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Research Programme

Learning and teaching in technology-enhanced environments

Welten Institute
Research Centre for Learning, Teaching and Technology

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1 Background

Launched on January 1, 2014, Welten Institute, Research Centre for Learning, Teaching and Technology (WI) is the result of a merger between the Centre for Learning Sciences and Technologies (CELSTEC), the Scientific Institute for Teacher Research (LOOK) and the research activities of the Teacher University (Lerarenuniversiteit).

CELSTEC was the key player of what the Open University of the Netherlands (OUNL; Open Universiteit) refers to as profile research and had as mission that it "aims to improve learning and knowledge handling at work, school, home and on the move by combining state-of-the-art knowledge in the learning sciences with the innovative powers of new information and communication technologies" (CELSTEC Self-Evaluation Report 2006-2011). CELSTEC started its research activities under different names (OTIC, OTEC) in 1997 and underwent two research evaluation in 2006 and in 2013 and has been evaluated as one of the best performing and impact generating research institutes national and worldwide in both evaluations (see Self-Evaluation Report and CELSTEC Research Review 2006-2011).

LOOK was an expertise centre within the OUNL with a focus on teacher professional development through practice-based research on the professional development of teachers and evaluation of teacher-learning activities (Diepstraten & Martens, 2013). The LOOK expertise centre has built a strong and broad network of professional teachers and innovative schools in the Netherlands. The strong commitment of the school network and the believe in the approach chosen by LOOK is still visible in social media and the community support to online documentation of support letters.

Finally, the *Teacher University* was an expertise centre at the OUNL for professionalisation of teachers in elementary and secondary education, primarily through the development of training/educational trajectories.

Welten Institute carries out integrated research, development, and valorisation activities to generate theory-based and technology-enriched educational methods and innovations that are effective, efficient and enjoyable for both the learner and the educator. In close collaboration with educational partners (e.g., the OUNL, other higher education institutions as well as schools (K-12), teacher training centres, governmental and semi-governmental institutions, and so forth), Welten Institute is working to improve the quality of education, promote the professional development of teachers, and advance knowledge and expertise in the field of educational sciences and educational technology. Welten Institute's research scope is broader than simply the innovation in higher education. More generally, it concerns research on learning and teaching, coupled with learning in the profession and the knowledge society, for educational and learning arrangements, and learning technologies. Its research output comprises both scientific knowledge and practicable, validated methodological and technological solutions for educational practice, encompassing all education sectors and levels.

2 Grand challenges for educational research in context

Context

Education is in the process of a dramatic change on all levels. On the one hand there is a demand for flexibility in highly educated humans with well-developed 21st century skills and the ability to adapt and self-direct their own learning throughout their lifetime. On the other hand there has been and will continue to develop a dramatic impact of information and communication technology (ICT) which has changed and will continue to change the context of education and learning in society.

On an international level[1] a variety of reports have discussed Grand Challenges[2] for educational technologies and learning sciences (Borgman, 2008). The journal Science[3] produced a Special Issue[4] on Grand Challenges in Science Education in 2013 (Gan, & Norman, 2013) stressing the importance of professional and well networked teachers, new media and technologies, as also innovative, efficient and effective educational media and methods.

On a European level from 2009 to 2013 the Network of Excellence STELLAR has formulated a Grand Challenge Framework for Technology Enhanced Learning and Learning Sciences and listed a number of relevant challenges for the field. As a result of this process the main recommendations of this effort have been the importance of cooperation between stakeholders and researchers in education, as also the relevance of multi-disciplinary research approaches that lead to important innovations and open areas of tension.

At the Dutch national level, the reports *Naar een lerende economie* (Towards a learning economy) by the Dutch Scientific Council for Government Policy[5] (WRR, 2013) and the study concerning the future of Dutch Universities conducted by the Association of Universities in the Netherlands[6] (VSNU) and the Rathenau-instituut in its report *Vizier vooruit* (Looking forward; 2014) together with the agenda of the Ministry of Education, Culture and Science (OCW, 2014) reveal different issues important for education. As main recommendations the reports stress the importance of circulating knowledge and cultivating and fostering the capability of knowledge absorption in society, as also the systematic research on new personalised learning and working environments in social networks enabling social and context-specific innovation.

