



DELPHI GCP 1: Computer-supported collaborative learning in teacher training and professional development

What problems of the European education system are addressed, and what are the long term benefits for society?

In order to foster computer-supported collaborative learning (CSCL) in classrooms, teachers have to develop professional practices for implementing various types of CSCL activities with ease and confidence. It is known that a teacher's own learning experiences are reflected in his/her teaching style; therefore, teacher education has to be renewed to include new teaching methods such as CSCL with teachers as active learners. In addition, continuous professional teacher development could benefit from networked teachers who form a community of practice to build and share professional knowledge. Learning activities that incorporate CSCL bear the potential to enhance teachers' pedagogical and content knowledge and to increase teachers' ability for creative problem-solving. Collaborative learning spaces like wikis and other social networking tools hold much promise for supporting ongoing reflective practice and teacher learning because they make teaching practices and reflection visible in ways that have not been possible before.

What are the main activities to address this Grand Challenge Problem?

When implementing changes to the teacher education curriculum and the professional development of teachers, the following research questions/issues have to be investigated:

- What methods can we use to ensure that professionals in education have face to face and digital opportunities to share their knowledge collaboratively and build new theory and practice in learning?
- How can a community of teachers grow and remain active through the implementation of CSCL?
- How and to what extent do networked learning environments enhance technological, pedagogical, and content knowledge for teachers?
- How might this spark innovation, creativity, and high level problem solving and solving in the classroom?
- What is the impact these activities may have on teachers' expertise and their professional practices in classroom?
- What is the impact of increased CSCL learning experiences made by teachers in networked communities on their students' learning?

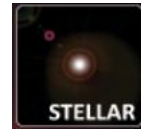
The renewed teacher education curriculum has to be monitored for difficulties and barriers (formative evaluation) and evaluated against the professional standards that the teachers in training have to reach (summative evaluation).

What is the timeframe for the Grand Challenge Problem?

In order to integrate CSCL into teacher education and professional development on a large-scale, a joint effort of researchers, teacher educators, and the national Ministry of Education in several European countries is needed; therefore, the timeframe is 10 years.

What are measurable progress and success indicators?

The clarification of the research questions and the monitoring of difficulties in the networked community is a first step towards solving this GCP. The teachers' level of activity



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in the CSCL environments should be monitored and the quality of interaction in terms of higher order problem-solving should be evaluated.

Additionally, the changes in teacher education and teachers' continuous professional development should be reflected in the quality of their teaching practice concerning the successful integration and execution of CSCL-activities in the lesson plans.

How can funding be attracted?

European research project funded under the European Commission. In order to ensure the close link between research and practice, the applying institutions should be required to commit to a working partnership with the national Ministry of Education. Thereby, the implementation of CSCL in the actual teacher education curriculum and the professional development can be guaranteed and investigated.

DELPHI GCP 2: Mobile augmented reality in health care training

What problems of the European education system are addressed, and what are the long term benefits for society?

The daily work practices in health care and medicine require skills for imagining physical processes that are invisible to the human eye. Modern technologies, such as smartphones, can be used for visualizing the hidden processes through creating an augmented-reality (AR), a virtual, visual layer on top of the actual captured images. Medical practitioners, nurses, or students could view and experience former imperceptible medical procedures and create richer representations and deeper understanding of bio-physiological mechanisms. In the long-run, the integration of AR in medical and health care practices might lower error rates in diagnosis and treatments. In addition, the delivery of AR on mobile devices offers the possibility to transfer high-tech simulations and scenarios to remote or less developed regions in the world.

What are the main activities to address this Grand Challenge Problem?

For developing a mobile AR tool for medical and health practices, a multidisciplinary team should base their work on the extended corpus of research within the field of mobile learning, medicine education and visualization programming:

- Which medical tasks are appropriate and suitable to be visualized?
- Which support structures (content, pedagogy, contextualization) are needed by learners and practitioners to use the tool successfully?
- Can the mobile AR tool be designed for satisfying the needs of learners and practitioners at the same time?
- Which are the essential requirements the mobile device has to meet?

In the implementation/evaluation phase, the usability of the mobile AR tool and its adoption in real-life settings should be investigated.

