design cycle</td>
</tr>
<tr>
<td></td>
<td>Cycles of evaluation and analysis</td>
<td>(Learner resources, MAPs, filters, elements)</td>
<td>Technology awareness</td>
</tr>
<tr>
<td></td>
<td>Emergent process model</td>
<td>Iterate as required</td>
<td>Conceptual design/prototyping</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Emergent design process</td>
<td>Enacting change</td>
</tr>
<tr>
<td></td>
<td>Presentation of conceptual design and prototyping to others</td>
<td>Iterative participatory design</td>
<td>Sharing results</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Co-design of technology solutions</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuity of change in action</td>
<td>Continuity of change in action</td>
<td>One or many learner(s)</td>
<td>Sustained practice-based professional development</td>
</tr>
<tr>
<td>Sustained professional growth</td>
<td>Sustained practice-based</td>
<td>Developing an ‘ecological’ mindset</td>
<td>Real-time adaptive teaching and learning</td>
</tr>
<tr>
<td>Developing an Inquiry Stance</td>
<td>professional development</td>
<td>Developing awareness of context</td>
<td>Continuous diffusion of innovation</td>
</tr>
<tr>
<td></td>
<td>Cycles of research</td>
<td>Psychological, social and material</td>
<td>Informed participation in research community</td>
</tr>
</tbody>
</table>

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The elements drawn from the literature and summarised in Table 6 can be used to generate a basic TISL model (Fig. 4, next page) for technology-supported teacher inquiry.

This preliminary modelling of the TISL approach is:

1. framed by principles of action, design, context and inquiry in teacher research; which
2. supported by advanced learning technologies;
3. contributes to an evidence-based approach
4. to innovation, assessment, and teachers’ guided professional development in the school setting.

The elements drawn from the literature and summarised in Table 6 can be used to generate a basic TISL model (Fig. 4, next page) for technology-supported teacher inquiry.

This preliminary modelling of the TISL approach is:

1. framed by principles of action, design, context and inquiry in teacher research; which
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3. contributes to an evidence-based approach
4. to innovation, assessment, and teachers’ guided professional development in the school setting.
At the heart of the TISL Model is the notion that ICTs (technology) can provide a useful support for teacher-led, evidence-based inquiry into students’ learning. In Figure 4, we see how the theoretical and empirical layers of the emergent TISL method (see also Figure 2, Section 4.1) are brought together to support teachers in developing an awareness of technology-rich teaching and learning contexts for managing innovation and change processes.

### 4.3 Developing a TISL method for teacher inquiry (Practical Layer)

The emergent TISL method described in the preceding section provides the foundations for a participatory, iterative and emergent approach to teacher-led research. In practice, the literature has shown that, in order to pursue this kind of research, teachers often require guidance and support. For TISL, such guidance and support must be developed in collaboration with teachers. To facilitate this need, TISL, as with related components within NEXT-TELL, will be developed in two phases: (1) researcher-led; and (2) teacher-led.

The TISL approach outlined in this deliverable is being developed as part of the researcher-led phase of the project. The emergent model (Figs. 2 and 4) and the related methods it depicts draws on the existing literature to provide a preliminary approach to the kind of technology-supported, evidence-based, teacher-led inquiry that TISL seeks to promote and support. Secondly, it provides a preliminary framework for identifying relevant tools and approaches on the use of available data for evaluating students’ learning (Table 7, see next page) in alignment with teachers’ professional development and schools’ strategic planning goals with ICTs in education (SPICE).

<table>
<thead>
<tr>
<th>TISL Method</th>
<th>TISL Tools and Data Handling</th>
</tr>
</thead>
<tbody>
<tr>
<td>• establishing a trigger</td>
<td>• identifying tools (ALTs) and potential data sources</td>
</tr>
<tr>
<td>• choosing a lens (researcher or teacher-led)</td>
<td>• planning for data capture and data sharing</td>
</tr>
<tr>
<td>• planning for and collecting evidence</td>
<td>• collaborative data analysis and interpretation</td>
</tr>
<tr>
<td>• analysing practices</td>
<td>• evaluating data and reflecting on inquiry process</td>
</tr>
<tr>
<td>• enacting and adapting an action/innovation</td>
<td>• data-driven decision-making for innovating practice</td>
</tr>
</tbody>
</table>

**Table 7: 10 steps to systematising teacher inquiry with TISL**

A key goal of TISL is for teachers to be able to conduct sustainable and relevant inquiry into students’ learning and related school-based practices (e.g. teaching, assessment, etc.). To this end, TISL aims to provide scaffolded prompts to the kinds of activity (Column 1, Table 5) teachers (as inquiry teams) can engage in to generate a robust and systemic inquiry. These scaffolds are key features of teacher inquiry across much of the relevant literature. The 5 steps of the TISL method are presented as sequential (but iterative) activities. Similar sequences are also reflected in the Ecology of Resources model which has as its focus the exploration of learner’s technology-rich contexts. In parallel with the 5 step TISL method, the literature on data-driven decision making (Mandinach et al., 2008) provides insights (Column 2, Table 5) into the kinds of data teachers can draw upon and ways in which this data can be shared, using appropriate tools. The starting points for teacher inquiry envisaged in the TISL method can also form the basis for preliminary development (a first iteration) of the TISL Planner. This Planner, a bespoke tool to be developed in collaboration with teachers, should provide opportunities and prompts to guide teachers in and through the teacher-led inquiry process. The TISL Planner (as discussed further in Section 5) must, therefore, enable teachers not only to plan and track their inquiry processes but also, specifically, it should encourage and/or prompt them with guided scaffolds which reflect/inform them about the TISL inquiry process/method (e.g. in the form of a library of prior inquiry projects). The TISL Planner should also prompt teachers to consider ways in which they will gather, capture, store, edit, share, recombine, refine, reflect and report on data about students’ learning.
4.3.1 Example Use Cases for TISL method

A descriptive overview of a potential use case for teacher application of the TISL methods and tools is provided below.

**Title:** Teacher Inquiry into Students’ Learning

**Goal:** Teachers share, analyse and interpret an existing set of data from STEM or TESL using a collaborative platform and inquiry process

**Initiating:** Teachers (Inquiry Question) and Researchers (Inquiry Process)

**Affect:** Teachers

**Start:** Teacher(s) pursue a collaborative inquiry process supported by ICTs, as a means of evaluating students’ learning in alignment with schools’ strategic plans and their individual professional development; teacher(s) may work collaboratively both f2f and/or at a distance

**End:** Evidence-based changes to assessment practices, informed by inquiry tools and processes

**Normal course for the Use Case (implementing basic level TISL method):**

- Teacher(s) identify a trigger for inquiry (burning question)
- Researcher (in RDS) co-designs lens for inquiry (formative assessment, real-time feedback requirements, support of ICTs)
- Teachers plan for and collect evidence (student data) for the purpose of inquiry and evaluation
- Teachers collaborate (using web-based tools and digital data) to analyse students’ learning data and their own and others’ teaching and assessment practices
- Teachers document the inquiry process and store and share digital data using web-based tools
- Teacher(s) adapt teaching and learning processes, based on findings of inquiry process

**Exceptions:**

- Teacher(s) are unable to identify a trigger using the recommended lens
- Teachers have insufficient time/skills to pursue the inquiry process
- Teacher(s) are demotivated through lack of skills/knowledge/competency using ICTs
- Teacher(s) are demotivated through lack of training/support/collaboration
- Teacher(s) are unwilling or unable to share sensitive student data
- Teacher(s) prefer to work f2f rather than at a distance
- Technological systems are inaccessible (for whatever reason)

This descriptive overview is intentionally generic and is intended only to quickly raise the kinds of things teachers might do in an inquiry-based research cycle that uses the TISL method (Normal Course) and tools (Goal) and the kinds of issues and requirements (Exceptions) that might arise in the implementation of an inquiry-based use case scenario. By way of example, a series of more concrete illustrations are provided below, focusing on STEM and TESL respectively.

4.3.2 Use Case 1: STEM

TISL will seek to engage teachers in the implementation and evaluation of the TISL method and related tools in STEM areas, primarily in science and/or mathematics education. The first example (Fig. 5) below shows a web 2.0 scenario for technology-supported learning in science education.
In this example, students have collaborated on a web-based project about wind energy. They have used a mashup of available web 2.0 type tools (e.g. a blog, Google docs for data handling, Flickr for photo storage and YouTube for video storage). Whilst the design of such an activity might typically be enacted using the ECAAD processes within NEXT-TELL (see D2.1), data sets produced by learner activity at the ECAAAD level may then be evaluated at a meta-level as part of a TISL inquiry, e.g. teachers may instigate an inquiry process which seeks to examine ways in which such data might be used to demonstrate students’ learning progress over time (by analysing time-referenced activity logs, or tracing the impact of learner interactions with their peers, e.g. through discussion forums or comment logs). In TISL, however, such analysis would be at the level of evaluating students’ learning more generally (as a class, or group, or focus group) e.g. with the aim of evaluating the effectiveness of a teaching intervention, of technology integration, or as a means of identifying or evaluating innovative teaching, learning and assessment practices rather than assessing learning at the level of individual students (which would be more appropriately conducted at the ECAAD level). TISL inquiry at this level is likely to be driven by schools’ strategic planning goals or teachers’ individual and/or collaborative professional development goals. So, for example, in the use case illustrated in Fig. 5 above, a teacher inquiry process might look at how effectively Web 2.0 tools are integrated into classroom learning, or homework learning, or collaborative learning. Teacher might inquire into approaches to assessment that focus on the data output by student activity with these tools or they might inquire into approaches to integrating data from such activities with other technology-supported data tools used to support students’ learning. This focus on technology as a support for teaching, learning and assessment lies at the heart of TISL as a method for teacher-led inquiry or research.

Other areas where data about students’ learning are typically generated in the school setting are through the use of intelligent tutoring systems (ITS). One such example which is used widely in the UK is MyMaths (www.mymaths.co.uk). This tool is normally used to support students’ independent learning and/or homework.
(Figs. 6 and 7). This product (and others like it) is aligned to national standards for student achievement and allows for the import and export of data sets about students’ learning and progress across a range of curriculum topic areas, organised by age group and summative test range (e.g. Key Stage or GCSE or Advanced Level testing in the UK). A TISL use case might be set up around the use of this or similar product to inquire into the effectiveness of such tools as evidence of students’ learning over time. Teachers could draw down data sets across a range of age groups and compare different activity sets (class work, homework, test work). They might wish to capture additional data in the form of video recordings of student interactions with these tools in the classroom, homework clubs, etc (Sherin et al., 2009). Data generated in this way could then be used to inform the TISL inquiry process using the methods and tools developed in collaboration with teachers as part of NEXT-TELL. Such inquiry would allow teachers not only to learn more about students’ learning but to adapt teaching and learning practices to accommodate gaps between system affordances and students’ learning needs and to innovate as required.

Figure 6: Example of existing homework monitoring system in Maths Education in UK (from MyMaths website)

Figure 7: Example of student data in Maths Education in UK (from MyMaths website)

4.3.3 Use Case 2: Language Learning (TESL/MFL)

Similar scenarios, methods and tools to those outlined above for STEM can be envisaged for language learning. A key focus in NEXT-TELL is TESL or English as a Second Language. This is not an obvious area for inquiry in the UK where English as a native language involves quite different approaches to language learning than those applied to foreign or second language learning. An alternative in the UK might be MFL (modern foreign language) curricula, or English (as a native language). This difference does, however, raise some issues for interaction between partner schools on a pan-European basis in relation to the TESL focus. Possible solutions have focused on creative writing or role play scenarios in immersive environments. The case of creative writing is a useful one. TESL scenarios have been outlined in detail in D2.1. In terms of the kinds of data teachers might extract from such a scenario for TISL purposes, the following examples (Figs. 8 and 9) from an essay scoring application (the use of which is now being promoted in many native English language curricula) demonstrate similar opportunities for evaluating students’ learning to those outline in relation to MyMaths above.
Figures 8 and 9 illustrate individual student data of use to teachers at the ECAAD level in terms of assessing student progress around a particular learning goal and in terms of their progress and interactions with that goal. From a TISL perspective, individual student data (Fig. 9) can also be evaluated at the meta-level, where the focus will more likely be on a group of students or a whole class (Figs. 8 and 10). In this case, teachers can track learning gaps in particular areas and adjust teaching and learning accordingly and, at the same time, track the impact of interventions over time. So, for example, a teacher inquiry team assessing a set of data drawn from such a tool might note that students had difficulty with word choice (Fig. 10). They might then propose an intervention or programme that focused on increasing learner vocabulary. After intervening, data could be reconsidered to see if the intervention produced additional learning gains. As a course of action leading to innovation and change, teacher inquiry teams would make use of the TISL inquiry planner to identify, track and

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develop the intervention. In this sense, the ability to make use of existing data sets allows teachers to ‘notice’ learning gaps that may then become a focus for inquiry, intervention and innovation. This, then, represents the kind of mixing of different layers in the TISL model (Fig. 2, section 4.1) as (1) framed by principles of action, design, context and inquiry in teacher research; which, (2) supported by advanced learning technologies; (3) contributes to an evidence-based approach (4) to innovation, assessment, and teachers’ guided professional development in the school setting.

Contributing to this inquiry-generated data, in addition to the ability to plan and track the intervention, is the generation of supplementary data that promotes dialogue around the intervention and/or provides additional contextual data, e.g. in the form of annotated videos, teacher reflection and discussion, and so on (see also Section 5 for additional commentary on TISL tools) about the original data set and its relevance to the focus of inquiry – in terms of research outcomes, i.e. effectiveness of practices, innovations in practice, and so on.

A key issue here, as outlined in the introduction to this deliverable, is in ascertaining how to go beyond the current state of the art (i.e. existing forms of Intelligent Tutoring System [ITS] like the MyMaths example described above) to capture the more qualitative, rich data generated in technology-supported environments that are increasingly web-based, distributed and modular (mashups) as in the Web 2.0 example provided above. How can data be managed and visualised (see, e.g. D4.1) in such emergent settings? These are the kinds of questions and issues that must be explored with teachers through the collaborative development of TISL methods and tools as part of the ongoing work of WP5.

4.3.4 High level requirements for implementing and developing TISL methods and tools

In light of the aforegoing, Table 8 provides some preliminary (but not exhaustive) examples of the kind of high level requirements that will need to be met in order to support effective collaboration between teachers, researchers and designers in the participatory development of TISL methods and tools.
<table>
<thead>
<tr>
<th>Req. No</th>
<th>Formulation</th>
<th>Rationale</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Initial iterations of TISL methods and tools with teachers should be participatory and exploratory</td>
<td>Teachers may not be familiar with systemic research processes or ICTs and researchers will not be familiar with local contexts</td>
<td>Literature, Informal discussions</td>
</tr>
<tr>
<td>2</td>
<td>There needs to be a high level of e-maturity in initially participating schools</td>
<td>To gain the most effective outcomes, teachers need to be confident and enthusiastic users of ICTs, and school infrastructures need to be able to accommodate innovations in practice</td>
<td>Literature, Informal discussions</td>
</tr>
<tr>
<td>3</td>
<td>The inquiry process needs to be documented at both teacher and researcher level</td>
<td>Exploration and adaptation of TISL methods and tools need to be understood at both the implementation level and the metalevel of theory, method and tool development</td>
<td>Literature</td>
</tr>
<tr>
<td>4</td>
<td>There needs to be a way of capturing and sharing data, and of documenting inquiry processes</td>
<td>Minimal requirements are for guided investigation (researcher-led support) and documentation (of teacher inquiry practices)</td>
<td>Literature</td>
</tr>
</tbody>
</table>

Table 8: High level requirements for developing TISL methods and tools
5 TISL Tools

In conjunction with the TISL method, a set of related tools will be provided to participants in the NEXT-TELL project to support the inquiry process. In addition to generic tools for computer-supported collaboration, the TISL toolset will include the iterative co-design of an inquiry process planner (the TISL Planner) with the support of participating teachers. The range of generic tools is wide and varied and will be subject to change as new technologies continue to be developed and emerge over time. The kinds of tool envisaged at this stage of the project include, for example:

- An inquiry process planner (bespoke TISL development)
- An online platform for communication and collaboration between teachers (with a common GUI)
- Generic collaboration tools (e.g. Web 2.0 - blogs, wikis, Flickr, Google docs, Zoho)
- A teacher e-Portfolio (which can be a bespoke solution, or something as simple as a blog)
- Video analysis tools (again, can be bespoke, or can be a mashup of web-based tools)
- Web-based data analysis services (e.g. WEKA, Diaz, Anagora, Calico)

The Illustration below (Fig. 11) presents an architecture overview of TISL tools as well as possible relations to ECAAD tools and data.