[1] http://www.ed.gov/technology

[2] http://www.ed.gov/technology/draft-netp-2010/grand-challenge-problems

[3] http://www.sciencemag.org

[4] www.sciencemag.org/special/education2013

[5] Wetenschappelijke Raad voor het Regeringsbeleid: http://www.wrr.nl/en/home/

[6] Koninklijke Nederlandse Akademie van Wetenschap: https://www.knaw.nl/en/homepage

Measuring change in a multi-disciplinary complex field

Specifically for the OUNL, the Performance Criteria[7] agreed upon with the ministry of Education, Culture and Science define the focus of attention. On the one hand this is the research quality as it is measured in the Netherlands. With respect to the Performance Criteria the OUNL stated: "The first ambition is further strengthening the relation between the Open Universities profile research, its innovation activities and its education. To this end, it is necessary to strengthen the connection between Open Universiteit research and Open Universiteit educational offerings, the further development of its new educational model and collaboration with other institutes for higher education in the area of complementarity of offering" (p. 37). Further, OUNL expressed therein the ambition "to maintain and, if possible, strengthen the international reputation of its profile research. That must result in maintaining the high citation impact scores of the former CELSTEC and her position in the international rankings. Income from second- and third-stream funding (in particular NWO and EU) need to increase. This is the case for both programmatic as personal support and funding (Talent Scheme[8] and ERC-grants)" (p. 41).

With respect to research quality, Welten Institute has a reputation to uphold in both the national and the international context. The Netherlands Initiative for Education Research (NRO[9]) has indicated that practice-based research must meet the scientific criteria relevant for all quality research. This means that the Welten Institute faces a twofold challenge involving standards and funding. At the national level, its research must meet the stringent standards of the Royal Netherlands Academy of Arts and Sciences (KNAW[10]), which monitors the quality of research in the Netherlands. The Academy is joined by the Netherlands Organisation for Scientific Research (NWO[11]) and the Association of Universities in the Netherlands (VSNU[12]) in this endeavour. Together these organisations have developed the Standard Evaluation Protocol (SEP[13]) to assess scientific research in the Netherlands which consists of both a self-evaluation and an external expert review or audit, including a site visit every six years and an internal midterm review between official assessments. The protocol's evaluation criteria include indicators as the number of academic promotions (PhDs) awarded, the quantity and quality of publications produced, and citation indices and h-indices (i.e., bibliographic data). In addition, significantly more importance is placed on valorisation and the societal impact of research.

The need for more valorisation activities is also acknowledged by the 14 Dutch universities. For the educational sciences a sector plan has also been produced (VSNU, in press), which addresses this increased need for valorisation. It builds on the findings of the National Taskforce for the Future of the Educational Sciences (Commissie Nationaal Plan Toekomst Onderwijswetenschappen, 2011) and the Education Council of the Netherlands (Onderwijsraad,

[7] http://www.vsnu.nl/files/documenten/Domeinen/Accountability/HLA/OpenUniversiteit.pdf

[8] Vernieuwingsimpuls

[9] Nationaal Regieorgaan Onderwijsonderzoek: http://www.nwo.nl/en/about-nwo/organisation/nwo-divisions/nro

[10] Koninklijke Nederlandse Akademie van Wetenschap: https://www.knaw.nl/en/homepage

[11] Nederlandse Organisatie voor Wetenschappelijk Onderzoek: http://www.nwo.nl/en

[12] Vereniging van Samenwerkend Nederlandse Universiteiten: http://www.vsnu.nl/index.html

[13] https://www.knaw.nl/en/news/publications/standard-evaluation-protocol-sep-2009-2015?set_language=en

2011) also recognising the gap between educational practice and educational science. It has been agreed that educational research should strengthen its collaboration with educational practice and research institutes should invest in long-term structural collaboration with schools.