In order to facilitate integration and distributing of the mobile AR tool in countries around the world, a mixed-method study (incorporating ethnographic research perspectives) should be conducted which reveals differences as well as similarities in using and learning with the tool within multiple cultures:



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- What are the human factors contributing to or limiting the up-take of ubiquitous and mobile learning tools such as the mobile AR tool within healthcare and medicine?
- Will lesser developed regions adopt the mobile AR tool in healthcare and medicine and will AR scenarios increase the overall access to health services?

What is the timeframe for the Grand Challenge Problem?

In order to develop and evaluate AR tools for education and professional development in health care and medicine, a joint effort of researchers, medical practitioners, and technology developers is needed; therefore, the timeframe is 10 years.

What are measurable progress and success indicators?

This GCP involves the following milestones: analysis of medical tasks and writing of software script, development of educational software tool, evaluation of tool in laboratory and real-life settings. Implementation and evaluation of AR tool in hospitals and medical practices in several European countries.

How can funding be attracted?

European research project funded under the European Commission. In order to ensure the evaluation of the AR tool in real-life settings, the applying research institutions should be required to commit to partnerships with a hospital and several medical practices.

DELPHI GCP 3: Acquisition of graphical and digital literacies through learning with ICTs

What problems of the European education system are addressed, and what are the long term benefits for society?

We live in a digital world that demands new skills and literacies. Being 'literate' in today's society has wider implications beyond typographic text. With new and varied means of communicating available through the existence of ICTs, there is a need to develop more understanding into the way in which people construct and interpret multimodal representations. Students are increasingly exposed to an ever-widening array of graphical representations (e.g., data visualizations, interactive multimodal texts, or hybrid text and graphical combinations). Diagrams and other graphics also cross cultural and linguistic boundaries - another facet of their importance. Graphical literacy is crucial for all STEM domains and as interactive graphical systems become ever more ubiquitous, students must be equipped to exploit them for their own applications.

Taken together, students' digital literacy skills require increasing 'graphical literacy' or graphicacy as well as literacy. Yet there is very little direct instruction in the selection, creation, and application of graphics and multimodal texts - at least not in a subject-independent way akin to 'languages' as subjects.

What are the main activities to address this Grand Challenge Problem?

First, we need a better understanding of how students acquire graphicacy skills and common graphical misconceptions (e.g., 'graph as picture') as well as how to best teach student teachers effective principles for assigning particular representational forms to educational



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contexts and problems, i.e., what some researchers have termed the 'applicability conditions' for selecting, say, tables or network diagrams or hierarchical graphs, set diagrams, and so on. Additionally, further examination is required into the way in which students 'read' multimodal texts and the way in which such texts can be integrated into the formal educational context.

In a second step, multimodal texts and graphical teaching materials have to be designed. These study materials should be based on the implications for formal literacy education that were revealed in the research advances described above. In addition these materials should support teachers in their efforts to design and implement lessons on digital literacy skills.

What is the timeframe for the Grand Challenge Problem?

A joint effort of researchers, literacy and STEM teachers, software designers, and the national Ministry of Education in several European countries is needed; therefore, the timeframe is 10 years.

What are measurable progress and success indicators?

The clarification of the skills students acquire for deciphering multimodal texts and complex graphical representations is the first step towards solving this GCP. The cognitive processes that are relevant for learning with multimodal texts and multiple graphical representations should be described in an empirically-tested model or theory.

The second step is the creation of teaching/studying materials based on the identified cognitive processes. In this step, software designers have to overcome technical difficulties in the design process.

How can funding be attracted?

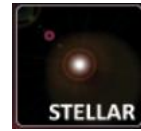
European research project funded under the European Commission. In order to ensure the close link between research and practice, the applying institutions should be required to commit to a working partnership with the national Ministry of Education for updating the curricula to include graphical literacy and the appropriate teaching material.

DELPHI GCP 4: Increasing student motivation to learn and engaging the disengaged

What problems of the European education system are addressed, and what are the long term benefits for society?

What if school was optional? What if educators, researchers, and parents couldn't rely on school being compulsory and had to make it a different kind of place? Even though school will probably remain compulsory in the future; we should start addressing the issues at hand: how can we increase student motivation to learn and how can we integrate disengaged students?