![Figure 11: Architecture Overview of TISL tools and relations](image)

In Section 3.5.7 a sample set of case studies (Table 5) were identified which reflect exemplar use cases for each of these kinds of tool in relation to existing research on teacher inquiry processes involving the use of ICTs. This section builds on those earlier references to provide an overview of specifications and requirements for TISL tools. The utility of these tools in this preliminary phase of the project is framed by their potential as a support for teacher inquiry processes relating to the planning and design of research activity (TISL Planner); teacher
reflection, and documentation of the research process (e-Portfolio and collaborative communication tools, e.g. blogs or wikis); teacher analysis and interpretation of data about students’ learning (video analysis tools, data analysis services); and ways of storing, managing, sharing and disseminating data and research findings (collaborative platform and generic tools). What is not specifically addressed, here, is the identification of particular kinds of hardware, e.g. computers, laptops, handheld devices, mobile phones, dataloggers, digital cameras and camcorders, scanners, etc. The rationale for this exclusion is that identification and selection of appropriate devices as a support for teachers’ technology-supported inquiry into students’ learning is an aspect more appropriately forming part of the TISL method (see Section 4), i.e. through planning and teachers’ developing awareness of context.

In the individual sections that follow (5.1 to 5.5) a narrative overview and, where appropriate, illustrated exemplification of TISL tools is provided. Each section concludes with a specification of high level requirements for use of these tools in TISL.

5.1 Inquiry process planner (TISL Planner)

The inquiry process planner (TISL Planner) is a software component which will be developed in collaboration with participating teachers and schools. It is based on the same meta-model architecture as the ECAAD planner (see D2.1). The TISL Planner serves the purpose of enabling the planning of a collective inquiry process in a team of (not necessarily co-located) teachers. It essentially takes the form of a process planning editor. The artefact produced with this editor is a research plan that guides teachers’ collaborative activity throughout a specific inquiry project (using a teacher-led design research methodology).

The inquiry process planner consists of two layers:

- design
- execution

The structure and dependencies of each of these layers are illustrated below (Fig. 12):

![Figure 12: Structure and dependencies for TISL Planner](image-url)
Both layers of the inquiry process planner (TISL Planner) interact with each other, and with other modules, as follows:

**Inquiry process planner (design)**

This is a modeling environment for the design of inquiry processes. A form of graphical process modelling seems to be appropriate for the design of inquiry processes, individually or collaboratively, by teachers. To reduce efforts for teachers, this tool should link to best practices stored in teacher e-Portfolios and the library of inquiry plans which will be generated via teachers’ use of the TISL Planner. The output from this layer is code (e.g. BPEL – Business Process Execution Language) that may be executed by the execution layer of the inquiry process planner. In the design layer, teachers will use the inquiry process planner to design, identify, plan and document the inquiry process as an iterative cycle of planning, implementing, reviewing and refining the subject of the inquiry. When the inquiry cycle is deemed to be ‘complete’, the inquiry plan is stored in the TISL database/library and can act as a prompt, exemplar material, guide for further iterations or to related inquiry processes.

**Inquiry process planner (execution)**

This is a run-time environment for inquiry processes. Based on inquiry process definition (i.e. during the design phase), different services available via analysis services gateway are called/executed in this environment, i.e. this is the digital coding layer – pushing, pulling, storing, transferring and translating data sets in support of the inquiry process. For example, the execution layer may pull in required data sets for teachers to explore (identified by them during the design phase) drawing from students’ prior activity at the ECAAD level or from other data sets within the educational system (e.g. test scores, student grades, etc.).

**Analysis services gateway:**

This provides web access to computational services and tools and, based on user needs, provides for quantitative and qualitative methods (e.g. content analysis) as well as services for video analysis and (collaborative) annotation. It also provides a means of accessing data from the ECAAD evidence and learner model layer in an appropriate format (i.e. as database queries, rather than requiring use of ECAAD tools’ graphical interfaces).

In the sections that follow, requirements for both the design and execution layers of the inquiry process planner (TISL Planner) are described.

**5.1.1 Inquiry process planner (TISL Planner) – DESIGN**

This tool is designed to support the planning of a collective inquiry process in a team of (not necessarily co-located) teachers, and will essentially be a process planning editor. It will support the same meta-model as architecture as the ECAAD planner. On the entry level, for designing inquiries a list of existing projects/inquiries should be provided (Fig. 13).

![Figure 13: List of Existing Projects/Inquiries](http://en.wikipedia.org/wiki/Business_Process_Execution_Language)
After selecting a project (or inquiry) a more detailed representation of available methods should be shown to the user, supporting teacher(s) in the design of an inquiry process (Fig. 14).

![Teacher Inquiry Design Activity Sequence](image)

**Figure 14: Teacher Inquiry Design Activity Sequence**

One tool that could be adapted and used for inquiry process planning is ADVISOR® (Utz et al., 2009). ADVISOR is a meta-modelling platform developed by BOC Group, used as the basis for method development. ADVISOR provides a model-based, yet method-independent, platform enabling the addressing of internal requirements such as the learners’ abilities, integration of multimedia tools and external factors such as rules and regulations, e.g. for quality assessment of courses. It equips the end user with mechanisms to easily create new or to adapt existing method libraries according to different sets of requirements. According to Utz, et al. (2009):

> The ADVISOR has been developed by BOC Group within the European Commission ESPRIT 1998 - 2000 Programme as a method and platform independent environment based on meta-modelling concepts for the design and management of training and learning courses. Method independency means that the ADVISOR framework is applying a graphical model-based approach but does not force the user to use a predefined language and allows the flexible integration of methods or method building blocks or patterns as discussed in the previous section. Platform independence means that the ADVISOR framework is regarded as the design environment for individual course design and supports various Learning Management Systems (LMS) as runtime environments in a flexible manner. The ADVISOR framework therefore is regarded as a mediation service between the designer and the execution environment of courses. (Utz et al., 2009)

ADVISOR’s core features include a GUI using a graphical modelling language/method as a design environment for students/learners’ practices; generic platform features such as information acquisition, analysis and checking of models, as well as generic interface definition; reporting features in on and offline format; and deployment in a client/server environment allowing collaborative access to the model repository.

### 5.1.2 Inquiry process planner (TISL planner) – EXECUTION

This is an execution layer for designed inquiry processes. It interprets user’s graphical design activity as an executable language (e.g. BPEL – Business Process Executable Language). The execution of user interactions with the system, as code interpreted through the user’s selection of graphic elements in the design environment, is a key feature of this layer.

### 5.1.3 High level requirements for inquiry process planner (TISL Planner)

Table 9 provides an illustrative (but not exclusive) overview of the kinds of high level requirements that need to be in place to support the collaborative development, implementation and use of the TISL Planner by teachers, researchers and designers. The examples given are those that have arisen at the baseline level and these are...
expected to be added to, refined and adapted in and through the participatory design process as teachers, researchers and designers engage in a more active development of the tools throughout the NEXT-TELL project.

<table>
<thead>
<tr>
<th>Req. No</th>
<th>Formulation</th>
<th>Rationale</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Teachers should be able to systematically document inquiry processes</td>
<td>TISL as a teacher-led inquiry method requires a systematic approach to support evidence-based activity/reporting</td>
<td>Literature Interviews</td>
</tr>
<tr>
<td>2</td>
<td>Teacher design of inquiry processes will benefit from guided scaffolds/prompts from the system</td>
<td>Scaffolding will support teachers who lack familiarity with the TISL methods</td>
<td>Literature</td>
</tr>
<tr>
<td>3</td>
<td>The planning tool needs to be aligned with other evidence layers at the ECAAD and SPICE levels to allow teachers to access and/or transfer data between levels</td>
<td>Teachers need to draw on, and share, data across different levels of the school system</td>
<td>Literature Project Proposal</td>
</tr>
<tr>
<td>4</td>
<td>The system should be web-based to permit synchronous and asynchronous interactions between teachers and, if desired, other stakeholders; should allow for mobile/handheld access</td>
<td>Teachers are unlikely to have free time at the same time as their peers; an ability to work between home/school/when mobile increases flexibility</td>
<td>Literature Project Proposal</td>
</tr>
<tr>
<td>5</td>
<td>Multiple teachers should be able to contribute to the same inquiry process design</td>
<td>TISL focuses on teacher teams collaborating around specific inquiry projects</td>
<td>Literature</td>
</tr>
<tr>
<td>6</td>
<td>The planning tool should allow for tracking of revisions to inquiry processes over time, and by different users</td>
<td>Tracking will contribute additional data to support users’ systematic analysis of inquiry processes; tracking will also allow teachers to organise, manage and make sense of their activity and interactions throughout the inquiry cycle and across iterative inquiry cycles</td>
<td>Literature Project Proposal</td>
</tr>
<tr>
<td>7</td>
<td>The planner should allow for data output in different formats according to user needs (e.g. as a pdf, html, text or combined file, e.g. script or embedded audio/video)</td>
<td>A key goal of the teacher inquiry process is as a support for teacher CPD, adaptive teaching and learning and to contribute to schools’ strategic planning and wider policy goals – to facilitate this, teachers need to be able to share data and findings with other stakeholders</td>
<td>Literature Project Proposal</td>
</tr>
</tbody>
</table>

Table 9: High level requirements for TISL Planner

### 5.2 Generic collaboration tools and web-based platform

The user (i.e. teacher’s interface with the planning tool) environment in TISL is, essentially, a web-based mashup interface to a set of services and tools. In addition to the inquiry process planner outlined above, this also comprises a more or less generic collaboration platform, comprising components for synchronous and asynchronous communication (chat, discussion board), writing (wiki), and document/file management.
None of these tools will be specifically developed, but criteria for their use as a support for teacher inquiry processes will be developed in relation to Task 5.1 of this deliverable and a combination of existing tools (e.g., wiki engines, Google Docs, Zoho, Google Groups, and Yahoo! Groups) will be able to be selected by participating teachers based on these criteria.

There are many collaboration tools available (Figs. 15 and 16) that can be used to support TISL activity by teachers. A useful overview of such tools is provided in “Top 100 Tools for Learning 2010 List” compiled by Jane Hart of Centre for Learning & Performance Technologies [http://www.c4lpt.co.uk/recommended/top100-2010.html]. For the purposes of NEXT-TELL, this list was filtered to identify (1) online tools; and (2) tools relevant to teacher inquiry scenarios, further details of which are provided in Appendix 1 of this deliverable.

A comparison of these two representations of the ‘networked’ teachers demonstrates the rapidly changing environment of advanced learning technologies, in particular, Web 2.0 and cloud computing. Even in the short...
period between 2006 and 2009, evidence of a greater focus on web-based social and collaborative networking tools can be seen to be emerging, with additional foci represented in such additional tools as: online conferencing, podcasting, bookmarking, twitterfeeds, and (the explosion of) popular media, as well as new perspective on the blurring of boundaries between home, workplace and community and the shift of curriculum documents to online spaces. Interestingly, although gaining increasing prevalence in technology research, mobile and handheld technologies remain conspicuously absent from these representations generated by the teaching community. Nevertheless, this small comparative exemplar of the two models of networked teacher demonstrates the complex and shifting contexts faced by teachers and schools as they seek to embrace and integrate advanced learning technologies in the school setting. They represent useful illustrations for the underlying inter-relationships between schools and communities, school leaders and teachers, teachers and their peers, and of all of these to students and parents, that NEXT-TELL and its components ECAAD, TISL and SPICE aim to support.

5.2.1 **High level requirements for generic collaboration tools**

Table 10 provides an illustrative overview of the kinds of high level requirements that need to be in place in order to support teachers in their engagement with generic collaboration tools as a support for teacher-led team inquiry into students’ learning.

<table>
<thead>
<tr>
<th>Req. No</th>
<th>Formulation</th>
<th>Rationale</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The platform (GUI) must be flexible and controllable by teachers</td>
<td>New tools are constantly made available; teachers should be able to make use of what they already know and are familiar with</td>
<td>Literature, Interviews</td>
</tr>
<tr>
<td>2</td>
<td>The process of combining, selecting, changing and re-arranging tools should be quick and easy</td>
<td>Teachers’ time is limited</td>
<td>Literature, Interviews</td>
</tr>
<tr>
<td>3</td>
<td>Data handling should be easy but also secure; capacity to deal with multiple input/output formats is desirable (e.g. text, audio, hyperlinks, video, survey/quiz data, etc.); capacity to transform formats is desirable</td>
<td>Teachers need to use data for multiple purposes, uploading and download, transfer and edit data as required; use of student data is sensitive</td>
<td>Literature, Interviews</td>
</tr>
<tr>
<td>4</td>
<td>Communications channels should be flexible and allow collaboration and dialogue with multiple others; levels of access/interaction should be controllable by teachers</td>
<td>Teachers, in TISL and in general, will need to dialogue with peers and other stakeholders, often at a distance</td>
<td>Literature, Project Proposal, Interviews</td>
</tr>
</tbody>
</table>

Table 10: High level requirements for generic collaboration tools in TISL

5.3 **Teacher e-portfolio**

In general, teacher electronic portfolios (in short, teacher e-portfolios) are concise, annotated collections of teacher work and things they have accomplished, in and outside the classroom. In NEXT-TELL, the teacher e-portfolio, as part of the TISL platform, is intended to be used by teachers to store reflections and related artefacts on their learning about students’ learning, including samples of student work and/or student data, as well as evidence of the competencies, experiences and understandings generated in teacher-led design projects. The combination of teaching and learning artefacts (e.g. student data and teachers’ evaluation(s) of...
students’ learning) and written reflections (e.g. the contribution of these data and evaluations to improving teaching and learning) are core to the teacher e-portfolio in TISL. The benefit of this combination is the chance to reflect on one’s own (i.e. the teacher’s) practice as a form of continuous professional development (CPD). This, in turn, contributes to a sustainable approach to teachers’ professional practice which, supported by the design processes envisaged by NEXT-TELL, allows for the effective alignment of teacher professional development with the wider contexts of schools’ strategic planning. Traditionally, an e-portfolio is a purposeful collection of work and information that:

- represents an individual's efforts, progress and achievements over time
- is goal-driven, performance-based and indicates evidence of the attainment of knowledge, skills and attitudes
- includes self-reflection
- is a tool for facilitating life-long learning and career development

The teacher e-Portfolio in TISL can also be used to support such elements of teachers’ CPD but, in addition, these would be supported and guided by the design-based focus and systemic methods of TISL. The reflective process of portfolio development can promote better teaching, develop fresh thinking about education, and encourage personal and professional growth. The NEXT-TELL approach to teacher e-portfolio use will provide a design-based, evidence-centred, problem-based toolkit which combines relevant tools (e-portfolio) and methods (TISL method). This will provide teaching staff and school leaders with a robust method for evidence-based reflection on teaching and learning goals, instructional strategies, methods, and materials, as well as student/teacher relationships and their inter-relationships with strategic innovations at whole school, regional, national and international levels. Thus, in addition to the traditional elements outlined above, a TISL-focused teacher e-portfolio can contain:

I. Personal and contextual information

- background information on teacher and teaching context
- educational philosophy (e.g. school ethos)
- teaching, learning and professional development goals

II. Teaching artifacts, data and reflections on teachers’ learning about students’ learning

- inquiry process plans (generated by TISL Planner)
- data sources, e.g.
  - student data (from school records, activity logs, etc.)
  - data visualisations (e.g. illustrations of OLMs)
  - video clips
  - examples of students’ work
  - related/relevant curricular materials (e.g. lesson plans, units of work, etc.)
- annotated commentaries, e.g.
  - reflective commentary on the inquiry process (e.g. using a wiki or blog)
  - commentary/discussions about student data as evidence of students’ learning (e.g. using a discussion/chat forum)
  - annotated video (e.g. lesson observations, students’ generated videos)
  - teachers’ reflective journaling (e.g. using a blog)
This element of the TISL Platform is closely linked to Work Packages 2 (designing students’ learning activity), 3 (e-Portfolio, capturing students’ learning activity and video analysis tools) and 4 (visualising, representing and sharing information about students’ learning). In this respect, the functional and non-functional requirements for this tool need to be read and understood in relationship to these related areas.