To conduct its research, Welten Institute relies in part on second- and third-stream funding. The second-stream funding is primarily financed by the NWO/NRO, the European Union (EU) and other such bodies while third-stream is primarily financed by government bodies (e.g., local, provincial, national), commercial entities, foundations and other such bodies. Welten Institute's scientific reputation is vital to the acquisition of these funds because it is one of the factors affecting the awarding of grants. At both national and international level (European and the world stage), this means actively pursuing publication in high-impact scientific journals and participating in leading conferences. This also applies to acquiring grants in the EU and participation in European knowledge networks (i.e. Networks of Expertise) and working groups. Finally, this implies also the acquisition of second- and third-stream funding based on systemic co-creation and collaboration with schools or other educational institutes.

Challenges

In nearly all recent studies, current educational systems and educational spaces are not seen as being as efficient and/or effective as they could be and as far from being enjoyable and fostering meaningful learning that leads to inspired and curious individuals. In that sense Welten Institute aims at an overarching challenge of designing and co-creating the educational spaces of the 21st century that enable context-specific innovation based on high impact research outcomes.

The overall Grand Challenge has to be seen in different context in which Welten Institute operates and in which it carries out its research on the level of the OUNL and its operation, the level of the Dutch education system, as also in a European and worldwide context.

At the level of the OUNL new forms of distance education spaces are the main challenge for Welten Institute. The OUNL began an initiative in 2013 to completely redesign its educational model and its vision for distance and part-time education (i.e., the New Educational Model[14]). In this context Welten Institute faces challenges on all levels. Examples are: student motivation, progress and drop-out; insufficient knowledge and facilities for self-monitoring, remote assessment and self-regulation in distributed distance education; conflicts between sustainable and cost effective mass-distribution and personalised learning support; tensions of scaling up education while still maintaining high quality learning outcomes; and the necessity of learning support in hybrid working and learning environments.

On the national level, the overall role of the traditional university in higher education and society is under discussion (WRR, 2013). Welten Institute, building on 30 years of OUNL expertise in the field of open higher distance education, plays a key role in the definition of new learning spaces for higher education. The main challenges at the national level are: transforming traditional higher education into new forms that seamlessly blend pedagogies and educational technologies; rapidly changing societal and dynamic professional environments

[14] http://tinyurl.com/l2u6jtv

where we need to train people today for jobs/professions that do not yet exist; professional development of education professionals to function in this unsure world; and the efficient alignment of stakeholder contexts, applied research and basic research fields. A unique challenge of Welten Institute in the Dutch context is the research towards a resilient, future-proof professional development system for teachers and educators.

On an international level, Welten Institute is confronted with global challenges for education such as: designing and validating personalised learning experiences; designing valid, reliable, and cost effective assessment methods; capturing, aggregating, mining and creating learning content, real-time tracking data and multi-purpose usage of resources; and developing effective, efficient, and enjoyable principles of learning and instructional designs (DoE, 2010[15]).

The Welten Institute research programme will meet the grand challenges by carrying out integrated research, development, and valorisation activities, by generating theory-based and technology-enriched learning environments and innovations that are effective, efficient and enjoyable for both the learner and the educator. This will be done in close collaboration with educational partners (at all levels as well as inside and outside the OUNL), teacher training centres, governmental and semi-governmental institutions. Welten Institute is dedicated to improving the quality of education, promoting the professional development of teachers, and advancing knowledge and expertise in the field of educational sciences and educational technology. The research focuses on learning and teaching, coupled with learning in the profession and the knowledge society, for educational and learning arrangements, and learning technologies. Its research output comprises both scientific knowledge and practicable, validated methodological and technological solutions for educational practice, encompassing all education sectors and levels.

This programme will help to realise the Mission of Welten Institute, which is formulated as follows:

> *Welten Institute integrates perspectives in carrying out scientific research of complex, practice-relevant issues in the ecology of education. Its research delivers ecologically valid and high-quality results through an integrated approach to issues that draw upon theories of learning and cognition, technology, new media, networking, and educators' practices and behaviour. The objective of this research is the improvement of the quality of education and the professionalisation of educators. To this end, Welten Institute contributes to the design and development of tools for learners and educators, as well as the growth of knowledge and expertise in the educational sciences and educational technology.*

In realising the mission and co-creating the educational spaces of the 21st century, Welten Institute chooses the ecology of education as the defined object for and of research. In the following we will first define the ecology of education and the relevant entities.