Indicators for the increasing number of unmotivated students are high attrition rates and low interest in school, especially in STEM subjects. Debates about academic achievement often focus on cognitive aspects and neglect the role motivation plays in it. In general, the importance of intrinsic motivation isn't new, but the education systems around the world



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should get on board quickly and should aim to make learning personally rewarding and valuable for every student. Technology could be a useful instrument for providing learning experiences that meet those goals. It could provide tools to educators, researchers, parents, and learners that enable self-directed learning driven by need for mastery.

What are the main activities to address this Grand Challenge Problem?

In order to examine the potential of TEL for increasing students' motivation, the following research questions should be investigated:

- What factors in TEL environments promote self-directed and intrinsically motivated learners?
- Extrinsic rewards have been shown to impede intrinsic motivation. How can technology offer alternatives to standardized testing and extrinsic/conditional rewards for good performance?
- Are there individual aspects that moderate the effect of TEL on motivation, such as affinity to computer games or ICT in general, social background/social status, etc.?
- How can technology relate learning in school to self realization, self expression, and identity formation?
- Could technology help to make students' productive activities outside of the school context more accountable in school and how would that affect students' perception of such activities?

While enabling students to be intrinsically motivated learners, we should not forget those students who are unmotivated and disengaged from learning as a whole:

- How to identify disengaged and unmotivated learners? How can they be re-engaged in the learning process?
- How can we identify and differentiate states of demotivation and unmotivation?
- How can we remediate these different kinds of states in a way that improves the situation and causes minimal negative side-effects?

What is the timeframe for the Grand Challenge Problem?

The thorough investigation of the research questions posed above necessitates the cooperation of researchers (experts in motivation, serious games, didactics, software design) and practitioners (teachers, students, parents, educators outside of formal learning) from several European countries; therefore, the timeframe is 10 years.

What are measurable progress and success indicators?

The investigation of the research questions should reveal possible actions to be taken in school learning for increasing students' motivation to learn. Even further, strategies for engaging unmotivated students should be outlined and tested.

Overall, the implementation of potentially motivating technology-enhanced learning environments should lead to measurable increases in student motivation and in a second step to increase academic achievements.

How can funding be attracted?

European research project funded under the European Commission. In order to ensure the cooperation between research and practice, the applying institutions should represent experts in motivation as well as educational technology experts and should be required to



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commit to a working partnership with schools and educational institutions outside of formal learning settings.

DELPHI GCP 5: Bridging informal and formal contexts to create a unified learning landscape

What problems of the European education system are addressed, and what are the long term benefits for society?

In today's knowledge society, we come across learning opportunities literally around every corner. Mobile devices and other technological innovations have changed the basic conditions for learning and introduced new learning spaces in everyday life and, to a lesser extent, formal (schools) and informal (museums) learning institutions.

The resources that especially young people use for learning and constructing knowledge can be characterized by mobility and multiplicity – ubiquitous access to multiple resources for information. This means that schools are not the only privileged source of knowledge; young people participate and learn in a broad range of contexts and have to translate/transform knowledge between these spaces. This characteristic of today's learning landscape leads to an interconnectedness or divide between student learning inside and outside the formal classroom. With this gap between youth cultures of learning and school education that students often perceive and feel, there is a lot of lost and missed opportunities for engaging and enriching learners.

Research is needed that explores how learners translate and transform knowledge between contexts, with a particular focus on technologies that support learning across school and informal learning settings.

What are the main activities to address this Grand Challenge Problem?

First of all, we need to better comprehend the characteristics of how students connect learning between contexts, especially between school and informal learning settings. A theoretical framework addressing the following research questions should be built based on empirical evidence:

- What are students learning outside the formal classroom?
- Which technologies are used, and how are they used?
- What are the cognitive, emotional and motivational processes when learning in informal learning contexts as opposed to learning in the formal classroom?
- How is learning shaped by the purposes to which knowledge and understanding are put?
- Where are the connections between what students are learning inside the formal classroom and what they are learning outside the classroom? How do they translate/transform knowledge between those contexts?

In a second step, we should explore and evaluate possibilities for facilitating, that is, orchestrating, the translation of knowledge between informal and formal contexts for ultimately creating a unified learning landscape:

- How can technologies that have been identified as being used in informal learning settings be emulated within classroom contexts?