Figure 17: A model of e-portfolio-based learning, adapted from Kolb (Kolb, 1984 cit. in, Gray, 2008)

Gray (2008) suggests that the most effective approach to e-portfolio use as a support for professional development is one that incorporates support for ongoing, iterative and collaborative practice amongst groups of teachers and related stakeholders (Fig. 17), e.g. teachers in initial training and their mentors, or between early career teachers and their more experienced peers. She further suggests that a process of guided reflection is useful where users are not familiar with this mode of reflection and evidence-based learning. She warns, too, that successful implementation of e-portfolio methods as a tool for reflection and collaborative practice and development can only be achieved with the support of school leaders, adding that “e-portfolio systems and tools must form part of a strategic approach to learning and teaching” (Gray, 2008). Such findings are aligned with the aims of ECAAD, TISL, SPICE and NEXT-TELL more generally, where the overarching goal is integrating advanced learning technologies across all layers of the school system.

5.3.1 High level requirements for teacher e-portfolio

Table 11 provides a preliminary overview of the kinds of high level requirements that need to be in placed in order to support teachers’ adoption and use of E-Portfolios as a support for teacher inquiry and teacher professional development in alignment with the TISL methods and tools. At this stage of the NEXT-TELL project, these requirements, as with other tools and methods outlined in the deliverable, have been adduced mainly from the existing literature. These preliminary understandings will be further advanced in and through collaboration with teachers and schools in the RA phase of the project and beyond.

<table>
<thead>
<tr>
<th>Req. No</th>
<th>Formulation</th>
<th>Rationale</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Should allow teachers to capture and store evidence of their own and students’ learning</td>
<td>Teachers require data/evidence to support their development activity</td>
<td>Literature</td>
</tr>
</tbody>
</table>
D5.1
Methods and Specifications for TISL Components V1

<table>
<thead>
<tr>
<th>Req. No</th>
<th>Formulation</th>
<th>Rationale</th>
<th>Source</th>
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<tbody>
<tr>
<td>2</td>
<td>Should provide a space for teacher to reflect on their practices and professional growth</td>
<td>A web-based space for reflection allows teachers to keep reflections in one space available across multiple contexts and modes (e.g. home/school/desktop/mobile)</td>
<td>Literature</td>
</tr>
<tr>
<td>3</td>
<td>Should allow teachers to work and/or to collaborate with others at a distance</td>
<td>Collaboration, dialogue and sharing of ideas and best practice are key elements in teacher CPD and the development of innovation and change</td>
<td>Literature</td>
</tr>
<tr>
<td>4</td>
<td>Should support teachers in setting, planning and tracking goals</td>
<td>The idea of the e-Portfolio as a one-stop shop, a digital ‘desk’ for the teacher is attractive as it reduces teacher time in organising and managing resources</td>
<td>Literature</td>
</tr>
<tr>
<td>5</td>
<td>Should provide teachers with an evidence-bank for professional development</td>
<td>Evidence-based inquiry is a key aspect of TISL and the foundation of teacher CPD and related notions of teacher certification, validation or, just generally, recognition at the local level.</td>
<td>Literature</td>
</tr>
</tbody>
</table>

Table 11: High level requirements for Teacher e-Portfolios

5.4 Video analysis tools

Videos have long been used for educational purposes (Goldman et al., 2007). Early work in educational video capture, authoring, storage and retrieval has focused primarily on the mechanisms of time-shifting and place-shifting. That is, to make recordings of learning activities available for reuse at a different time in the future and/or at a different place. As such, primary concerns were focused on the delivery of educational content. The current generation of educational video tools innovates both on content delivery (such as web-based streaming) as well as student interaction (and the ability to introduce collaborative annotations and multiple perspectives). Further, video increasingly serves a key research tool for analysis of learning processes (Goldman et al., 2007). A selective survey of the current state-of-the-art relating to educational video tools is presented below.

- **DIVER (Digital Interactive Video Exploration and Reflection)**[^4] is a video authoring and annotation tool that supports multiple perspectives and annotated paths (called DIVES) through a video. DIVER solves the problem of video recordings of an event being limited to a single perspective. DIVER is designed to support “guided noticing”. Guided noticing refers to the dyadic interactional structure of a more capable peer or teacher focusing the attention of a

[^4]: http://diver.stanford.edu/what.html
student on a particular object in, or on an aspect of, the video scene and providing a conceptual explanation and/or facilitating a cognitive exploration. DIVER has been used in teacher education, individual learning with DIVES and collaborative learning settings (Pea et al., 2008, Pea and Lindgren, 2009).

- **Spark MediaMarkups** at the Tufts University, USA is a video annotation tool that allows students to markup audio and video files with annotations. Additionally, teachers have the ability to provide feedback to students on their recorded work at specific points. Access control mechanisms allow for public and private annotations.

- **EVA (Education Video with collaborative Annotations)** is a web-based asynchronous teaching and learning platform. EVA supports collaborative temporal video bookmarking, real-time HTML annotations, synchronized video and annotation delivery, auto-indexation of video bookmarks and associated annotations. EVA (Fig. 18) is currently being pilot tested and the initial results are promising (Wong and Reimann, 2009).

![Figure 18: EVA (Education Video with collaborative Annotations)](https://spark uit tufts edu/video_selection.jsp)

The use of video as a support for teacher inquiry into students’ learning can support enhanced dialogue between collaborating teachers and/or the transition from researcher-led to teacher-led research (Armstrong and Curran, 2006). Rich and Hannafin (2009), for example, examined the development and use of a wide range and variety of video annotation tools, e.g. VAST, VAT, VITAL and others in recent educational research, comparing a range of tools and their functionalities. In their comparisons, Rich and Hannafin draw out important characteristics and issues that are relevant for TISL as a method:

---

5 [https://spark uit tufts edu/video_selection.jsp](https://spark uit tufts edu/video_selection.jsp)
• standalone -v- web-based tools
• user control over resources and components
• means of annotating and facilitating dialogue
• ability for multi-user annotation
• ability to contextualise video (e.g. through comparison with related resources)
• ability to link to other data sources
• ability to synchronise related data (e.g. clips showing different perspectives of same event)

The complex inter-relationships of the social interactions and contextual materials which might be analysed using video analysis tools are reflected in the following illustration (Fig. 19) depicting the use of VAST (van Es and Sherin, 2006).

![Figure 19: VAST (Video Analysis Support Tool) - User Interface (Sherin and van Es, 2005)](image)

(A) video is captured, uploaded and transcribed
(B) interface includes scaffolding in the form of ‘guided noticing’
(C) guided scaffolds for extending initial discussion on ‘noticing’ - teachers’ framing questions
(D) display of related non-video resources (e.g. student work, lesson plans, etc.)

Such tools, accompanied by an appropriate research design such as TISL can provide rich data for teachers’ learning about students’ learning as well as being a rich source of evidence of inquiry processes. The kinds of tools teachers may use to capture video data are many and varied, e.g. handheld flip cameras, mobile phones, digital video cameras, wearable video cameras. Decisions about ways in which data will be captured (e.g. which tools to use, whether multi-camera use is needed/desired) and how much data should be captured (bearing in mind purpose, editing and analysis requirements) are important factors in the research design. In addition to general video capture, recordings of screen activity may also be captured using screen capture tools such as Camtasia. The kinds of activities that may be captured and analysed by teachers include such things as observations of teaching and learning, social interactions in the classroom and beyond, i.e. even to immersive/virtual learning environments such as Second Life.

As this kind of activity has traditionally been facilitated by researchers, TISL envisages that opportunities for teacher training in the capture, analysis, interpretation and dissemination of data will be provided for as part of teachers’ ongoing professional development.
5.4.1 *High level requirements for video analysis tools*

Table 12 provides a preliminary overview of the kinds of high level requirements that need to be in place in order to support teachers’ adoption and use of video analysis tools as a support for teacher inquiry and teacher professional development in alignment with the TISL methods and tools. These are not intended to be exclusive and are merely representative of preliminary examples gleaned from the literature and through informal discussion with teachers around existing practice.

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<tr>
<th>Req. No</th>
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<th>Rationale</th>
<th>Source</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Teachers should be able to upload, download, edit, annotate and share video data; data should be secure and shared access controllable by teachers.</td>
<td>Teachers can use video tools to capture non-digital interactions, e.g. lesson observations.</td>
<td>Literature, Interviews</td>
</tr>
<tr>
<td>2</td>
<td>The ability to contextualise video data with the display of related data (e.g. documents, images, text) is desirable.</td>
<td>Multiple data sets can be used to extend analysis and interpretation.</td>
<td>Literature, Interviews</td>
</tr>
<tr>
<td>3</td>
<td>The system used to facilitate video analysis should be web-based to facilitate collaboration and data mashups.</td>
<td>TISL aims to support teacher collaboration in inquiry processes, using multiple data types and ALTs.</td>
<td>Literature, Project Proposal</td>
</tr>
<tr>
<td>4</td>
<td>Video analysis data should be exportable in multiple formats (e.g. as audio, video, text, time-stamps, activity logs, etc.); video data should also be able to be coded and analysed digitally.</td>
<td>Teachers need to be able to manipulate data about students’ learning in many different ways.</td>
<td>Literature, Project Proposal</td>
</tr>
<tr>
<td>5</td>
<td>Video file sizes and formats should be controllable to ensure optimal system performance but not overly controlled thereby restricting user interaction.</td>
<td>School IT systems generally have high use levels and multimedia data often placed high demands on system bandwidths.</td>
<td>Literature, Interviews</td>
</tr>
</tbody>
</table>

**Table 12: High level requirements for video analysis tools**

5.5 *Data analysis services*

Data handling is a core characteristic of TISL. The teacher inquiry process requires teachers to make use of data about students’ learning to generate innovation and change to existing systems and processes in order to improve teaching and learning and to contribute to schools’ strategic planning goals at a wider level. School systems already make wide-ranging use of a variety of information management systems which collate student data in the form of grades, behaviour tracking, test results, etc. In TISL, these data need to be accessible to teachers as part of teacher-led inquiry processes. With this in mind, the TISL platform envisages the configuration of access to databases containing relevant student data and for accessing specific analysis services (e.g. statistical analysis with R, data-mining with WEKA).

As part of this configuration process, NEXT-TELL envisages the development of interfaces to these web-based analysis services, and interfaces between these analysis services and NEXT-TELL data resources (for example, the activity logs generated by participants at the ECAAD level). Data analysis services, such as for statistical analysis (R) and data mining/visualisation (WEKA) become increasingly available as web services (Fig. 20).
In coordination with TISL and developments in Strategic Planning, requirements for these services (in particular their usability by teachers) will be identified and suitable ones integrated into the TISL platform. For instance, integration of the functionality made available by web platforms for interaction analysis such as Diaz, Anagora, and Calico will be one of the objectives. For example, the Calico Platform (Giguet et al., 2009) is a shared space where researchers and practitioners come together to share information about Computer Mediated Communication (CMC). The site incorporates a toolkit which is specially adapted to allow for a simultaneous exchange of data formats to include detailed meta-information. The toolkit facilitates the analysis of user dialogue which is timestamped and anonymised. This can then be used to illustrate patterns in user interactions around content, objects and time-relevant topic discussions (e.g. start, middle, end). It can also be used to illustrate ‘spikes’ (Fig. 21, next page) in user interaction (such ‘spikes’ may, for example, indicate a rise in interest levels around a particular object or topic by users).
Within TiSL, such data tracking/analysis tools could, for example, usefully be used to identify the impact of the TiSL method on teacher inquiry processes or as a meta-level inquiry process enabling teachers to draw out key points of interest around a specific topic of inquiry about students’ learning.

5.5.1 High level requirements for data analysis services

There are several key issues surrounding data handling and data management that are key for schools and teachers:

- Security and privacy of data
- Ease of use
- Interoperability (compatibility between systems)
- Teacher understanding of the use, purpose, value and role of data

Both the literature and informal discussions with teachers and schools indicate that this area will require great care, sensitivity and clarity of explanation, alongside support in use of methods and tools for data handling and data sharing.

Table 13 provides a preliminary overview of the kinds of high level requirements that need to be in place in order to support teachers’ awareness, understanding and use of data analysis services as a support for teacher inquiry and teacher professional development in alignment with the TiSL methods and tools. At this stage of the NEXT-TELL project, these requirements, as with other tools and methods outlined in the deliverable, have been adduced mainly from the existing literature. These preliminary understandings will be further advanced in and through collaboration with teachers and schools in the RA phase of the project and beyond.
<table>
<thead>
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<th>Req. No</th>
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<th>Rationale</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Data analysis services should be web-based, accessible and easy to use</td>
<td>Teachers like tools that are readily available, familiar and easy to learn and use</td>
<td>Interviews</td>
</tr>
<tr>
<td>2</td>
<td>Data should be extractable in multiple formats (including, e.g., .csv or other format capable of being picked up by spreadsheet style software) and be able to be integrated with other systems</td>
<td>Teachers performing teacher inquiry activities need to be able to share data in multiple ways, with multiple stakeholders, across multiple systems</td>
<td>Literature, Project Proposal</td>
</tr>
<tr>
<td>3</td>
<td>Support tools, guides and/or prompts may be needed to help teachers identify analytical opportunities</td>
<td>Teachers may not be familiar with complex data analysis methods</td>
<td>Literature</td>
</tr>
<tr>
<td>4</td>
<td>Data visualisations and exemplars of data interpretation will help teachers to better understand what data analysis tools can do</td>
<td>Teachers can benefit from illustrative examples of new practices, preferably relevant to teaching and learning</td>
<td>Literature, Interviews</td>
</tr>
<tr>
<td>5</td>
<td>The ability to import, export and share data across systems is desirable; interoperability, however, raises issues around security, privacy, ownership and control of data</td>
<td>Data systems are often segregated ‘silos’ in traditional school systems; there may be resistance to integrating data sets from other systems from technicians, administrators and analysts; the support of school leaders for teacher inquiry process is therefore an absolute must</td>
<td>Literature, Interviews</td>
</tr>
</tbody>
</table>

Table 13: High level requirements for data analysis services
6 Strategic Planning with ICTs in Education (SPICE)

The aim of this task is the facilitation of school leaders to develop a school's capacity to integrate advanced learning technologies into teaching and learning and, alongside this, to foster and integrate teachers' innovations of IT-related teaching, learning and assessment practices.

Within TISL, the SPICE component will work with school leaders to identify and define relevant KPIs (see Section XX) and appropriate methods for adapting the BSC/Baldrige approaches to performance and change management, and the cultivation of innovative practices. A key component in achieving this goal is the co-development with school leaders of a strategic planning tool (Strategy Planner).

6.1 Strategic Planning

The SPICE component of TISL focuses on the development of a set of methods and tools that support school leaders strategic planning in alignment with teachers' professional development.

6.1.1 Strategic Planning using a BSC approach

The Balanced Scorecard (BSC) is a management-tool, derived from vision and strategy implementation. It was originally designed to help companies to communicate planning strategies to all involved stakeholders, and to clearly indicate each individual's responsibilities and accountability (Kaplan and Norton, 1992). The BSC approach compels organisations to undertake rigorous and continuous strategic planning based on performance data. It promotes the “active formulation” of strategic plans, and its aim is to involve all members of the organisation in the development of the plan.

The BSC approach begins with the definition of the organisation’s vision, enabling it to derive its strategic goals and to translate them in the form of clearly measurable Key Performance Indicators (KPIs). Typical, major projects steps when implementing BSC are illustrated below (Fig. 22):

![Figure 22: Implementing the BSC approach](image-url)
Leaders in the organisation need a balanced presentation of financial and operational measures, formulated to demonstrate key factors in the strategic planning vision, e.g. project progression, cost implications and structures, stakeholder satisfaction and the like.

Initially, the BSC approach comprised four key dimensions (Fig. 23)

- customer perspective
- internal process perspective
- innovation- and learning perspective (internal growth)
- financial perspective

![Figure 23: BSC Vision Strategy](image)

Farid et al’s (2008) explain the BSC model as follows:

The financial and customer perspective describes the desired outcomes sought by the organization. However, these measures may contain many lagged indicators of performance. The internal process and internal growth perspectives, on the other hand, show how the organization creates these desired outcomes. In this way, managers can identify a causal chain from the performance drivers to financial outcomes. From the top of the chain on down, desired financial outcomes can only be accomplished if customers are satisfied. To realize the customer value propositions, internal processes must be created and delivered. Finally, the internal process must be supported by an organizations learning and growth.