[15] http://www.ed.gov/technology/draft-netp-2010/grand-challenge-problems

3 The Ecology of Education

Education and educational processes are determined by the interactions that take place between learners (i.e., their cognition, motivation and the social interactions between them), educators (i.e., teachers, tutors, mentors and their professional development) and the use of technologies and media (i.e., tools that support both learners and instructors). This is what Welten Institute calls the ecology of education (Figure 1). As in all ecosystems, education is both a system and systemic in nature. As a system, education is a complex whole made up of a set of elements that work together as parts of an interconnecting network.

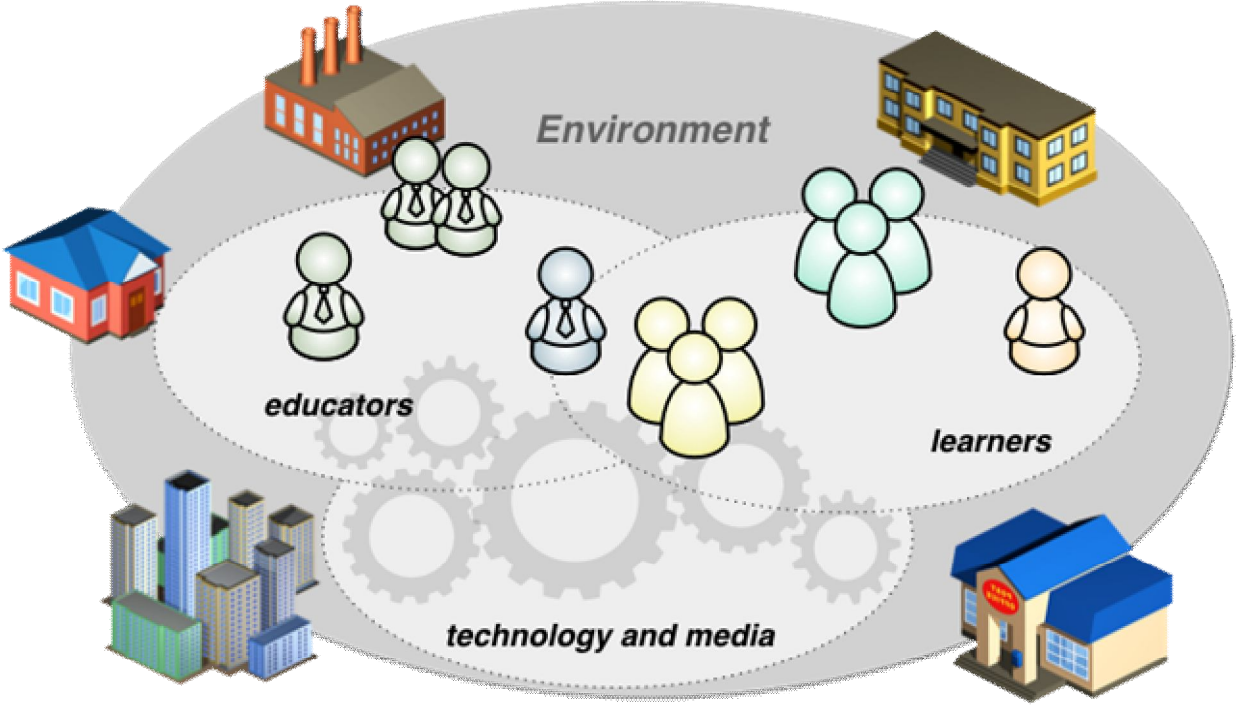

Figure 1. The ecology of education and its main components

Though bounded and separate from its environment, the educational system which is made up of educators, learners and technologies/media, is nevertheless surrounded and influenced by that environment (e.g., government policy, political parties, commercial companies, controlling organs such as the educational inspectorate, teacher trade unions and student groups, national and international laws and treaties, the economy, etcetera) which influences its structure, purpose and functioning. As systemic, any change or changes made in any part of the system will affect not only that part, but rather all the rest of the system. As such, education is an integrated system, which requires an integrated systemic approach to research on and in it.