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- How can we orchestrate learning within and between spaces of different nature: Web, 3D virtual and augmented physical spaces?
- How can we enable the flow of activity state and data between spaces, and the linking of objects in different spaces, so that orchestration can be achieved?

What is the timeframe for the Grand Challenge Problem?

Researchers specializing in formal learning as well as informal learning should work together with practitioners in both learning contexts (e.g., teachers, pedagogical staff in museums, etc.) for investigating the research questions presented above. Even further, the national Ministry of Education in several European countries should be involved for implementing the findings in the national school curricula and teaching practices; therefore, the timeframe is 10-15 years.

What are measurable progress and success indicators?

After completion of the first step, a comprehensive framework describing the interconnectedness of learning in formal and informal settings should be created. The second step towards addressing this Grand Challenge Problem should result in the implementation of facilitating technologies/teaching practices for bridging formal and informal learning into school education.

How can funding be attracted?

European research project funded under the European Commission. The applying institutions should represent both formal and informal learning institutions in order for the research project to reflect the close link between both learning spaces. In addition, the national Ministries of Education should be supporting the research proposals and be willing to appoint project schools for implementing/investigating the presented research questions.

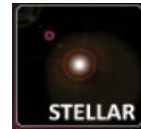
DELPHI GCP 6: The ‘perfect’ Personalized Learning Environment – Conceptual considerations

What problems of the European education system are addressed, and what are the long term benefits for society?

Personalized learning environments (PLEs) aim to offer learning experiences that are tailored to the individual learning profile; thereby, students should receive the support they need for succeeding in school. Existing theories for creating PLEs are often partial and contradictory, and cannot provide good models for practice. Developing, broad exchange, implementation, critique and incremental improvement of explicit unified models of educational goals, objects and processes would be very beneficial for progress in the field. Researchers and industry have to involve pilot schools, universities and companies in extensive and large-scale participatory design research focusing on next-generation PLEs. This will enhance our understanding of individual learning paths in relation to personal differences.

What are the main activities to address this Grand Challenge Problem?

Before designing any TEL application for personalization of learning a number of conceptual issues need to be resolved. For example, many studies do not distinguish between level type of constructs (ability, intelligence, level of knowledge; the question here is, how much?) and



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style constructs (cognitive style, learning style; the question here is, in what way?). This conceptual confusion leads to wrong technological solutions.

Therefore, this Grand Challenge Problem addresses main conceptual research questions, such as the following:

General research questions

- Does a personalized trajectory lead to better learning than one-size-fits-all?
- Who should be responsible for personalization? The system, or can we put the learner in the driving seat? What is necessary to achieve the latter without losing effectiveness and efficiency of the learning process?
- Does a self-directed PLE lead to more motivation and less frustration?

Didactics/Pedagogy

- What learning designs best support personalised learning?
- How is prior knowledge accounted for in the personalization process?
- How can instructional explanations be adapted to the learners' prior knowledge and to possible misconceptions in computer-based learning environments?
- How to reach a predefined accredited level of expertise?
- How can different learning styles theories and models be integrated to propose a unified learning style model?
- How can we offer ill-structured and ill-defined learning in PLE? How do we teach and learn about dealing with ambiguity? Can we develop chaos pilots (learners) that navigate this learning landscape?

Implementation

- How to promote and sustain teachers' interest in and enthusiasm about PLEs?
- How to build secure personalized/student owned databanks (secure privacy and portability of data by student control of his/her data)?

What is the timeframe for the Grand Challenge Problem?

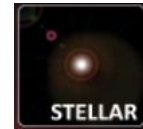
This Grand Challenge Problem presents a collection of relevant and important research questions that can only be investigated in a joint effort of experts in cognitive psychology, educational sciences, law, artificial intelligence, computer sciences, educational data mining, as well as accreditation organizations and providers of data storage; therefore, the timeframe is at least 10 years.

What are measurable progress and success indicators?

First of all, receiving answers/solutions to the multiple questions and issues illustrated above should be the basis for identifying design principles for PLEs. In the next step, scale is the key for testing PLEs based on these principles and involving schools/universities/businesses from all over the world would add to the research. It would also be important to test the hypotheses in different educational phases - e.g., primary education, K-12, secondary education, and workplace learning.