(Farid et al., 2008)

Translated for the school context, this suggests that school leaders can benefit from the use of BSC approach insofar as it provides them with a guided, systematic process for planning school vision which focuses, simultaneously, on both the organisation and the needs of other stakeholders (customers) such as students, parents and educational policy-makers. For example:

- the customer perspective in the school setting might involve how, when, why, what type and for what purpose communications are effected with parents;
- the internal process perspective might focus on effective use of available resources with a particular focus on ‘value’ and ‘strengths’;
• the *innovation and learning perspective* might focus on how a school and its teachers and learners adapt to continuous processes of change in education and society (e.g. in integrating ICTs as a support for teaching, learning and assessment); finally
• the *financial perspective* might focus on ways of optimising the financial resources of an institution by looking at ways of integrating existing and available resources (in and out of school), e.g. in developing innovation networks or partnerships with interested organisations.

In essence, the BSC approach provides a scaffold for generating a contextual awareness around the dialogue between internally- and externally-oriented change management processes. Kaplan & Norton (2004), for example, suggest that the alignment of objectives around the four key perspectives highlighted in Fig. 23 is “key to value creation, and, hence, to a focused and internal consistent strategy.”

However, whilst the business sector, and large companies and corporations in particular, have widely adopted the BSC approach, the adoption and use of this approach and a focus on performance management more generally has, until now, been under-represented in the public and educational sectors. Key reasons for this gap have been a general lack of management know-how, as well as access to relevant data and the necessary IT-solutions to analyze them.

Lichka & Karagiannis (2006) suggest that whilst a typical “private economy BSC” may focus on the strategic relations between the four perspectives of learning and growth, processes, customers and finance; the same is not necessarily true for the education sector (e.g. a school or university). There, finances and budget are, in contrast to the private sector, not an ultimate goal but a basic constraint. In such contexts, the BSC framework is adapted to reflect cause-and-effect relations between financial and personal resources (as the most basic level focus) and processes, students and partners, and research and education (as the highest strategic orientation).

Lichka & Karagiannis (2006) also point to the importance of communication in the education sector, arguing that educational systems require “a very flexible communicational front-end” enabling the communication and control of selective information depending on targeted stakeholders (e.g. internal control vs. external communication). Strategic communication within the educational sector, therefore, also requires a level of operational control and the ability to selectively distribute information in response to internal and external demands.

Since its introduction (Kaplan and Norton, 2001), the BSC model had been adapted, re-designed and modified to meet the requirements of a much wider range of organisations, including: manufacturing, services, non-profit and governmental organisations with excellent effects. Alongside these adaptations, the mutuality of influences across BSC factors have become increasingly complex. In order to implement the BSC approach successfully, these inter-relationships need to be made transparent and controllable. Thus, identification of relevant influencing factors, i.e. contextual variables, is a must. This is particularly true for the adaptation of this approach to school systems. As a supplement to the BSC approach in its application to school settings, therefore, the SPICE (Strategic Planning with ICTs in Education) component of TISL also looks to the Baldrige approach to performance excellence as a guiding framework which offers a systematic approach to schools’ strategic planning aligned to teachers’ continuous professional development and the integration of advanced learning technologies in education.

### 6.1.2 The Baldrige Performance Excellence Model

The Baldrige Performance Excellence Program[^6] was first introduced in the USA in 1987. This programme awards organisations who have demonstrated outstanding performance excellence and competitiveness, and who have implemented continuous improvement methods and tools that involve customers and other

stakeholders. The goal of this program is to promote the sharing of successful performance strategies and the benefits derived from using these strategies in the health-care, educational, industrial, non-profit and services sectors, as well as among small and medium enterprises. The programme emphasises the need for effective data exploration tools and effective and relevant training for implementing the performance improvement process. More recently, Farid et al. (2008) and Karathanos & Karathanos (2005) have highlighted the successful adaptation of the BSC approach from business to education, in conjunction with the Baldrige Performance Excellence Programme. Using this combined approach of BSC and Baldrige, six key measurements have been identified:

1. Customer-focused results
2. Product and service results
3. Financial and market results
4. Human resource results
5. Organizational effectiveness results, including key internal operations performance measures
6. Governance and social responsibility results

As can be seen, these are congruent with the BSC perspectives reflected in Fig. 23, i.e. customer perspective (1), internal process perspective (2 and 5), financial perspective (3), innovation and learning perspective – internal growth (4). To these, in addition, a perspective on wider contexts has been added (6).

6.1.3 Applying the Balanced Scorecard approach to school systems

Duffy (2005) describes possible practices for applying the BSC approach to Public Schools in the US. Her general assumption is that principals face similar challenges to those faced by leaders in the for-profit sector but that they also face particularities of the educational context which mean that BSC must be adapted for use in schools. The similarities between schools and the for-profit sector can be summarized as follows:

Schools:

- are not stagnant organizations,
- have heavy investments in human resources; and
- have multiple stakeholders.

This suggests that application of the BSC approach by school leaders in the education sector will generate similar benefits to those experienced in the for-profit sector through the alignment of organisational processes and resources, effective communication and systemic strategic planning (Duffy, 2005).

Despite these opportunities, a basic assumption must be explained: principals and school leaders are required to operate in the context of objectives given to them through government ministries and educational policymakers. These objectives are generally required to be aligned throughout the entire hierarchy of the school system (at local, regional, national levels) and, at the same time, must be embodied in school ethos, values and teaching practices. In short, it is necessary to ensure that “time, talent and instructional processes are aligned and purposeful in support of the school’s mission and goals” (Duffy, 2005).

6.1.4 Particularities of the educational sector

School systems have a wide range of stakeholders to consider. These stakeholders have vastly variable interests and communication/information need/requirements. Communication channels must be adapted to each of these groups. A BSC approach can help school leaders meet these requirements by encouraging stakeholder-input and providing “robust measures that enable school leaders to more effectively communicate
with their stakeholders” (Duffy, 2005). In so doing, this creates a climate for involvement and commitment of stakeholders through increased participation and transparency.

A key issue for implementation of the BSC approach is that a widely contextualised, systemic approach to strategic planning is often new to principals and other school leaders and, until recently, has not formed a large part of their everyday practice which, to date, has been more concerned with internal functioning than internal/external dialogue. Increasingly, however, effective strategic planning in schools requires school leaders to look beyond the local and the now and to commit to a process of continuous adaptive innovation and long-term developments influenced by practices, policy, available resources and a world of rapidly changing contexts.

In order to implement the BSC approach for school systems, it must be modified. In NEXT-TELL, these modifications will be identified in collaboration with teachers and schools. Relevant key performance indicators need to be defined that take into account the particularities of the educational sector. As it can be difficult to define a school’s “customers” the term “stakeholder” is deemed to be more appropriate. The notion of “making a profit” is a key financial measure of BSC as introduced for the corporate sector. Translated into the school context, this can be interpreted as a measure of the effectiveness of students’ learning as evidenced in, e.g. test scores, continuous learner development (evidenced in, for example, student e-Portfolios), as well as student retention rates and parental satisfaction. The combination of relevant KPIs can be used to provide a detailed and comprehensive picture of a school’s performance (Duffy, 2005).

### 6.1.5 Development of Strategic Planning Tool (Strategy Planner)

An IT-based solution can support a reduction in the complexity of the cause-and-effect relationships discussed above. The IT-based Balanced Scorecard and Performance Management toolkit, ADOscore, will be adapted for use in NEXT-TELL. This tool can provide up-to-date information on Balanced Scorecard indicators. In this respect, the ADOscore Controlling Cockpit, which aggregates all relevant data, represents a workplace-independent management information system.

The added value of using ADOscore (Fig. 24) in BSC projects in NEXT-TELL lies in its provision of:

- An intuitive graphical editor for planning and defining BSC indicators
- Opportunities for linking KPIs to existing operational data
- Graphical reporting and the use of Controlling Cockpits for presenting Management information
With its modelling technique, the ADOscore planning tool facilitates the implementation of the BSC approach by enabling all relevant information for strategic performance management to be represented. ADOscore facilitates the implementation of all steps required in introducing a Balanced Scorecard\(^7\) as a means of support for change management in the school setting. It offers opportunities for documenting strategic variables, goals and performance indicators, via the definition of target levels and thresholds, to analyzing and controlling the achievement level of strategic and operational goals via the ADOscore Controlling Cockpit (tool interface).

ADOscore offers a range of options for documenting strategic variables, e.g. through manual data input, interface to Access data stored in relational databases, or via an interface that draws down data from spreadsheets.

ADOscore offers an array of visualisation options. These are structured dynamically, allowing for an instantaneous overview of the most important performance indicators, as well as their current status. Detailed information can be selected and read \textit{ad lib}, and negative development can be seen at an early stage using the trend view. By means of predefined analyses, web-based documentations, and the Controlling Cockpit, school leaders are able to pursue efficient performance management and communication goals.

The ADOscore Controlling Cockpit is based on a three-stage filtering concept for managing goals and performance indicators. This concept supports both rapid first selection and the detailed comparison of individual elements in all their aspects. The layout concept of the Controlling Cockpit is flexibly designed to support easy adaptation to an organisation or school’s ‘corporate’ identity, as well as to specific reporting and documentational needs. Furthermore, it is designed to allow users to easily add additional features as required, and/or to integrate the ADOscore Controlling Cockpit with existing management information systems.

\section{Developing a network of school leaders}

After the baseline/RA phases of the project, when the first pilots have been completed, an exchange with school leaders and decision makers in the educational system regarding the benefits and challenges of the integration of advanced learning technologies will be sought. Starting with leaders in those schools which are

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\(^7\) \url{http://en.wikipedia.org/wiki/Balanced_scorecard}
already participating in the project, a network of school leaders will be instigated across the participating countries. This network will employ existing electronic and/or digital tools used for disseminating information and for communication (e-mail, discussion groups). For participating schools, events tailored to the needs of school leaders will be organised by local partners in each country on an annual basis, which events will also be open to other schools that might be interested.

Some partner countries already have existing networks for school leadership, e.g. the ESLN\(^8\) in Europe, the Leadership in Education programme of Comenius\(^1\) or related national networks such as the NCSL\(^10\) in the UK or the National Network for School Leadership run by the University of Oslo in Norway and, for example, related research, e.g. the recent Norwegian-led HEAD project on school management training (Tjeldvoll et al., 2005, Tjeldvoll, 2008) or, for example, Møller et Schratz’s (2008) work on the preparation and development of school leaders in Austria, Germany and Europe more generally. Engagement with these existing networks and prior research will be used to develop a coherent approach to engaging leaders in SPICE and managing leadership events. Lessons learned from the existing literature on school leadership networks and Eurowide school leadership programmes will be reviewed in more detail in D7.1 in M10.

### 6.1.7 Use, evaluation and review of SPICE methods and tools by school leaders

Alongside the review of the literature and existing networks, the ADOscore toolkit and methods for engaging school leaders in its use will be reported in greater detail in D7.1. In this preliminary overview for D5.1, a brief overview of the methods to be used, i.e. BSC/Baldrige have been outlined in Sections 6.1.1 to 6.1.6 above. In summary, however, the use, review and evaluation of SPICE as a set of methods and tools that can be used by schools will involve (1) the development (in collaboration with school leaders) of a BSC/Baldrige-oriented method for conducting strategic planning with a particular focus on the integration of ICTs and, more generally, teaching, learning and assessment at the school level. A key goal of SPICE also lies in (2) supporting school leaders in aligning their school's overall strategic goals with decisions regarding IT implementation and with initiatives that support and frame teachers’ continuing professional development, with a particular focus on ICTs. Research will focus on how interested school leaders and IT coordinators from participating schools interpret and make use of the BSC/Baldrige method and the ADOscore tool, and how this impacts on/affects the school, its teachers, students and related stakeholders such as parents and policy makers.

### 6.1.8 High level requirements for SPICE (Strategic Planning)

Table 14 provides a preliminary set of examples of the kind of high level requirements should be taken into consideration in relation to the SPICE component of the NEXT-TELL project. These are illustrative examples and further formulations will be developed in collaboration with schools and teachers throughout the NEXT-TELL project.

<table>
<thead>
<tr>
<th>Req. No</th>
<th>Formulation</th>
<th>Rationale</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>School leaders should have control over data management and integration tools</td>
<td>Security of data about minors is of key importance</td>
<td>Literature Interviews</td>
</tr>
<tr>
<td>2</td>
<td>System should be easy to use and flexible in meeting user needs</td>
<td>School leaders’ time is limited, system needs to be able to adapt to local contexts and also to meet needs of wider contexts</td>
<td>Literature</td>
</tr>
</tbody>
</table>

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\(^8\) [http://community.eun.org/entry_page.cfm?area=1361](http://community.eun.org/entry_page.cfm?area=1361)


\(^10\) [http://www.nationalcollege.org.uk/](http://www.nationalcollege.org.uk/)
<table>
<thead>
<tr>
<th>Req. No</th>
<th>Formulation</th>
<th>Rationale</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>There needs to be consistency in formatting of data types</td>
<td>Allows for coherency across contexts and systems</td>
<td>Literature</td>
</tr>
<tr>
<td>4</td>
<td>School leaders should be able to communicate and share data with multiple stakeholders (e.g. students, parents, teachers, administrators, peers, policy-makers, PFI partners, etc.)</td>
<td>Leadership management of change and innovation requires transparency of communication and educational systems must meet needs of multiple stakeholders</td>
<td>Literature</td>
</tr>
<tr>
<td>5</td>
<td>System needs to be able to manage dynamic data which is continuously updated</td>
<td>School environments are dynamic and data about students’ learning changes regularly</td>
<td>Literature</td>
</tr>
<tr>
<td>6</td>
<td>School leaders need tools which will support a holistic view of the school system (e.g. in NEXT-TELL – links, access to all levels/layers of the system – ECAAD, TISL, SPICE)</td>
<td>In order to inform SPICE practices and planning, school leaders need to draw down data and to communicate with partners in different layers/levels of the system</td>
<td>Literature, Project Proposal, Interviews</td>
</tr>
</tbody>
</table>

Table 14: High level requirements for SPICE (Strategic Planning with ICT’s in Education)
7 Teacher Certification

Despite the rapid technological changes and advancements of modern society – rushing from the rise of PCs and the internet to the social web (such as Facebook or Twitter) and the omnipresent powerful mobile devices of recent years – the demands on teachers, and their ability and willingness to pursue lifelong learning and continuing education, are enormous. The requirements of teaching and educating learners to become successful members of the 21st century information society are also contributing to the need for effective and enduring teacher education.

7.1 Rationale for and approach to teacher certification

In TISL, attempts to establish teacher certification methods and tools will build on the CbKST methodology (Albert and Lukas, 1999, Doignon and Falmagne, 1985, Doignon and Falmagne, 1999) – see section 7.1.4 below for more on this; as well as on recent ideas and demands around the notion of lifelong learning, competence development, and proficiency development. In line with this, a particular focus of TISL will be the exploration and development of a common European perspective on notions of teacher certification.

The main aim of this task is to investigate the necessary foundations for an approach to teacher certification with regard to competencies by (a) developing teachers’ awareness and understanding of computer-supported classroom assessment; and (b) supporting teachers in analysing student assessment and performance data. These are competences of considerable complexity and high relevance for the 21st classroom (see also D2.1, Section 3).

7.1.1 Teacher’s continuing education

In this section, teachers’ professional development in Europe is presented by summarising studies by the OECD (OECD, 2005) and Eurydice (Desurmont et al., 2008). To achieve the aims of quality education, throughout the course of their career, it is necessary to provide teachers with the skills needed to perform their tasks well. One way to acquire and to update those skills is ‘in-service training’ (INSET). In this context, the terms ‘continuing professional development’ (CPD) or ‘teacher continuing education’ (TCE) are also often used to refer to the wide range of professional development opportunities made available to teachers.

In-service training is directly related to the everyday work of teachers. Its main purpose is, on the one hand, to update, develop and broaden the knowledge teachers acquired during their initial training or basic education and, on the other, to provide them with new knowledge and professional skills which they may not yet have acquired at any given stage of their career.

7.1.2 Road map to teacher certification

NEXT-TELL aims to develop a Euro-wide perspective and pan-European approach to teacher certification, specifically relating to the acquisition of key 21st century skills with a particular focus on use of ICTs and the development of formative e-assessment methods. This may, for example, include relating teachers’ specific competences in e-assessment to the European Computer Driving License (or similar certification approaches), unified approaches to e-Portfolios (e.g., the Europortfolio initiative; http://www.eife-l.org/about/europortfolio) and national standards for teachers’ ICT competences and skills, as well as to any (emerging) standards for teacher assessment literacy (e.g. as in the UK with the CEA – Chartered Educational Assessor qualification; http://www.ciea.org.uk/).