Educators. Numerous studies have demonstrated that the quality of the education depends greatly on the quality of the teacher (Diepstraten & Martens, 2013, McKinsey & Company, 2007,

Hattie, 2013). Teachers are vital, not only to the quality of education; they are also responsible for the success or failure of educational innovation in the classroom. In the (near) future a development is foreseen in which this vital role of teacher transforms into a role of educator. Teachers become more and more the ones who arrange education. With the emergence of seamless education it is more likely other roles will be employed in education, for instance that of coach, performed by parents or subject matter specialists.

Learners. We choose the word 'learner' so as not to differentiate with respect to age (e.g., child, adolescent, adult, senior) or educational level (e.g., preschool, elementary, secondary, tertiary, post-tertiary, lifelong) and whether the learning takes place in a formal, non-formal or informal setting (Van Merriënboer, Kirschner, Paas, Sloep, & Caniëls, 2009). Seeing the Performance Agreements as delineated in the Institutional Plan 2012-2016 - Learning in changing times[16] (Instellingsplan 2012-2016 – Leren in tijden van verandering) that the OUNL has made with the Ministry of Education, Culture and Science, the primary focus will be on learners in higher education in general and specifically those learners at the OUNL. This however is not restrictive, seeing Welten Institute's role in Dutch education and society as well as at the European and international level. As all learners enter into a learning situation with 'baggage', the following elements are taken into account: learner knowledge and skills, learner attitudes and dispositions (e.g., motivation, determination), learner meta-cognitive knowledge and skills (e.g., self-regulation), and the biological/environmental factors that can affect the learner and learning.

Technology and media. In recent years, the term 'learning environments' has been used in multiple facets and increasingly stands for a blend of digital tools, virtual environments and physical spaces. Recent research stresses the linking of the design of physical spaces, the special affordances of specific environments and objects in a physical environment and the services and digital information to be used for learning and problem solving within these environments. Research is also stressing the seamless and ambient integration of technologies in physical environments in the sense of Weiser's notion of ubiquitous computing (Weiser, 1991).

Research questions in that sense have to be seen embedded in a complex system in which different perspectives and subsystems work together. However, the programme defines three research groups in line with the three main components of the ecology of education:

- *Fostering Effective, Efficient and Enjoyable Learning (FEEEL)*: The cognitive, affective and social learning mechanisms in interaction with the learning environment (i.e., learning materials, teachers/instructors, tools for guidance and support) which guide and influence pedagogy, learning/teaching behaviour, and the strategies employed for effective, efficient and enjoyable learning.

[16] http://www.ou.nl/documents/14956/887099/Instellingsplan+Open+Universiteit+2012-2016.pdf

- *Technology Enhanced Learning Innovations for teaching and learning (TELI)*: The innovations in technologies in general and educational technologies in particular which influence and lead to changes in the practice of teaching/instruction and learning.
- *Teaching and Teacher Professionalisation (T2)*: The equipping of the student, teacher and educational organisation to deal with changing cognitive, motivational, and physical changes specifically relating to changes in the interactions amongst them (e.g., networks of learners, teacher networks, teacher professionalisation).

The three research groups also have a different focus in methodology and are complementary according to methodological approaches and produced research outcomes. We first elaborate on the three programme lines and then go into the methodology.

4 Programme Lines and Research Groups

4.1 Fostering Effective, Efficient and Enjoyable Learning (FEEEL)

Focus and aim

Fostering Effective, Efficient and Enjoyable Learning (FEEEL) focuses on the cognitive, affective and social characteristics of learners and their interaction with learning environments (i.e., learning materials, other learners, teachers/instructors/tutors, tools for supporting and guiding learning, the physical environment inside and outside of the school, et cetera) which guide and influence pedagogy, learning behaviours, and the strategies employed for learning. It aims at understanding and developing theories of how to optimise the processes of formal and informal learning to make that learning more effective, efficient, and enjoyable for the learner. The research is embedded in the breadth of the learning sciences and its theories (i.e., cognitive, educational and neuropsychology; educational sciences; computer sciences and artificial intelligence; instructional design), carrying out research to describe, explain and predict learning so as to design and develop pedagogical tools and techniques for learners, teachers and technology designers.