How can funding be attracted?

European research projects funded under the European Commission. For this Grand Challenge Problem, multiple research projects will be necessary; however, these projects should be tightly interlinked and should build upon each other.



DELPHI GCP 7: The ‘perfect’ Personalized Learning Environment – Learner support and interoperability

What problems of the European education system are addressed, and what are the long term benefits for society?

Both hardware (smartphones, tablet/slate PCs, etc.) and software/services are rapidly developing towards increasing personalization and adaptation to the individual user. The business world already exploits activity data and user recommendations to personalize services and to gain Business Intelligence (e.g., Amazon, Payback). The current trend in the educational sector is to personalize instruction to best assist each individual student/learner. The necessary technological solutions for supporting each learner based on their specific needs and for interoperability of different systems/devices for personalized learning are still at their beginning. This Grand Challenge Problem addresses the questions many educational technologist and computer scientists are struggling with on a daily basis in designing personalized learning environments (PLEs).

What are the main activities to address this Grand Challenge Problem?

In order to develop technologies for personalization of learning the following aspects have to be explored:

- dynamically adaptive planning, execution, monitoring and testing of educational processes
- dynamically adaptive diagnosing and remediation of root-causes of educational problems.

Learner support:

Monitoring learning processes/data mining/adaptation:

- What variables are essential to assess when monitoring/adapting instruction to individual learner's needs?
- How do these variables interact – how should they be weighed in an assessment or task selection algorithm?
- How to use process data to make every classroom teacher an educational researcher who can assess the effectiveness of their own teaching?
- Find a way to identify the user's emotional state and react to it

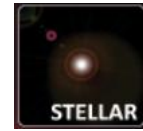
Recommender systems (use data to make recommendations regarding choices of resources):

- Do learners welcome this feedback and do they start to participate by making their own contributions?
- Are the trends and recommendations of value to teachers in designing learning and supporting learners?
- Does the system become more useful as it scales and does it become more useful if data is collected across institutions?
- What characteristics of learners and learning experiences are most important for establishing effective matches?
- How can the experience of past learners be effectively aggregated to inform recommendations for future learners?

Intelligent tutoring systems

- How to reduce the cost of developing intelligent tutoring systems (ITS)?
- How to apply ITS to ill-defined domains such as language learning, etc.?
- How to integrate more elaborated pedagogical strategies in ITS?

Pedagogical agents



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- Create an intelligent agent who models the behaviour of an effective human tutor

Interoperability/Reusability

- Create universal standards to describe learning objects/user learning profiles
- How to create shareable and reusable e-learning designs?
- How can learning management systems and PLEs interact/complement each other?
- Explore methods for adaptive learning objects retrieval from learning objects repositories

What is the timeframe for the Grand Challenge Problem?

This Grand Challenge Problem presents a collection of relevant and important research questions that can only be investigated in a joint effort of experts in law, artificial intelligence, cloud computing, computer sciences, educational data mining, learning analytics, cognitive psychology, human computer interaction; therefore, the timeframe is at least 10 years.

What are measurable progress and success indicators?

First of all, receiving answers/solutions to the multiple questions and issues illustrated above should be the basis for identifying design principles for PLEs. The next step is the integration of these technological solutions with educational goals/theories in a generic PLE and to test these PLEs in schools/universities/businesses from all over the world. It would also be important to implement these PLEs in several educational phases - e.g. primary education, K-12, secondary education, and workplace learning.

How can funding be attracted?

European research projects funded under the European Commission. For this Grand Challenge Problems, multiple research projects will be necessary; however, these projects should be tightly interlinked and should build upon each other.

DELPHI GCP 8: Best practices for matching ICTs with pedagogy in the classroom at several educational levels

What problems of the European education system are addressed, and what are the long term benefits for society?

This Grand Challenge Problem addresses the societal need for improved education and a systematic use of technology in the classroom that is tailored to the teacher's and learner's needs and learning objectives. TEL offers a vast number of new pedagogical scenarios and methods, particularly in combination with social media, digital resources and software tools. However, more than three decades of media effects research have demonstrated what Clark (1983) asserted long ago: Technology integration research can no longer focus upon educational technologies' effects, since it is how the technologies are used pedagogically, in terms of curriculum, and relative to learners' needs and preferences, that determines the success or failure of a particular technological use. Improved student learning results from appropriate 'matches' among students' curriculum-based learning needs and preferences, the nature of the learning activities in which they engage, and the tools and resources (digital and non-digital) that support those learning activities.