For example, the CIEA (Chartered Institute of Educational Assessors) in the UK aims to promote teachers’ and other educational stakeholders’ assessment literacies through the provision of a validated professional qualification (see Appendix 1, Case Study 9). Teachers in initial training are encouraged to enter into this validation route through links to related accredited Masters level qualifications. The suggested framework takes practitioners through a systemic cycle/set of levels which aim to negotiate understanding of assessment methods, innovation in assessment methods, and sharing of good practice (Fig. 25). Whilst this approach is not focused specifically on ICT competencies or e-assessment literacies, it provides a useful example of ways in...
which an assessment literacy model for teacher certification in the use of advanced learning technologies as a support for formative e-assessment could be applied.

Figure 25: CIEA Model Framework for Assessment Literacy and Teacher Certification (Wright, 2008)

In this respect, though a combination of both CbKST competency modelling and the development of a validation process for teachers’ assessment literacy, TISL seeks to support current perspectives on necessary innovations in teacher quality and professional development at the pan-European level.

7.1.3 Organisation and access to teacher CPD across Europe (current state of the art)

In Europe all countries provide teachers with opportunities to participate in in-service training. However, the provision and accessibility of such training varies considerably between countries depending on how, where and when it is organized. Normally legislation or working contracts specify whether participation is obligatory, or whether professional development is a right to which teachers are entitled and must therefore be granted. In-service training is compulsory in 16 European countries (e.g. Austria, Germany, France, Ireland, and Switzerland). However, in most of them it is limited to a certain amount of time each year. Nevertheless, teachers do have the opportunity to participate in such training on a voluntary basis in many countries (e.g. Belgium, Netherlands, Finland, Sweden, and the United Kingdom). In some countries in-service training is optional, but promotion is not possible without participating in it (e.g. Spain, Portugal, and Slovenia). In Denmark and Luxembourg participation is optional and is without consequence regarding career advancement and salary increases.

Regarding the organisation of in-service training, Finland, Sweden and the United Kingdom make use of specific training days during the year. In general, these occur at the start or end of the school year, in which training takes place. These days are counted as working time. In Greece, Spain, Ireland, Luxembourg, and Portugal optional in-service training is provided mostly outside working hours. Some countries annually grant their teacher several days of study leave which can be used for participating in in-service training (e.g. Belgium, Italy, and Slovenia).

In most cases the overall responsibility for in-service training lies with the central education authority. Often this is either the ministry of education or a council working for the ministry. However in the majority of European Countries this responsibility is at least partly decentralised and shared between central, regional, local and school levels (e.g. Belgium, Denmark, the Netherlands, and Sweden).

Centrally-directed recommendations for training often do not stipulate the content of training in great detail. For this reason a broadly diversified range of activities is covered by continuing professional development as it is currently offered by many European countries. In general, there are two main topics covered by in-service
training providers. One important part of in-service training focuses on the updating of subject knowledge. Another is the offering of specific courses for cross-curricular knowledge and skills which are intended to facilitate the daily work of teachers as well as to give them new directions for classroom interactions. A key area, where much time is invested in developing the skills of teachers, is information and communication technology (ICT). Here, specific programmes are provided to improve the use of ICT by teachers. Also frequently cited is in-service training dealing with various aspects of special education or teaching multicultural classes.

Teachers’ continuing professional development in Europe also refers to the policies and procedures designed to equip teachers in the skills and knowledge they need to perform their tasks well. In Europe there are wide differences within as well as between countries with respect to the organisation, status, responsibility, and content of in-service training. Within the NEXT-TELL project, TISL, and its focus on teacher certification, has as its goal the development of a set of methods and tools which will contribute to the future development of a more coherent, Euro-wide perspective of teacher professionalism, training and development and to provide, by way of example, an approach to teacher certification in the use of ICTs and e-assessment. To achieve this goal, TISL aims to introduce teachers to the theoretical perspective of CbKST as a means of understanding and evaluating students’ technology-supported learning activity in alignment with their own professional development and schools’ strategic planning goals.

7.1.4 A brief introduction to CbKST

Knowledge Space Theory (Albert and Lukas, 1999, Doignon and Falmagne, 1985, Doignon and Falmagne, 1999) provides a set-theoretic framework for organizing a domain of knowledge and for representing the knowledge based on prerequisite relations and is the basis for several approaches to competence structures. In its original form, KST is somewhat behaviouristic, focusing on observable performance without referring to the competencies that underlie that performance. Among others (Doignon, 1994, Düntsch and Gediga, 1995), one extension, which incorporates explicit reference to the competencies that are required for mastering the problems of a domain is CbKST (Korossy, 1997, Korossy, 1999). By assigning competencies to the problems of a domain, a “problem structure” on the set of problems may be obtained. TISL builds on this using the idea that CbKST (Computer-Based Knowledge Space Theory) can be used as a means of exploring the knowledge state of a learner in terms of a set of available problems (knowledge) and the subsets of problems that s/he is able to answer (see Appendix 3 for a more detailed explanation of the technical aspects of the CbKST approach).

7.1.5 Using CbKST as a means of professional competence development for teachers

In order to reach a professional and pan-European approach to teacher certification in the area of ICTs and assessment, relevant competencies need to be identified. This identification process must be framed independently of specific national requirements, tasks, school systems, or language settings.

To meet these requirements, CbKST provides a sound and (scientifically as well as practically) robust method. In the first instance, the methodology requires a separation/distinction between latent unobservable competencies and behaviour (observable performance in specific tasks).

In the context of teacher certification at the European level, the CbKST approach allows us to clearly and precisely define the relevant field(s) of certification. This means that we (1) can specify what competencies a teacher must acquire to reach a certain level of certification independently of the above-mentioned contextual conditions (e.g. national policies, etc.). Moreover, in the context of rapidly-changing technology and software applications, the competence-performance separation allows for a (2) stable specification of certification requirements without relying overly on concrete technologies or tools.

CbKST allows the set of competencies to be accorded a meaningful structure in the sense of meaningful developmental paths. i.e. by aligning teacher development activity to school development goals, national standards, etc. In this sense, prerequisite relations between individual competencies allow for the identification of admissible and rational competence states in teacher development activity. The advantage of this, in the context of teacher certification, is that the developmental paths and the competence structures allow a very precise description of the domain within which a teacher can achieve certification competencies.
For the certification process, this means that we can (a) precisely define the goal independent from performance, tasks, test items, achievements, language barriers, or school systems. More importantly, we can determine with a high level of precision the starting points for the continuing professional development activity and we can determine the content of teachers’ continuing professional development activity. To illustrate this approach: imagine a fictitious certification domain which focuses on, say, the “use of visualization technology for teaching natural sciences (STEM)”. This CPD domain may consist of 6 given competencies (a-f). For example, a might refer to the ability to use concept maps for educational purposes, whilst f might refer to use and configuration of computer games in the classroom. A teacher may start from having none of those competencies and a certification level might be reached when competency f is available (i.e., via a mix of competences achieved \(\{a, b, c, d, f\}\) or \(\{a, b, c, d, e, f\}\)). The use of CbKST in this manner may be formative and/or summative, depending on the desires/needs of schools and teachers.

The advantage of the CbKST approach is that, depending on country and context conditions, arbitrary assessment methods can be mapped to latent competences in order to measure a teacher’s professional growth (formatively and/or summatively). These methods may, for example, refer to concrete tests of ICT competencies or, from a TISL perspective, this may more likely refer to a teachers’ individual or collaborative development as documented in a teacher e-Portfolio and/or via evidence of participation in collaborative workshops or knowledge exchange forums with other teachers. Formatively, the value lies in supporting teachers in developing an awareness of the relevance and contribution of their continued professional development both at individual, school and wider community levels. Summatively, the value lies in the provision of a framework for external validation of teacher activity and innovative practice (see also, for example, section 7.1.1 above).

In combining CbKST competency modelling with the development of a validation process (see section 7.1.1) for teachers’ assessment literacy, TISL seeks to support current perspectives on innovations in teacher CPD and at the pan-European level.

### 7.1.6 High level requirements for teacher certification tools

In the course of the NEXT-TELL project, we will specify the CbKST approach to teacher certification in greater detail and illustrate its potential using convincing examples based on teacher’s practice. Using developments and findings from the project, we will propose a concrete approach to certification in the use of ICTs and e-assessment in schools. This, in turn, will be discussed and negotiated with relevant stakeholders (e.g. teachers and school leaders) and aligned to their concrete requirements and ideas as part of a participatory design process. In the meantime, Table 15 provides some illustrative examples of the kinds of high level requirements that will need to be addressed in this area which, at present, have mainly been drawn from the existing literature, recent empirical studies in the UK and through informal discussions with teachers.

<table>
<thead>
<tr>
<th>Req. No</th>
<th>Formulation</th>
<th>Rationale</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Evaluation of teacher competencies should be formative rather than prescriptive/summative</td>
<td>In order to be motivating for teachers it needs to be guided by their own intrinsic needs as well as being tailored to wider extrinsic values</td>
<td>Literature</td>
</tr>
<tr>
<td>2</td>
<td>Should be modular and web-based, accessible when needed</td>
<td>Allowing teachers to use their time effectively</td>
<td>Interviews</td>
</tr>
<tr>
<td>3</td>
<td>Should allow teachers to have some control over selection/sequence of competency mastery; guided progression is desirable</td>
<td>To give teachers ownership of learning process whilst maintaining a level of systematics</td>
<td>Literature</td>
</tr>
<tr>
<td>4</td>
<td>Should be easy to understand and use, without need for f2f training</td>
<td>To allow teachers to progress independently and at own pace</td>
<td>Literature, Interviews</td>
</tr>
<tr>
<td>5</td>
<td>Should be free or low cost and relevant to teacher/school needs</td>
<td>To fit with shrinking school budgets and perceived value-added</td>
<td>Interviews</td>
</tr>
<tr>
<td>Req. No</td>
<td>Formulation</td>
<td>Rationale</td>
<td>Source</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>6</td>
<td>Should allow for a web-based peer support/collaboration network</td>
<td>To enable teachers to share competencies and skills</td>
<td>Literature</td>
</tr>
<tr>
<td>7</td>
<td>Should offer a robust framework (e.g. CbKST) for competency modelling; some user selection is desirable</td>
<td>To ensure coherency of validation processes, whilst allowing user to adapt system to reflect personal levels of progress</td>
<td>Literature</td>
</tr>
<tr>
<td>8</td>
<td>Should offer validation at professional or higher educational levels</td>
<td>Teachers can gain recognition and reward for their efforts</td>
<td>Literature</td>
</tr>
</tbody>
</table>

Table 15: High level requirements for teacher certification
8 Summary

This report has provided an overview of current state of the art around teacher inquiry, teacher-led research and the integration of advanced learning technologies in technology-rich learning contexts (Section 3). Drawing on this existing literature and informal interviews with teachers and researchers, a preliminary method which sets out 5 key steps for conducting teacher inquiry processes alongside 5 parallel steps for identifying supporting tools and processes for data handling, has been developed (Section 4). Building on this, key tools and processes that can be used to support teacher inquiry into students’ learning in alignment with their own professional development and schools’ strategic planning have been identified, evaluated and described (Sections 5 and 6). Finally, an overview of current state of the art of teacher certification in relation to technology and assessment has been provided, together with a theoretical method for modelling teacher competencies (Section 7). Key foci for the specification of TISL tools and methods were:

- Teacher-led research and inquiry
- Teachers’ professional development and certification
- Schools’ strategic planning
- Data-driven decision making
- Monitoring, assessing and evaluation of students’ learning
- Integrating advanced learning technologies into educational systems

Two sample use cases for STEM and one for language learning (TESL/MFL) were provided (Section 4) by way of illustration of potential applications of TISL methods and tools in practice. A further nine case studies from the literature have been provided (Appendix 2) to illustrate potential applications of key tools comprised in the basic TISL platform (Section 5) together with a list of additional technology tools (Appendix 1) which may be explored in more detail in future collaborative work with teachers and schools.

Each of the key sections pertaining to the elaboration of specification requirements for TISL methods and tools (Sections 4, 6 and 7) concludes with an outline of high level requirements for implementation of the TISL approach. In addition, Section 5 incorporates an extended set of high level requirements for each of the specified tools considered core to the TISL toolset. Further, an more detailed overview of the technical aspects of CbKST as a theory and method has been provided (Appendix 3).

This document will enable us to proceed to the next stage – the participatory exploration and co-development of TISL methods and tools with teachers and schools.
Appendices

Appendix 1: List of generic collaboration tools
Appendix 2: Exemplar case studies (9)
Appendix 3: Overview of CbKST approach
9.1 Appendix 1

List of generic collaboration tools
(drawn from the existing literature)

Twitter
YouTube
Google Docs
Delicious
Slideshare
Wordpress
Facebook
Moodle
Dropbox
Blogger
diigo
Wikipedia
Wikispaces
VoiceThread
flickr
Evernote
Wallwisher
PBworks (prev PBwiki)
Posterous
Google Sites
Edmodo
Edublogs
Amplify
Scribd
Screenr
Livebinders
SecondLife
Basecamp
Elgg
TeacherTube
TypePad
Voxopop
Wetpaint

Source: selection of tools from Top 100 Tools for Learning 2010 List
(http://www.c4lpt.co.uk/recommended/top100-2010.html)

As an entry point for further additions directory of learning tools 2011 may be used:
http://www.c4lpt.co.uk/Directory/index.html
9.2 Appendix 2

Use Cases: TISL Components v1
(drawn from the existing literature)

1. Teacher Inquiry with ICTs
2. Teachers Collaborative Inquiry Platform
3. TISL Planner – Evaluating Students’ Learning
4. Video Analysis Tools
5. Data Analysis Services Gateway – (1) Generic Tools
6. Data Analysis Services Gateway – (2) Open Learner Models/Data Visualisation
7. Teacher e-Portfolios
8. Strategic Planning and Student Data
9. Teacher Certification Methods and Frameworks
### Case Study 1: ICT and Technology – Its Role in Teacher Inquiry

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Who</td>
<td>Prospective (preservice) and Practicing (inservice) teachers (acting as mentors), K-12 Education</td>
</tr>
<tr>
<td>Where</td>
<td>US, 2007, links to ProTeach program at Uni. of Florida</td>
</tr>
<tr>
<td>Focus</td>
<td>Using technology and teacher inquiry to enhance curriculum-based, technology-enhanced field experiences (school placements) for prospective teachers.</td>
</tr>
<tr>
<td>Definition of TI (Teacher Inquiry)</td>
<td>Teacher inquiry, [is] a strategy for helping educators through a systematic, intentional study of their own professional practice.</td>
</tr>
<tr>
<td>Links to TI Method and Supporting Toolkit</td>
<td>Teacher inquiry used to support prospective teachers as they systematically and intentionally study their own practice; students attend a series of three 3-hour seminars/workshops designed to support and guide their teacher inquiry; an overview of teacher inquiry; finalize plans for technology implementation and define a question or wondering to guide their inquiry; a workshop – fine-tune inquiry and develop an inquiry plan for data collection and analysis and a timeline for completion; meeting with course leader to support analysis activity use of supplementary textbook: <em>The reflective educator’s guide to classroom practice: Learning to teach and teaching to learn through practitioner inquiry</em> (Dana &amp; Silva, 2003) to guide on inquiry methods</td>
</tr>
<tr>
<td>Method</td>
<td><strong>5 principles for teacher inquiry (D&amp;S, 2003)</strong> developing a ‘burning question’ developing an inquiry plan collecting and analysing data take action to implement results of investigation share with others</td>
</tr>
<tr>
<td>Tool</td>
<td>Generic collaboration tools and/or specific tools designed to support TI, e.g. planning tool</td>
</tr>
<tr>
<td>Study</td>
<td>Field experiences, matching pairs of teachers, providing preliminary planning tool. <strong>Research Question:</strong> The overarching research question for this exploratory study is “What roles can teacher inquiry play when it is used by prospective teachers during curriculum-based, technology-enhanced field experiences?” <strong>Data Sources:</strong> final inquiry papers (15-20 pages) completed by 13 prospective teachers participating in curriculum-based, technology-enhanced field experiences in six elementary schools. The inquiry papers included sections related to the (1) background or context of the inquiry, (2) personal experiences leading to the “wondering” or inquiry question, (3) a plan for gaining insight into this wondering (including (3a) a brief literature review and (3b) data collection and data analysis strategies), (4) findings from the inquiry and (5) a conclusion in which prospective teachers (5a) assessed the outcomes and (5b) made plans for future work.</td>
</tr>
<tr>
<td>Issues</td>
<td>Moving from a technology-centred to a learning-centred view of technology integration Becoming bogged down in technical issues at the expense of a focus on learning</td>
</tr>
<tr>
<td>Benefits</td>
<td>Encouraging teachers to systematically and intentionally study their own practices leads to a series of benefits related to professional growth including improved practice, heightened professionalism and activism for positive educational change; when prospective teachers are supported through the inquiry process during technology integration, student learning comes to the forefront</td>
</tr>
</tbody>
</table>
| Findings/Claims | Teacher inquiry may serve a variety of roles during curriculum-based, technology-enhanced field experiences including: (1) as a lens through which to consider student learning; (2) as a bridge between content learned in university courses and authentic practices; and (3) as a light bulb for conceptual change. Teacher inquiry begins with a ‘burning question’ – most burning questions framed by ‘8
passions’ (Dana & Silva, 2003): (1) a specific child or group of children; (2) the curriculum; (3) content knowledge; (4) teaching strategies and techniques; (5) beliefs about practice; (6) personal/professional identities; (7) social justice; and (8) context.