The premise underlying FEEEL is that to design, develop and implement innovative teaching and learning in technology-enriched educational environments we, as educators, instructional designers and technology developers, must understand how learners learn and how this learning can be facilitated, positively influenced and fostered (and possibly how undesired or undesirable learning can be discouraged or impeded).

To this end, the results of research in this area of interest (i.e., practical and implementable theories, principles, guidelines, methods, models, instruments and technologies) will facilitate individual learners and groups of learners - ranging from peers to collaborative teams to whole classes to MOOCs - to (1) acquire domain-specific knowledge, skills and attitudes, (2) acquire higher-order metacognitive knowledge and skills, (3) plan, regulate and maintain their own further, self-directed learning and (4) achieve transfer of acquired knowledge and those skills to a variety of learning and working settings.

As research in FEEEL focuses on the cognitive, affective and social characteristics of learners and their interaction with their learning environments which guide and influence pedagogy, learning behaviour, and the strategies employed for effective, efficient and enjoyable learning, FEEEL has two leading questions, namely:

- Uncovering cognitive, social and affective processes along with their behavioural and psychological determinants for acquiring domain-specific skills, knowledge and attitudes and/or higher-order skills for thinking, learning and life.
- Designing and developing effective, efficient and enjoyable technology enriched learning environments for acquiring and assessing domain-specific skills, knowledge and attitudes and/or higher-order skills for thinking, learning and life.

To achieve this research will be conducted in four research themes.

Theme 1: Adaptive and dynamic learning environments

Problem statement

Most learning environments as we know them are static in nature. This means that they are primarily designed and developed to meet the needs of the 'average' student with minimal possibilities to adapt/be adapted to the specific needs, qualifications and desires. This makes typical learning materials to be less effective, efficient and enjoyable than they can be. The question, though, is how to properly design develop and implement dynamic and adaptive learning materials and environments for learning and thus is a major challenge for the research group to understand and develop those theories and principle that can allow the environment to dynamically adapt itself to the individual student.

Theoretical contribution

At the heart of this theme are three major theories of research and design, namely theories relating to how human cognitive architecture works, theories relating to how humans learn and specifically how they learn in multimedia environments, and theories of how learners organise and guide their own learning and how environments that facilitate and encourage this can be designed and developed.

At a basic information processing level, psychological theories describe memory systems and cognitive processes that explain how people process different types of information and how they learn with different senses: Paivio's dual coding theory (1986; Clark & Paivio, 1991), Baddeley's working memory model (1992; 1997), and Cowan's model of attention and memory (1998). Basic here is that our working memory is limited and thus that learning materials should minimally tax this working memory allowing for increased capacity for effective and deep information processing.

This leads, at the instructional message design level, to the identification of principles and guidelines for designing and developing instructional messages. At the heart of this are Mayer's *cognitive theory of multimedia learning* (2009) and Sweller's *cognitive load theory* (Sweller, Ayres, & Kalyuga, 2011; Van Merriënboer & Sweller, 2005).

But it is not only the teacher/instructional designer who plays a role in effective, efficient and enjoyable learning, but also the learners. This means that meta-cognitive factors as *self-directed learning* (SDL), *self-regulated learning* (SRL) and *self-determination theory* need to be studied. Self-directed learning is "a process in which individuals take initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes" (Knowles, 1975, p.18). A key aspect of SDL is that learners plan and execute their learning trajectories in the long term (Kicken, Brand-Gruwel, Van Merriënboer, & Slot, 2009). Self-regulated learning concerns processes within the execution of a specific learning task. While SDL includes SRL, the opposite is not the case (Jossberger, et al., 2010; Loyens, Magda, & Rikers, 2008). Self-directed learners can self-regulate their learning, but self-regulated learners cannot necessarily self-direct their learning. In the SRL literature, there is a variety of perspectives on how cognitive, metacognitive, motivational and contextual factors influence the learning process (e.g., Boekaerts, 1997; Pintrich, 2003; Zimmerman, 1989,

2002). Self-determination theory (SDT; Deci & Ryan, 2002) is a *theory of motivation* for supporting a learner's innate psychological needs and behaviours. In SDT, autonomy, competence, and relatedness are seen as the three innate needs that, if satisfied, allow optimal function and growth; including enhanced performance, persistence, and creativity.