Practitioners often seek advice on when and in which circumstances to choose which technology for which purpose. This Grand Challenge Problem aims at closing the gap



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between educational research and educational practice by developing best practices for matching ICTs with pedagogy in the classroom.

What are the main activities to address this Grand Challenge Problem?

The main question that this GCP is addressing is the following: Which technologically-supported curriculum-based learning activity types are most effective for which types of student learning goals?

In order to solve this challenge, we need to develop, test, refine, and apply a strategy for testing the efficacy of technologically supported learning activity types within specific curriculum content areas and for students with particular learning goals. The testing strategy will then be applied in multiple content areas to address multiple learners' needs.

- First, we could look at technologies that have been developed far enough to be easily usable (e.g., concept mapping, web lectures, electronic voting) by teachers who are not experts in educational technology, and investigate to which learning tasks/goals they can be applied. Which scenarios and methods do actually work?
- For which content/tasks/types of knowledge is ICT enhancing educational practice?
- What are the context factors that make a specific best practice a success?
- What is the role of teachers when using ICT in the classroom? (Do we need new didactical concepts that consider both technology and other forms of learning, and give advice as to the question of when to use which?)
- What kind of knowledge / skills do teachers and pupils need to benefit from ICT? (in relation to the Technological Pedagogical Content Knowledge framework)
- How can we embed ICT in a smooth/seamless way through blending technology-based and non-technology instruction?

In the end, the best practices identified from many similarly structured studies can advise teachers when they are planning curriculum-based, student-centered instruction.

What is the timeframe for the Grand Challenge Problem?

The solution to this GCP has to be worked on collaboratively across institutions and countries in close cooperation with teachers (secondary and higher education) in the next 10 years; it would benefit the national Ministries of Education in their efforts of implementing ICTs in educational practice across Europe.

What are measurable progress and success indicators?

The identification of existing best practices for implementing TEL in teaching is a first step towards solving this GCP. Even further, the deduction of curriculum-specific guidelines for integrating ICTs in teaching would offer valuable advice to teachers.

How can funding be attracted?

European research project funded under the European Commission. In order to ensure the close link between research and practice, the applying institutions should be required to commit to a working partnership with the national Ministry of Education.

DELPHI GCP 9: Interest-driven lifelong learning - Learning across the lifespan in networked learning ecologies



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What problems of the European education system are addressed, and what are the long term benefits for society?

In order to create a foundation for the learning societies of the 21st century, we need to rethink the way we support interest-driven lifelong learning. Moving responsibility for education beyond 'school-only' and creating technology-supported learning environments for lifelong learning empowers the individual learner to navigate and manage their own learning trajectories.

People learn in various settings, formal, non-formal and informal, often through digital means. How can we facilitate learning, collaboration and development of learning trajectories among learners in networked learning ecologies that integrate these various settings? The notion of networked learning ecologies aims to stress and understand the inter-connections and the knowledge flow between people and resources in differently tied networks (collaborative, cooperative, individual) of varying scale (group to mass-collaboration), with changing participants (teachers, peers, researchers, practitioners) and contexts (work-based, institutional, non-institutional). The emphasis of this GCP is on providing a fuller picture of learning trajectories and developing organic, continually changing technologies (networked learning ecologies) which support these complex trajectories.

What are the main activities to address this Grand Challenge Problem?

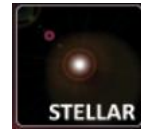
The development of these networked learning ecologies requires first a deep understanding of lifelong learning trajectories. This means a focus on how people or groups of people collect information, make sense of it and create knowledge among them, and how this becomes both collective and individual learning. One approach would be to examine learners at different stages of their expertise/lifespan and to investigate the following questions:

- What pathways/trajectories have these people taken to reach their professional practice and expertise?
- What skills and influences were enabling factors on their journey? What extraordinary talents or gifts stand out?
- Which institutions, learning settings, contexts (physical and digital) were involved and at which stages in their learning processes?