**Case Study 1: Screenshots**

**Table 1: Catalyst for Conversation and Planning**

<table>
<thead>
<tr>
<th>Possible Ways to Integrate Technology</th>
<th>Using technology to support all students</th>
<th>Using technology in classroom instruction</th>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support a struggling reader</td>
<td>Content-specific software</td>
<td>Content-specific software in a whole group setting</td>
<td>Technology to support teacher communication</td>
</tr>
<tr>
<td>Support a struggling mathematician</td>
<td>Content-specific software</td>
<td>Content-specific software in a small group setting</td>
<td>Technology to support teacher productivity</td>
</tr>
<tr>
<td>Meet student needs with assistive technologies</td>
<td>Generic software in a whole group setting</td>
<td>Generic software in a small group setting</td>
<td>Technology to support teacher planning</td>
</tr>
<tr>
<td>Meet the students with differing intelligences</td>
<td>Whole group setting</td>
<td>Alternative assessment strategies</td>
<td>Technology to improve delivery of instruction</td>
</tr>
<tr>
<td>Meet the needs of visual, auditory, and/or tactile learners</td>
<td>Whole class projects</td>
<td>Intersocietal projects</td>
<td>Instructional projects</td>
</tr>
<tr>
<td>Meet the needs of students (ESOL students)</td>
<td>Small group projects</td>
<td>Authentic projects</td>
<td>Daily uses</td>
</tr>
<tr>
<td>Meet the needs of a gifted student(s) in a regular classroom</td>
<td>Differentiated instruction</td>
<td>Differentiated instruction</td>
<td></td>
</tr>
</tbody>
</table>

*The technology may be used by teachers or by students.*

**Table 2: Overview of Inquiry Process—Modified from Dana & Silva (2003)**

<table>
<thead>
<tr>
<th>Step*</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defining the problem</td>
<td>Prospective teachers identify a burning question, concern, or wonder that arises from participation in curriculum-based, technology-enhanced field experiences. The wondering is often described to prospective teachers as a passion or something about which they lay awake at night thinking. They describe their wondering and how it came about.</td>
</tr>
<tr>
<td>Developing a plan to collect data</td>
<td>Prospective teachers are guided to develop a data collection plan that fits with what is going on in the classroom. Inquiry should integrate with classroom happenings rather than become separate from them. The goal is to help prospective teachers think about the multiple forms of data available to them in their classroom. One data collection strategy must be a literature search related to the wondering. Other data often includes student artifacts, test scores, journals, informal interviews, and habit-type assessments.</td>
</tr>
<tr>
<td>Analyzing data</td>
<td>Prospective teachers are supported as they develop a plan for making sense of the data collected. They are encouraged to use systematic strategies that directly relate to the wondering.</td>
</tr>
<tr>
<td>Presenting findings</td>
<td>Prospective teachers present their findings (often in terms of themes, patterns, categories, assertion, or metaphor) in written format and via a presentation at the annual conference, inquiry and innovation showcase, a regional event recently recognized as an exemplary practice by the Florida Association of Staff Development.</td>
</tr>
</tbody>
</table>

**Methods tools used to support teacher inquiry**

- **Example 1:** Project-based learning is said to have positive influences on student learning through increased involvement, motivation, and achievement. However, how do we know students are truly making strides that could not be achieved by more traditional teaching strategies that require less planning, time, and hands to implement? My inquiry project began by looking at the influence of project-based learning (with integration of technology) on different levels of Bloom’s taxonomy and extended itself into how group dynamics influence the learning of its students.

- **Example 2:** My goal as a teacher is to meet the challenges of students with diverse needs. I believe that in many situations technology can be used practically and meaningfully to support curricular goals while simultaneously meeting the unique needs of students. My inquiry involves what I learned about a first-grade student with autism and how technology can enhance and support one of his greatest challenges: communicating with others academically and socially.

**Examples of teacher questions and responses to Inquiry Process**
Case Study 2: Inquiry Learning Forum – more CoP and Online Communities than Teacher Inquiry.

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Who</td>
<td>Teachers (K-12 Education), Grade 5-12 Maths and Science Teachers (Inservice and Preservice)</td>
</tr>
<tr>
<td>Where</td>
<td>USA (Indiana), Online Community of Practice (CoP)</td>
</tr>
</tbody>
</table>
| Focus | **Online Learning Community**  
Sharing lesson plans  
View video examples of teaching  
Engage in online discussions  
Work online with groups focused around a particular topic or idea (Inquiry Circles) |
| Links to TI | Teacher Inquiry as a CoP. Within the context of CoPs, learning is conceived as a trajectory in which learners move from legitimate peripheral participants to core participants of a community of practice. CoP defined as a collection of individuals sharing mutually defined practices, beliefs, and understandings over an extended time frame in the pursuit of a shared enterprise. Characteristics: (1) shared knowledge, values, and beliefs; (2) overlapping histories among members; (3) mutual interdependence; and (4) mechanisms for reproduction; (5) a common practice and/or mutual enterprise; (6) opportunities for interactions and participation; (7) meaningful relationships; and (8) respect for diverse perspectives and minority views. |
| Aims and Assumptions | Goal: to examine the dynamics of building a social network through which participating teachers will seek to share and improve their pedagogical practices. Assumption: Designing for virtual communities involves balancing and leveraging complex dualities from the “inside”. |
| Method | Participatory design, CoP, online community, design experiments (Brown, 1992), STIN (Kling, 2001). Notion of system dualities (Wenger, 1998, extended by 2): participation/reification; designed/emergent; local/global; identification/negotiation; online/face-to-face; coherence/diversity |
| Tool | Website, discussion forum, digital video, web-based repositories, e-portfolios |
| Study | The project involved the design and evaluation of an electronic knowledge network, the Inquiry Learning Forum (ILF), a web-based professional development system designed to support a CoP of in-service and preservice mathematics and science teachers who are creating, reflecting upon, sharing, and improving inquiry-based pedagogical practices. (See: [http://ilf.crlt.indiana.edu](http://ilf.crlt.indiana.edu)). |
| Design Principles (Participants) | Foster ownership and participation  
Focus on inquiry (inquiry pedagogy and teacher inquiry)  
Visit the classroom (video-streaming for collaborative practice)  
Support communities of purpose (collective experience/interest)  
The hallmark of this environment is that teachers with a broad range of experiences and expertise come together in a virtual space to observe, discuss, and reflect upon pedagogical theory and practice anchored to video-based teaching vignettes. |
| Issues | Tension between design/emergence and between understandings/needs of designers/researchers  
Defining ‘inquiry’ – who should define – participant-oriented definitions.  
Balance between researcher guidance and teacher opportunity/agency  
User complaint: that it is unclear what the ILF is about, and what is meant by inquiry.  
Teacher identity, critiquing practice, misunderstandings, out of context, etc.  
Tension between “teaching for today” (local) and “teaching for tomorrow” (global)  
Finding a balance between sociality, anonymity and ability to contribute to critical dialogue  
What kind of community (bottom up, inside-out, outside-in) to create  
How do you want teachers to use a collaborative space (integrated/fragmented/personalised) |
| Benefits | Collaboration, critical dialogue, feedback, resource sharing, community support, sharing of expertise |
| Limitations | Trade-offs in relevance/generalisability in shift from local/global practices  
Specificity of evidence shared across contexts lacks benefit of contextual data and may be less
Negotiating external technical systems (firewalls, etc.)
Demands on teacher time

Case Study 2: Screenshots

The Inquiry Learning Forum - Spaces


FIG. 2. Current iteration of a specific Classroom, including links to an overview of the lesson, reflective commentary, descriptions of teaching activity, lesson plans, student examples, and connections to both state and national standards.
### Case Study 3: Personalisation by Pieces: Student e-Portfolios and AfL

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Who</strong></td>
<td>Teachers and Learners, Federation of 5 schools, 280 students, age 3-16</td>
</tr>
<tr>
<td><strong>Where</strong></td>
<td>UK, Scilly Isles, 2002-5</td>
</tr>
<tr>
<td><strong>Focus</strong></td>
<td>Student e-Portfolios, AfL, Skills</td>
</tr>
<tr>
<td><strong>Links to TI</strong></td>
<td>Adapted-generated data, teacher assessment of students' learning, formative assessment, 21st century skills, frameworks (lens)</td>
</tr>
<tr>
<td><strong>Method</strong></td>
<td>Adapted National Key Skills (e.g. empathy, negotiation, interpreting information, finding solutions, etc.)</td>
</tr>
<tr>
<td></td>
<td>Converted into skills ladder with 9 rungs (achievement all years Reception to Year 13)</td>
</tr>
<tr>
<td></td>
<td>Combining sources</td>
</tr>
<tr>
<td></td>
<td>Presenting to an audience</td>
</tr>
<tr>
<td></td>
<td>Writing</td>
</tr>
<tr>
<td></td>
<td>Doing calculations</td>
</tr>
<tr>
<td></td>
<td>Interpreting results</td>
</tr>
<tr>
<td></td>
<td>Presenting information</td>
</tr>
<tr>
<td></td>
<td>ICT creativity</td>
</tr>
<tr>
<td></td>
<td>ICT research</td>
</tr>
<tr>
<td></td>
<td>ICT to communicate</td>
</tr>
<tr>
<td></td>
<td>ICT handling data</td>
</tr>
<tr>
<td><strong>Tool</strong></td>
<td>Web-based portal, suite of tools, e-Portfolio, email</td>
</tr>
<tr>
<td></td>
<td>PbyP is a website (<a href="http://www.pbyp.co.uk">www.pbyp.co.uk</a>) and suite of online tools used to assess a learner's competencies such as their ability to work in a team, be creative and research. Each skill ladder has been designed on 9 steps of progression from beginner to professional. The starting point on the skills ladders is set individually for each learner. A licence provides each learner with their own skills Profile, e-portfolio and secure login to access these from home and school, including via mobile phone. Each learner sets their own targets and submits their own evidence. Currently, 8000 children are submitting one piece a week on average and mostly from outside school. Most of the assessment is carried out by learners who are sent work anonymously between schools. Learners who have 'qualified' in one level of a skill then become an assessor for that skill.</td>
</tr>
<tr>
<td><strong>Study</strong></td>
<td>Research project aimed to support learners to:</td>
</tr>
<tr>
<td></td>
<td>set their own targets</td>
</tr>
<tr>
<td></td>
<td>identify appropriate activities</td>
</tr>
<tr>
<td></td>
<td>collate evidence</td>
</tr>
<tr>
<td></td>
<td>submit evidence for peer assessment</td>
</tr>
<tr>
<td><strong>Benefits</strong></td>
<td>Clear, stepped progression through required skills</td>
</tr>
<tr>
<td></td>
<td>Stage not age, personalised progression</td>
</tr>
<tr>
<td></td>
<td>Assessment for learning principles</td>
</tr>
<tr>
<td></td>
<td>Pupils in charge of their learning</td>
</tr>
<tr>
<td></td>
<td>Engagement parents and pupils in e-assessment</td>
</tr>
<tr>
<td></td>
<td>Using technology for target setting and assessment</td>
</tr>
<tr>
<td></td>
<td>E-portfolio of evidence for each pupil</td>
</tr>
<tr>
<td></td>
<td>Opportunities for external accreditation</td>
</tr>
<tr>
<td></td>
<td>Bridging gap between home/school/beyond school and formal/informal learning</td>
</tr>
<tr>
<td></td>
<td>Easy monitoring of pupil skills and progress</td>
</tr>
<tr>
<td></td>
<td>Improved pupil behaviour</td>
</tr>
<tr>
<td></td>
<td>Pupils taking responsibility for their own learning</td>
</tr>
<tr>
<td><strong>Findings</strong></td>
<td>246 pieces of work were uploaded by 200 students over the summer holidays</td>
</tr>
<tr>
<td></td>
<td>Most common file uploads are document files</td>
</tr>
</tbody>
</table>
Video, audio and animations are also used. At least 11 different subjects use PbyP to support learning. English, Maths and Technology are the most popular.

Case Study 3: Screenshots

**Personalisation by Pieces (PbyP)**

- **21st century skills**
- **Student-led Inquiry**

**Decide on the activity and collect the evidence**

- The activity could be something in class, after school, at home, on holiday, etc.
- Evidence could be a short written account, a written testimonial, a photo, an audio/video interview, a presentation, etc.

**Managing PbyP**

- Pupils manage their own PbyP account online.
- Support from staff where needed.
- Parents encouraged to support.
- Management information available to SLT.

**Using the skills ladder/Peer Review**

**Multi-stakeholder interaction**
## Case Study 1: Preservice teachers in the US and use of a Video Analysis Tool for Teacher Inquiry

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Who</td>
<td>Pre-service teachers (STs) and their school-based mentors (CTs)</td>
</tr>
<tr>
<td>Where</td>
<td>USA, indirectly linked to E-TEACH programme - involves developing and refining a technology innovation—Web based tools and evidence-based practices—using design-based research</td>
</tr>
</tbody>
</table>
| Focus | Five principles underlying teacher inquiry  
*Establishing (and refining) a trigger*  
*Choosing a lens (framework)*  
*Planning for and collecting evidence*  
*Analysing practices*  
*Developing, enacting (and adapting) a course of action* |
| Definition of TI | Inquiry in teacher education involves systematically researching one’s practices in context in order to improve teaching and learning. |
| TI aligned with | Action research, critical inquiry, reflective practice, teacher research |
| Method | EBDS (Enquiry Based Decision Support) – a scaffolded inquiry approach.  
EBDS involves planning, analysing, reflecting, and adapting instructional approaches by comparing evidence of one’s practice with accepted norms, conventions, and standards. |
| Tool | Video Analysis Tool (VAT) |
| Study | Examines how preservice teachers enact teacher inquiry to make instructional decisions using tools and feedback from cooperating teachers (CTs) to analyse their practices.  
26 student teachers used EBDS to examine a self-defined attribute of their practice.  
All had previously used the VAT to analyse their teaching during a 1-month internship in their third semester of teacher education  
All student teachers engaged in two EBDS cycles during a 10-week student teaching experience.  
Survey information was collected from the entire cohort.  
Individual experiences were drawn from 4 motivated preservice teachers (STs).  
Mentors (CTs) of each of these 3 students also participated. |
| Methods (Participants) | Intermediate and follow-up surveys, PDP (plan), application of a lens as analytical framework, data collection, analysis and interpretation using VAT (tool) and commenting, pre-briefing and de-briefing videos, follow-up interviews, final reflection paper (2-3 pages) |
| Methods (Researchers) | Collected and analysed ST and CT comments and analyses of VAT videos.  
Follow-up interviews, coding scheme, constant comparison method, use of time stamps. |
| Issues | Preservice teachers initially accepted the guidance provided by teaching analysis tools, but abandoned the tools in favour of informal self-assessments and feedback from cooperating teachers when they assumed teaching responsibilities in their own classrooms.  
Despite offering a stipend, some students were less motivated to complete the study due to “anticipated concerns over adding tasks during their teaching practice. |
| Benefits | Shared comments (between STs and CTs) made feedback more visible and in-depth than f2f and also offered opportunities for 3rd party feedback (e.g. external observers). |
| Limitations | VAT tool viewed important for analysis BUT  
CTs and other observers viewed more important for directing and refining inquiry (scaffolding)  
Provision of a framework may not be sufficient, and may need to be balanced with individual teacher agency  
Reliance on a single source of evidence (video) to supply evidence |
| Findings | Possible ‘resistance’ to standards-based lenses  
Greater focus on trigger than lens by participants when analysing evidence |
| Recommendations | Allowing participants to choose their own lens |
Important to encourage teachers to critique and improve their own teaching. A ‘second voice’ is crucial to the provision of insight and furthering guidance on inquiry (refining trigger and enacting a solution).