At the course and curriculum design level, prescriptions are given for how to develop educational programmes containing a mix of educational media including texts, images, speech, manipulative materials and networked systems: *Four Component Instructional Design model* (4C/ID; Van Merriënboer, 1997) and the *Ten Steps to Complex Learning* (Van Merriënboer & Kirschner, 2013). 4C/ID is an instructional design model for designing and developing learning and/or training programmes for the development of competencies or complex skills. Its basic assumption is that blueprints for complex learning can always be described by four basic components, namely: authentic, whole learning tasks, supportive information, procedural information, and part-task practice. The 10 Steps provides a systematic approach to designing educational programmes based on the four components.

Finally, gaming is a challenging, *immersive and dynamic learning environment* that mimics real world complexity and/or creates absorbing non-existing realities. *Games* combine realistic challenges with rich media resources offering learners a safe, motivating and challenging space to explore, experiment and practice (Westera, 2008). They address a wide range of cognitive, sensorial and emotional responses, supporting experience-based learning, situated cognition, and adaptive personalised learning. While their development is a challenge in its own right, the main challenge is how to design and use them for effective, efficient and enjoyable learning. This calls for research linking evidence on learning outcomes with game design issues including tracking of user performance data for the assessment of learning progress. This theme is linked to the programme line TELI and cooperation with projects is this line will be established.

Leading research questions

The leading questions in this theme are:

- What cognitive factors are most important for designing, developing and implementing adaptive, flexible learning in the educational system (both the traditional classroom and learning-enhanced environments)? Why are they important and how do they affect learning?
- What meta-cognitive factors are most important for designing, developing and implementing adaptive, flexible learning in the educational system (both the traditional classroom and learning-enhanced environments)? Why are they important and how do they affect learning?
- How are the cognitive and meta-cognitive factors related and how do they affect and influence each other?
- How can we best design (technologically enhanced) learning environments that are adaptive and dynamic (including games)?

Theme 2: Learning in an information-rich environment

Problem statement

This theme deals with research on the processes that take place when students have to learn in environments in which a huge amount of information is available (e.g., the Internet). Students have to deal with this information and should be able to construct knowledge (e.g., they should be information literate) and it is a challenge in education to design learning environments to foster this 21st century skill (Brand-Gruwel & Stadtler, 2011). Because, not only from literature (Bråten, Strømsø, and Salmerón, 2011; Britt & Aglinskas, 2002; Gerjets, Kammerer, & Werner, 2011; Kobayashi, 2009; Van Strien, Brand-Gruwel, & Boshuizen, 2014; Walraven, Brand-Gruwel, & Boshuizen, 2008) but also from practice (Onderwijsraad, 2011) we know that young children, teenagers, and adults do for instance not always know which search terms to use when searching the WWW for information, that their judgement of knowledge claim is often poor and not done spontaneously (e.g., Kammerer & Gerjets, 2012), and their justification process is under influence of peoples' attitude (e.g., Van Strien, Brand-Gruwel, & Boshuizen, 2014).

Taking this into account, it can be concluded that students must develop their information literacy skills and must learn transferable strategies. Moreover, educators must be facilitated to design learning environments to support student's information literacy.

Theoretical contribution

Research in this theme will contribute to the theories on *information literacy*. In the last decennia from an educational perspective research focused on how students deal with Internet information and how students evaluate sources and justify knowledge claims especially when confronted with sources with conflicting information (Kammerer & Gerjets, 2012, Kienhues, Stadtler, & Bromme, 2011; Rouet, 2006). Research shows that epistemic beliefs (Bråten, I., Britt, M. A., Strømsø, H. I., & Rouet, 2011), attitudes (Van Strien, Brand-Gruwel, & Boshuizen, 2014)) and prior knowledge (Bråten, Strømsø,, & Salmerón (2011) are influencing factors when students judge and select information for learning purpose. Future research should focus on how these factors interact when students search for and select information and how these interactions differ when carrying out different kind of learning assignments. In this research a focus on higher education and the academic search process will have an added value on the theory.