After having reached a better understanding of important aspects in the complexity of learning trajectories, the incorporation of these insights in the development of technologies should be underway. Overall, the networked learning ecologies should afford that:

- learners can individually or collectively (in collaboration with peers, teachers, institutions) monitor, follow, re-represent and document their learning in continually updated portfolios;
- learners can connect with each other and the wider world and form or join groups, communities or larger-scaled networks (streams/feeds/clouds) thus creating personal learning networks

In addition, this personal space of lifelong learning would require a) interoperability in data sharing between different educational organisations and b) data privacy and management regulations that would ensure correct sharing protocols with external applications.



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What is the timeframe for the Grand Challenge Problem?

The investigation of the questions posed above and especially the development of the according technology necessitates the cooperation of researchers (with expertise in data management, social computing, learning sciences), major software developers of learning platforms for schools/universities/workplaces (CISCO, Microsoft, Blackboard, etc.), major software companies of the most commonly used web applications (Google, Facebook, Microsoft MSN, etc., and representatives of the European Commission (data privacy, joint ID management, standardisation); therefore, the timeframe is at least 10 years.

What are measurable progress and success indicators?

Ultimately, this GCP would be solved, when every European citizen would have their own personal lifelong learning space. In the meantime, progress indicators would be the identification of pathways and milestones in individual learning trajectories and how these can be represented in networked learning ecologies. Another step towards the final goal is the development of interoperable technologies that better facilitate the exchange of information amongst people and institutions across a lifespan.

How can funding be attracted?

European research project funded under the European Commission. In order to ensure the cooperation between research, industry, and government agencies, the applying institutions should represent multidisciplinary experts and should be required to commit to a working partnership with companies and European representatives.

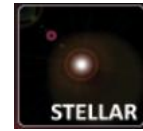
DELPHI GCP 10: Making use and sense of data for improving teaching and learning

What problems of the European education system are addressed, and what are the long term benefits for society?

This Grand Challenge Problem (GCP) highlights new opportunities for improving teaching that arise from the introduction of information and communication technologies (ICTs) in learning settings. Technology-enhanced learning gives us data that was not previously available. For example, in tutoring systems, it may be recorded how students moved through the learning environment down to the exact time when a hint was requested. The use of ICTs in learning settings creates a new channel of information for teachers and learners by generating data as a side product of learning activities. The massive amount of data (real time and outcome data) represents a challenge and opportunity at the same time: The main challenge for future teachers and learners is to make sense and intelligent use of the data provided by ICTs in order to facilitate learning. This GCP aims to incorporate the data that becomes available with the use of ICTs in the teaching and learning practices and to make this data part of the learning environment.

We propose to investigate the potential of real time data as well as summative/outcome data for deliberately informing teachers about their students' progress and success in learning and for providing feedback to students. This may for instance increase teacher's ability to adapt to individual students.

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What are the main activities to address this Grand Challenge Problem?

In order to provide teachers with intelligent technology that assists them in monitoring their students' learning progress, the following research questions have to be investigated:

- What real time data do teachers need for monitoring their students? And how can this data be collected and presented in an efficient and useful way?
- How can teachers adapt their teaching in order to improve their students learning after having received real time data?
- How can students themselves benefit from real time data collection? (Can students be challenged cognitively or be provided with feedback through representations of real time data?)

Another field of application for data usage is the summative assessment of student learning outcomes:

- How can we analyze students' usage data (i.e., stored by TEL tools such as learning management system) to identify conditions that impede or facilitate student achievement?

What is the timeframe for the Grand Challenge Problem?

Practitioners (teachers/educators on all levels of education) should work together with researchers (experts learning assessment, data mining, cognitive psychology, human-computer interaction/usability) and National Ministries of Education for capitalizing on the potential of data usage in formal education; therefore the timeframe is 10 years.

What are measurable progress and success indicators?

The first milestone in solving this GCP is to reach a better understanding of how real time and outcome data has to be collected and presented so that teachers can react more precisely towards their students' needs. The successful development and evaluation of technologies that support teachers in their efforts of monitoring their students learning progress and success is the second milestone that has to be reached.

How can funding be attracted?

European research project funded under the European Commission. In order to ensure the close link between research and practice, the applying institutions should be required to commit to a working partnership with the national Ministry of Education.