Case Study 4: Screenshots

VAT (Video Analysis Tool)

Example of a lens available to participants to guide/interpret their inquiries.

<table>
<thead>
<tr>
<th>Attribute H:</th>
<th>Net yet evident</th>
<th>Basic</th>
<th>Problems</th>
<th>Advanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification of student strengths and needs</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Develops differentiation</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Plan activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Applies differentiated assessment to all students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needs receive direction and support to develop and implement differentiated assessment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To knowledge of verbal assessment approaches</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Organizes assessments based on individual student needs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Applies methods for assessing individual student needs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uses feedback from peers to refine assessment for individual student needs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needs support to refine assessments</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needs opportunity to discuss new assessment methods</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamically adapts assessments to address specific students’ needs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Implements a range of assessments for the needs of each child</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develops innovative assessments for specific students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Makes assessments on the fly based on “washable moments” to account for individual student needs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inappropriate to peers for sharing varied and individualized assessment methods</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Example of a lens: Standards – Assessment
Study Methods: VAT case study
Case Study 5: e-Science and Web 2.0 – Data Analysis Services Requirements

**Paper**

**Who**
Teachers and Learners, Secondary School

**Where**
UK, 2007

**Focus**
Web 2.0 and mobile technologies to support e-Science in schools

**Links to Tl**
Student-generated data, teacher assessment of students’ learning, formative assessment, 21st century skills, frameworks (lens)

**Method**
Participatory design, teacher workshops, collaborative practice

**Tool**
Flickr, Blogs, YouTube, Google Docs, Shozu, VRE (Virtual Research Environment), Hyperlinks, Experts Database, Skype

**Study**
The e-Science Usability project (funded by ESRC) sought to understand what Web 2.0 offers school science in terms of hands-on experiments that engage students and support their science research both in the lab and outside; use of familiar tools in new learning contexts; collaborative review and reporting activities; and how collaborations across geographic boundaries can be initiated, serviced and maintained. Technology rich, hands-on science sessions, designed from teacher-inspired curriculum topics, use the more promising technologies and were tested and evaluated in DIY Energy, a wind energy generating task. A project blog indicates how some of these tools were pulled together into a single interface. Learners designed blades to affix to a turbine and measured how much electricity their design could generate. Power outputs were accumulated online in a battery charging visualisation, along with the various windmill designs, and questions for a collaborating scientist. For further indications of the children’s and teachers’ response to the energy generating experiment, see our blog ([http://windenergyexpt1.blogspot.com](http://windenergyexpt1.blogspot.com)).

**Issues**
School network connections may not allow access to Web 2.0 sites (Blogger, Flickr, Skype etc.) Mobile network coverage may be limited
Teachers can lack confidence in using these technologies without IT support in class
Through discussion with teachers on the potential use of these technologies applied to their own curriculum topics, we identified a number of further issues with bringing their design into practice: How do you find a scientist willing to participate? How do you find out about which technologies are available to support each kind of activity? How do you find the time to learn the technology? How do you cope with school rules and regulations around using mobile and sites/software blocked on school networks?

**Benefits**
Participatory and observational research with teachers and students provided an in depth awareness of the science learning context.
The Wind Energy collaborative task was very popular across a variety of ages, and replication of the task in teacher workshops revealed similar enthusiasm for the topic.

**Findings**
Trials with learners and teachers in science festival, teacher workshop and student summer-camp contexts indicated a high level of enthusiasm for hand-held technologies for school learning through immediate data upload and sharing, blogging and scientist connectivity.
Some key technological challenges and constraints were also identified in school contexts: the time required to transfer and process collected data across devices; difficulties with school networks; fit with the curriculum; and preparation time and technical support. Finally, we have identified appropriate matches between current educational priorities and learning opportunities with school e-Science, e.g. changing attitudes to science, public participation, and the real science agenda. However, while previous research demonstrates the potential, there is little evidence of teachers or learners adopting this approach.
Case Study 5: Screenshots

Screenshots from Wind Energy Activity

<table>
<thead>
<tr>
<th>Science task</th>
<th>Technologies used</th>
<th>Benefits and challenges identified in school science context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gather and store own science data</td>
<td>Mobiles and handhelds in school,</td>
<td>Engagement of mobile phones used to capture photos, audio, video evidence of experiment</td>
</tr>
<tr>
<td></td>
<td>for experiment reports</td>
<td>Teachers’ concern on provision of technology</td>
</tr>
<tr>
<td>Facilitate data share and review with</td>
<td>Mobiles to upload to Flickr; You</td>
<td>A publicly available shared web space to use beyond school lesson, add to with friends and family; allows collaborators to see progress; different reporting skills</td>
</tr>
<tr>
<td>others</td>
<td>Tube, Blogs from laptops,</td>
<td>Work of moderating inappropriate uploads; potential for off-topic distractions in-class; some web 2.0 sites banned on school networks</td>
</tr>
<tr>
<td>Collaborative data collection &amp; reports</td>
<td>Google docs and spreadsheets</td>
<td></td>
</tr>
<tr>
<td>Collaboration with peers and science</td>
<td>Web cam; Blogs; Skype</td>
<td>Exposure to active scientists’ work context, post questions for scientists to answer on blog; collaborate via web chats and text; indication of availability</td>
</tr>
<tr>
<td>experts</td>
<td></td>
<td>Data security and ethics of video data, bullying etc.</td>
</tr>
</tbody>
</table>
### Case Study 6: Student data – Fraction Helper (OLMs) – Data Analysis Services Gateway/Data Visualisations

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Who</td>
<td>Teachers, learners (age 9-10), parents</td>
</tr>
<tr>
<td>Where</td>
<td>UK, England, Primary Schools, Home-School Learning</td>
</tr>
<tr>
<td>Focus</td>
<td>Fraction Helper is <em>not</em> a full intelligent tutoring system - it was <em>developed in the first instance to investigate the potential of an open learner model for children and their parents</em>, and so the focus is on open learner modelling.</td>
</tr>
<tr>
<td>Definition of an OLM</td>
<td><em>Open learner models</em> allow the learner (and/or others) to view information about him/herself.</td>
</tr>
<tr>
<td>TI aligned with</td>
<td>Student data, parental reporting/engagement</td>
</tr>
</tbody>
</table>
| Method | Provision of an open learner model for learners and parents  
Scaffolded questioning/prompts, feedback and provision of pictorial representations  
Identification of misconceptions  
Modelling of domain, learner, pedagogy  
Multiple visualisations (learner, parent) |
| Tool | Fraction Helper (lite ITS and OLM system) Investigation of an OLM for child and parent users. Extra open learner model developed for parents based on (and restricted to) the parent’s answers to questions that indicated their child had a misconception… also indicates whether the parents themselves have misconceptions. Fraction Helper models knowledge level over the last 10 attempts at answering questions. Offers 5 levels of knowledge: full understanding; good understanding; fluctuating/developing knowledge; weak, and very little/no knowledge. Misconceptions over the previous three attempts are identified by comparing input to a misconceptions library. Misconceptions demonstrated in 2 of these 3 responses are recorded in the learner model. |
| Study | Fraction Helper has the aim of helping to improve children’s fraction knowledge by involving parents in their children’s learning. The subject matter is Year 5 (age 9-10) fractions from the UK National Numeracy Strategy (2004) content of the National Curriculum for UK schools. Study took place in the Home. |
| Methods | Pre-test, system use by the child, system use by parent if child had a misconception, child-parent discussion, post-test, questionnaire and semi-structured interview. System logs and video recordings were also used. Pre-test and post-test each consisted of 10 questions, 10 mins, mixed short answer/multiple choice questions. |
| Benefits | Goes beyond a general performance score  
Tracks learner progress over a number of responses to identify current knowledge  
Learner model provides for more accurate detail about a student’s learning  
Information is available to student at any time  
Helps parents to identify misconceptions (in themselves as well as their children)  
Facilitates independent learning, learner reflection, links between home-school  
Use of colour coding (red/green) to provide ‘at a glance’ review of levels of understanding  
Other coding: happy/sad, growth indicators (sapling/tree) |
| Limitations | Misconceptions of adults may differ from those of children and so not be met by a system designed for children  
Parental engagement more common with younger children than older students |
| Findings | Both children and parents found the open learner model useful; OLM helped parents understand children’s difficulties/misconceptions (and their own) |
| Recommendations | Different visualisations for different users  
Variable language use for learners, teachers, parents, match language between home-school  
Pictorial representations to aid learner understanding |
Case Study 6: Screenshots

Children used Fraction Helper for between 25 and 35 minutes. Table 2 shows each participant’s usage as indicated by the system logs.

Table 2 – Usage levels (system logs)

<table>
<thead>
<tr>
<th>Student</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
<th>21</th>
<th>22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questions</td>
<td>19</td>
<td>20</td>
<td>20</td>
<td>26</td>
<td>20</td>
<td>22</td>
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<td>View GLM</td>
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<td>7</td>
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<td>5</td>
<td>1.5</td>
<td>2.3</td>
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<td></td>
</tr>
</tbody>
</table>

Fig. 1. Fraction Helper questions, explanations and feedback

Fig. 2. The open learner model for children

The table shows your child’s overall understanding of fractions.
The links indicate your child’s knowledge level.
Press UPDATE Parents Open Learner Model to update your child’s progress.

Fig. 3 The parent’s view of the child’s knowledge
Some student comments reflecting engagement and motivation

E: When you read the words in the misunderstanding box, did you try to solve the questions in a different way from before?
S1: Yes. Because I got a sad tree. I did not want to get sad trees.
E: What does the sad tree mean?
S1: I didn’t know my fractions.

E: Can you tell me the reason why you did not look at the open learner model often?
S12: When I checked my answers, they were correct. I did not have any problem so I checked whenever I felt like checking.
E: So why were you looking at your open learner model?
S12: Because it was fun to see how the tree was growing. So whenever I feel like checking my trees, to check if my tree grows well, then I check.

E: Can you tell me the reason you answered a lot of questions?
S4: I just want to get the big oak tree.
S12: I wanted my tree to grow biggest. If I answer more questions and I get them right, then my tree grows more. It’s so cool.
S17: If I do more questions and get them right, then I get the big tree, right? The biggest tree means like I am the master of fractions, right?

Table 4. Child and parent misconceptions (learner models)

<table>
<thead>
<tr>
<th>Student</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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</thead>
<tbody>
<tr>
<td>Child: had misconceptions</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D, G</td>
<td>E</td>
<td>D</td>
<td>B</td>
<td>D</td>
<td>B</td>
<td>F</td>
<td>E</td>
<td>A, E</td>
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<td>A, D</td>
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<td>A, D</td>
<td>F</td>
<td>D</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Child: parents helpful</td>
<td>*</td>
<td>*</td>
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<tr>
<td>Parent</td>
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<tr>
<td>Parent: had misconceptions</td>
<td>B</td>
<td>G</td>
<td>B</td>
<td>B</td>
<td>E</td>
<td>B</td>
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<tr>
<td>Parent: high confidence</td>
<td>*</td>
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<td>*</td>
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</tbody>
</table>

Table 4 shows 19 children (86%) having misconceptions, and 8 children being helped by a parent with a misconception in the same area that they held a misconception themselves. Nevertheless, all participating parents thought their knowledge of fractions was good. (The letters relate to the misconceptions listed previously in Section 2.) It can be seen that a range of misconceptions occurred amongst the sample. All children except S5, who had good knowledge from the start, stated that their parent’s help was useful.
Case Study 7: ICT and technology – its role in Teacher Inquiry – Teacher e-Portfolios

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Who</td>
<td>Prospective (preservice) and Practicing (inservice) teachers (acting as mentors), K-12 Education</td>
</tr>
<tr>
<td>Where</td>
<td>US, 2007, links to ProTeach program at Uni. of Florida</td>
</tr>
<tr>
<td>Focus</td>
<td>Using technology and teacher inquiry to enhance curriculum-based, technology-enhanced field experiences (school placements) for prospective teachers.</td>
</tr>
</tbody>
</table>

**Illustrative scenario for Teacher e-Portfolio**

5th grade students participated in a **project-based learning activity** in which they were responsible for creating a field guide and documentary about plants and animals on the school’s campus.

**Students’ Work**

The project, appropriately titled *Overhead and Underfoot*, required students to identify plants and animals on the school’s campus and create brochures and a video documentary about them. In addition, students were to identify an important environmental message they learned during the process. A **variety of technological resources** such as digital microscopes, the Internet, word processing programs, digital cameras and camcorders, digital video editing software and DVD burners were used in combination with more traditional resources such as **library books, hand drawn storyboards and journals** to complete this project-based, authentic learning experience.

Students’ work was highlighted to **authentic audiences** at the school’s **Curriculum Fair** and at a **conference** at our **local museum** of natural history.

**Teacher Reflection**

On the surface this learning experience would receive praise from most administrators and parents; however, this **prospective teacher’s passion for knowing whether the experience really made a difference in student learning** led her to explicitly explore student learning during this project-based activity. Interestingly she traced this passion back to her days as an elementary student. Her inquiry opens with the following paragraph:

... During my elementary school years I remember being the “ideal” student—well behaved, intelligent, and always on task. **I would complete all my work, study hard, and pass every test.** However, **looking back to those years I can only remember isolated instances of learning.** I can remember making waves and tornadoes using soda bottles, participating in the Tropicana Speech Contest, and learning about Native Americans and dressing up in costumes and sitting in tents. **Did I learn as much about these topics as I did through traditional forms of learning?** Of course I did, but do I remember them as vividly as I remember these instances? Clearly I remember these encounters with active learning more than the many hours I spent doing seat work and taking tests.

She continues to describe her own experiences and integrate literature on the impact of project-based learning. Her introduction ends in this way:

My only concern about this unit centers on whether or not students will learn as much with this project-based method as they would with the more traditional methods. This concern, which can be seen in my reflections of my own elementary school days and my years as an undergraduate student, is what sparked my interest and led me to the following wonderings:

**1. Will this project-based learning** **2. produce a significant impact on students’ learning** **3. at various levels of Bloom’s taxonomy?**
Case Study 7: ICT and technology – its role in Teacher Inquiry – Teacher e-Portfolios

Teacher collection of data (e.g. as digital e-Portfolio)

She then collected data from a variety of sources from within her classroom environment including a teacher journal, student journals, digital pictures of group work, a project rubric and informal interview with the students. As she analyzed her data she developed a coding system to help her organize her data. Her primary finding was that

“Sophistication of student knowledge increased as students progressed through stages of project development.” For example, during an early stage of the project students took the following notes on the white stokesia. The inquiry notes that the group “had four bulleted points, none of which pertained to why plants are important. They simply stated facts.” (See Figure 1).

Yet, by the time the documentary was filmed the student had moved beyond the mere facts through several iterations of their storyboard and created an environmental message to accompany the facts about the white stokesia. (see Figure 2)

Throughout the process of this inquiry I have realized that project based learning has the potential to be a positive experience for all involved. Students are actively involved in learning and are participating in experiences that in fact do allow them to transfer their knowledge to various levels of Bloom’s taxonomy… However, this is not to say that traditional teaching methods are never appropriate, because there are areas of content that are perfectly suited to the more traditional learning environment. It is the teacher’s responsibility to determine when and if project based learning will benefit his/her students, and in the case of my inquiry it was clearly a beneficial instructional method.

She concludes the inquiry paper by highlighting another “passion” she has developed during this process:

... within the completion of this wondering a new wondering has begun to develop. Project based learning is a wonderful tool for teachers, but I have noticed throughout this experience that although students learned more than I could have ever imagined, not all my students learned the same thing. Therefore, my future wondering stems from this inconsistency with exact concepts learned and how we, as teachers, can find a way to compensate for this phenomenon. Project based learning clearly provides benefits in learning and enhances the learning experience, but is there a way to be sure every student is gaining the exact knowledge every other student is gaining?

For this prospective teacher and others, teacher inquiry served as a lens to explicitly consider student learning via a process that involves analysis of data readily available within their classrooms.

The process of systematically and intentionally studying their own practice led some prospective teachers to question deeply held (and sometime subconscious) beliefs about teaching with technology. For example, one prospective teacher realized through the inquiry process that:

At the beginning of this project technology was leading me around by my nose, I felt out of control and vulnerable... [but now I understand the need to] to establish a vision of technology and purpose to adhere to.

This student moved from a technology-centered to a curriculum-centered view of technology integration. Her inquiry highlighted strategies she used to deal with the technical issues while keeping the focus squarely on the curricular goals. She notes that technical problems oftentimes push teachers’ concerns about student learning to the “wayside” and thus they view technology integration “as more of a headache than a blessing.” She vows to maintain a curriculum-centered focus as a practicing teacher and to provide support for her future colleagues to do the same.
**Case Study 8: Strategic Planning, Student Data and Data-Driven Decision-Making in Education**

<table>
<thead>
<tr>
<th>Papers</th>
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<table>
<thead>
<tr>
<th>Who</th>
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<tbody>
<tr>
<td>Schools, teachers, policymakers, stakeholders interested in data-driven decision-making</td>
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<th>Where</th>
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<tbody>
<tr>
<td>USA</td>
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<thead>
<tr>
<th>Focus</th>
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<tbody>
<tr>
<td><strong>Data-driven decision-making</strong></td>
</tr>
<tr>
<td><strong>Data capture, analysis, interpretation, evaluation</strong></td>
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<tr>
<td>Exposes problems, identifies effective teachers, smart allocation of resources, contributes to reform</td>
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<tr>
<td>In classroom, better data supports identification of learning gaps and behaviour patterns, allows instruction to be tailored for individual students</td>
</tr>
<tr>
<td>Impressive advances in use of data for accountability ‘barely influencing decision-making at classroom level’</td>
</tr>
<tr>
<td>Preoccupation with data collection can overshadow how it is (or isn’t) used</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Study – focus and benefits</th>
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<tbody>
<tr>
<td>New York – ARIS (Achievement Reporting and Innovation System)</td>
</tr>
<tr>
<td>Teacher ‘inquiry teams’</td>
</tr>
<tr>
<td>Collaborating to help students based on shared information</td>
</tr>
<tr>
<td>Data generated by specially developed database (ARIS)</td>
</tr>
<tr>
<td>Interim test scores</td>
</tr>
<tr>
<td>Subject grades</td>
</tr>
<tr>
<td>Attendance records</td>
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<tr>
<td>English language learner status</td>
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<tr>
<td>Able to spot long-term learning trends</td>
</tr>
<tr>
<td>Goal – to build evidence-based school cultures</td>
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<table>
<thead>
<tr>
<th>Issues</th>
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<tbody>
<tr>
<td>systems that can’t talk to each other</td>
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<tr>
<td>information silos preventing users from getting a complete picture of students</td>
</tr>
<tr>
<td>making data timely and accurate</td>
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<tr>
<td>giving teachers time and training they need to use system well</td>
</tr>
<tr>
<td>technology of little value unless it is flexible, relevant and fine-grained</td>
</tr>
<tr>
<td>building a system is only one side of coin, what teachers do with data is a critical second building conditions and demand for data-based analysis is often more difficult than collecting data itself</td>
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<table>
<thead>
<tr>
<th>Teacher inquiry teams</th>
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<tbody>
<tr>
<td>focus intensively on small groups of students, after identifying a focus group</td>
</tr>
<tr>
<td>team studies students’ work and data and reviews instructional approaches</td>
</tr>
<tr>
<td>develop theory around issue (focus of attention)</td>
</tr>
<tr>
<td>implement changes</td>
</tr>
<tr>
<td>ARIS provides teachers with a common set of data which they use to inform their collaboration for individual/groups of students</td>
</tr>
<tr>
<td>Data helps teachers identify students’ strengths and learning gaps and to inform parents of students’ progress</td>
</tr>
<tr>
<td>Other studies – teachers observed each others classes (independent of subject area)</td>
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</table>

<table>
<thead>
<tr>
<th>Key findings</th>
</tr>
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<tbody>
<tr>
<td>Two important prerequisites</td>
</tr>
<tr>
<td>Teachers must understand what the data is and what it means (must become data and assessment literate) before they can use it to support instruction</td>
</tr>
<tr>
<td>Operational structure of the school must accommodate teacher collaboration based on data – there must be opportunities for dialogue</td>
</tr>
<tr>
<td>Notion of “shared accountability across multiple educators for the same students” … represents a significant change in the “closed-door culture” of many schools.</td>
</tr>
</tbody>
</table>
Using data needs to become a component of applied professional development. Training needs to start from a specific question that teachers want answered. Teachers need to be able to add their own data to the system (locally) in consistent format.

Case Study 8: Screenshots

Examples of student data in alignment with schools’ strategic planning and data-driven decision-making.

**Data-Driven Decision-Making Cycles (Skelly, L, 2007)**

The collaborative inquiry process (Shuransky, S., NYC Department of Education, 2010)

**Conceptual Framework of DDDM in Education (Rand, 2008)**
**Case Study 9: Teacher Certification**

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<td>Where</td>
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<tr>
<td>Focus</td>
<td>Framework for Teacher Certification in Assessment Practices – focus is on:</td>
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<td></td>
<td>Delivering quality assurance of assessment practices in schools</td>
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<tr>
<td></td>
<td>Developing qualifications framework and methods</td>
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<td></td>
<td>Standardisation and moderation activities</td>
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<td>Teacher Professional Development</td>
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<td></td>
<td>Institutional management and policy-making in wider contexts</td>
</tr>
</tbody>
</table>

**Study**

Reports on a training and evaluation pilot study 2007-9 for potential Chartered Educational Assessors, 32 participants (Event 1), 18 participants (Event 2). One day workshop with follow-up over 9 month period for each event. Range of educational levels (nursery/kindergarten, through primary, secondary and tertiary, as well as examiners). Five elements reviewed:

- Planning/preparing assessments
- Conducting assessments
- Feeding back after assessments and handling data
- Managing oneself and working to deadlines
- Managing teams of assessors

**Methods (Participants)**

One day workshops, follow-up evaluations and interviews with participants

**Comments from participants**

Assessor, female, 30 years experience in vocational assessment programme was rigorous and systematic data analysis was challenging as I have limited experience in this area enjoyed opportunity to audit good practice and agree an action plan to move assessment process forward wonderful opportunity for continuing professional development it takes you out of your comfort zone Assessor, male, FE/HE an opportunity for recognition as an assessor an opportunity to undertake training that is relevant selection process was meticulous... you had to make your case, as you would with a job application training was well structured an opportunity to experience assessment in a different context part of the work towards the award has involved working with other teams on their assessment processes – developing, evaluating and standardising – that is a real bonus for me to be able to say that you are a Chartered Educational Assessor with validation from your peers is a sign that you must know something from the point of view of external stakeholders, it is also a marketable skill

**Benefits to Individuals**

- prestige and equivalent status with other professional organisations
- recognition of skills in assessment techniques
- adds credibility to assessment process
- builds confidence in others to guide, support and lead teams of assessors
- recognises individual skills and expertise, as well as validating those skills and judgements

**Programme Benefits**

- provides clear parameters and an objective framework
- supports professional development
- facilitates spread of good practice
- validates assessment as a skill inseparable from good teaching and learning
Case Study 9: Screenshots

Professional Master’s Programme
 Awards in Educational Assessment

This is a brand new course which we shall be offering from September 2008.

Educational assessment is something which is constantly in the news. There are issues surrounding the authenticity of coursework, the perceived "dumbing down" of examination content and concerns about the accuracy of examiners' marking of public examinations.

This course looks at these issues and more.

**EA4001:** The first module for 15 credits at either H or M-Level looks at:
- the development of examinations since the mid-nineteenth century
- the roles of government, awarding bodies and regulator
- issues surrounding coursework
- how examinations are conducted

**EA4002:** The second module for 45 credits at M-Level will cover:
- New qualifications at GCSE and GCE level
- Introduction of the new Specialised Diplomas
- Good practice in summative and formative assessment
- The role of the Chartered Educational Assessor.

Completion of this unit will provide an opportunity to become a Member of the Chartered Institute of Educational Assessors and to use the post-nominal letters MCIEA.

CEA - Example of links to accredited Masters Level Programme

Qualifications will be based upon the CIEA Professional Framework, an outline of which can be seen below:

The CIEA is working to align its framework with those of both the TDA and LLUK, so that skills and competencies can be professionally recognised.

Overview of CIEA Framework for Development of CEAs

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Overview of CbKST

Knowledge Space Theory (KST; Albert & Lukas, 1999; Doignon & Falmagne, 1985; Doignon & Falmagne, 1999) provides a set-theoretic framework for organizing a domain of knowledge and for representing the knowledge based on prerequisite relations and is the basis for several approaches to competence structures. A knowledge domain is represented by a finite set Q of problems. The knowledge state of a learner is described by a subset of problems that s/he is able to master. Due to prerequisite relations among the problems of a domain, not all subsets of problems are possible knowledge states. If two problems \( a, b \in Q \) are in a prerequisite relation, we can assume from mastering problem \( b \) a mastering of problem \( a \). To give an example, imagine five problems of the domain of basic algebra, an addition, a subtraction, a multiplication, a division, and an equation. For five problems the set of all possible knowledge states is 2^5; if we assume that addition, subtraction, multiplication, and division are prerequisites for solving equations, not all 32 knowledge states will occur, because it is highly improbable that a student will be able to solve equations but no addition problems.

The collection of possible knowledge states corresponding to a prerequisite relation, including the empty set \( \emptyset \) and the whole set \( Q \), is called a knowledge structure \( K \). To account for the fact, that a problem may be solved in different ways and thus may be associated to different sets of prerequisites, the notion of a prerequisite function has been introduced, which, as a generalisation of a prerequisite relation, associates a family of subsets of \( Q \) with each problem.

In its original form, KST is somewhat behaviouristic, focusing on observable performance without referring to the competencies that underlie that performance. Among others (e.g., Doignon, 1994; Düntsch & Gediga, 1995), one extension, which incorporates explicit reference to the competencies that are required for mastering the problems of a domain is CbKST (e.g., Korossy, 1997, 1999). The basic idea is to assume a basic set \( E \) of abstract, cognitive competencies that are relevant for mastering the problems of a domain. The competence state of an individual is the collection of all available competencies of that person, which is not directly observable but can be uncovered on the basis of observable performance on the problems representing the domain. As in KST, prerequisite relations are described on the set of competencies establishing a competence structure \( C \), which contains all possible competence states. Utilizing interpretation and representation functions, families of subsets of competencies (competence states) can be mapped to problems, which can be mastered with the given competencies and vice versa. By the assignment of competencies to the problems of a domain, a “problem structure” – which may be a surmise relation or a surmise function - on the set of problems is also induced.

To illustrate this approach, assume a knowledge domain that is represented by a set of four problems (e.g., test items), \( Q=\{a, b, c, d\} \). Consider the set \( E=\{V, W, X, Y, Z\} \) of competencies that are relevant for solving these problems. The prerequisite relations that exist among these competencies are demonstrated by the AND/OR-Graph in Figure 2a. Thus, if a student possesses competence \( X \) we can assume that this student also possesses either competence \( V \) or \( W \) or both; if a student possesses competence \( Y \) we can assume that this student at least possesses also competence \( W \). The prerequisite function establishes a competence structure (Figure 2b), which includes only thirteen possible competence states from a total of 25 states. Table 4 lists an interpretation function, which associates competence states that are adequate for mastering a given problem. This means, for solving problem \( a \) one of the two competence states \( \{V, X\} \) and \( \{W, X\} \) is necessary and sufficient; a student that has one of these two competence states (or a superior one) will be able to master this problem. Given the interpretation function, the representation function specifies the subset of problems that can be solved in each competence state.
Figure 2: AND/OR graph for competency functions

Figure 2: Panel (a) displays the AND/OR-graph for a prerequisite function among five competences (V to Z). The bended line below competence X indicates a logical OR. Panel (b) shows the competence structure established by the prerequisite function. The bold line indicates a valid learning path. Table 4, meanwhile, illustrates these problem/competency states as an interpretation function.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Competence states</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>{V, X}, {W, X}</td>
</tr>
<tr>
<td>B</td>
<td>{W, Y}</td>
</tr>
<tr>
<td>C</td>
<td>{V, W, X}, {W, X, Y}</td>
</tr>
<tr>
<td>D</td>
<td>{W, X, Y, Z}</td>
</tr>
</tbody>
</table>

Table 4. Interpretation function.

CbKST and competency development

In order to reach a professional and pan-European approach to teacher certification in the area of ICTs and assessment, relevant competencies need to be identified. This identification process must be framed independently of specific national requirements, tasks, school systems, or language settings.

To meet these requirements, CbKST provides a sound and (scientifically as well as practically) robust method. In the first instance, the methodology requires a separation/distinction between latent unobservable competencies and behaviour (observable performance in specific tasks).

To date a variety of definitions of competence/competency exist (e.g., Anderson, 2000; Reynolds, 1993). The American Heritage Dictionary of the English Language, for example, states:

> Competence means the state or quality of being adequately or well qualified; a specific range of skill, knowledge or ability.

This, and many other definitions have in common that they describe competence as an abstract, latent, indirectly observable quality. For the adequate development and assessment of competence, however, latent competencies must be associated with observable behaviour or achievements.

In a second step, CbKST allows the set of competencies to be accorded a meaningful structure in the sense of meaningful developmental paths. As briefly introduced, so-called prerequisite relations between the single competencies determine admissible and rational competence states. The advantage of this, in the context of teacher certification, is that the developmental paths and the competence structures allow a very precise and non-numerical description of the domain within which a teacher can achieve certification competencies. As
shown in Figure 3, we can obtain a list of competencies of the certification domain, apply prerequisite relations between them and derive a competence structure that yields meaningful competence states (the nodes of the rightmost graph) and admissible developmental paths (the edges of the rightmost graph).

![Figure 3: CbKST approach to modelling the certification domain.](image)

From left to right: (1) List of competencies, (2) prerequisite relation between the competences, and (3) the derived competence structure.

For the certification process, this means that we can (a) precisely define the goal independent from performance, tasks, test items, achievements, language barriers, or school systems. More importantly, we can exactly determine the starting points for the means of continuing education and we can determine the content of continuing education. To illustrate this approach using the example of Figure 3; imagine the fictitious certification domain “use of visualization technology for teaching natural sciences (STEM)”, it may consist of the 6 given competencies (a-f). For example, a might refer to the ability to use concept maps for educational purposes, and f might refer to use and configuration of computer games in the classroom. A teacher may start from having none of those competencies (indicated by the state {} as shown in the rightmost graph) and a certification level might be reached when competency f is available (i.e., competence states {a, b, c, d, f} or {a, b, c, d, e, f}).
10 References


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11 Glossary

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

**Partner Acronyms**

- **JRS** JOANNEUM RESEARCH Forschungsgesellschaft mbH, AT
- **Uni Research** UNI RESEARCH AS, NO
- **KMRC** Medien in der Bildung Stiftung, DE
- **TUG** Technische Universität Graz, AT
- **CBS** Cobenhagen Business School, DK
- **BHAM** The University of Birmingham, UK
- **IOE** Institute of Education, University of London, UK
- **EXACT** eXact Learning Solutions SPA, IT
- **TALK** Verein offenes Lernen, AT
- **BOC-AT** BOC Asset Management GmbH, AT
- **BOC-PL** BOC Information Technologies Consulting SP.Z.O.O., PL
- **MTO** MTO Psychologische Forschung und Beratung GmbH, DE

**Abbreviations**

- **ALE** Adaptive Learning Environment
- **AR** Action Research
- **CSCL** Computer-Supported Collaborative Learning
- **DBR** Design Based Research
- **HCI** Human Computer Interaction
- **KSA** Knowledge, Skills and Abilities
- **NEXT-TELL** Next Generation Teaching, Education and Learning for Life
- **OLM** Open Learner Model
- **PD** Participatory Design
- **RA** Requirement Analysis
- **STEM** Science, Technology, Engineering and Mathematics
- **TESL** Teaching English as a Second Language
- **TISL** Teachers’ Inquiry into Students’ Learning

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