Furthermore, in the past not so many research is conducted focussing on instructional design to foster information literacy (Walraven, Brand-Gruwel, & Boshuizen 2008). Research in instructional measures should adopt the principles of the most recent instructional design models (Van Merriënboer & Kirschner (2013). Promoting and stimulating information literacy means fostering the use of higher-order skills. In contrast to lower-order skills which focus primarily on knowledge, comprehension and/or application, higher-order skills refer to strategic knowledge and skills related to how to think well, such as widely applicable strategies for problem-solving and meta-cognitive activities (Perkins & Salomon, 1989). Information literacy, as a 21st century skill, can be characterised as a higher-order skill and transfer of this skills should be stimulated. Research should focus on tools and guidelines and the design of learning environments to foster information literacy and especially the design of instruction of

students in higher education focussing on the academic search process and the justification of knowledge claims.

Leading research questions

The research questions that are characteristic for this research theme are :

- Which strategies and processes do students employ when learning from multiple hypertext documents?
- How do students judge the trustworthiness of information and sources, and how do they integrate information from different sources to construct knowledge?
- What is the role of prior knowledge, epistemic beliefs and attitude when carrying out information literacy skills?
- How can instruction best be designed and how can students be supported in acquiring information literacy skills?

Theme 3: Learner characteristics - Biological and psychological determinants of learning

Problem statement

While learning materials play a major role in FEEEL, it is the learner who learns. Ernst Rothkopf (1970) once famously stated "You can lead a horse to water, but the only water that reaches his [*sic*] stomach is what he drinks". What the learner metaphorically drinks is for a large part determined by the biological and psychological state and traits of the learner. Unfortunately, little is known (and what is known is primarily related to young children) about how these biological and psychological factors help determine what and how a person learns, how they are related to each other and interact and how they can be affected to facilitate learning.

Theoretical contribution

Biological factors that influence cognitive functioning and learning include nutrition, sleep, and exercise. However, most evidence for the effects of nutrients on cognitive functioning (e.g., De Groot, Adam, Jolles, Houwelingen van, & Hornstra, 2001; De Groot, Vuurman, Hornstra, & Jolles, 2006) has come from research on diseased or malnourished individuals (Kretchmer, Beard, & Carlson, 1996; De Groot, Stein, Jolles, Van Boxtel, Blauw, Van der Bor, & Lumey, 2011), which cannot automatically be extrapolated to a healthy population in a learning environment. The same is true for sleep which has dealt with chronic sleep restriction finding a negative impact on mood, vigilance and reaction time, attention, memory, and behavioural control and motivation which, in turn, are associated with significant declines in learning performance (e.g., Curcio, Ferrara, & De Gennaro, 2006). In contrast, research on physical activity has found that it improves, among other things, circulation and increases blood flow to the brain, influencing cognitive functioning and resulting learning abilities (Taras, 2005).

The *psychological factors* are divided into cognitive factors, motivational/affective factors, and social factors. *Cognitive factors* relate to factors that influence perception, learning and reasoning; in other words, the mental process of knowing and understanding. Examples are awareness, perception, reasoning, and judgment. Optimal cognitive abilities are a prerequisite for optimal

learning capacities. This is especially true for executive functions, which represent higher-order cognitive functions such as planning, inhibition, organisation, speed of information processing, and flexibility do play an important role. With respect to cognitive functioning it is known that all cognitive functions decrease with age (Schaie, 1994). However, each function starts to decline at a different moment with large individual differences.

Motivational/Affective factors are emotional factors that influence learning. They describe a person's own ambivalent attitudes towards learning and training. How affect influences school performance can be divided into general affect and academic affect. Examples are:

- Anxiety and specifically test anxiety which is negatively related with academic achievement (Hembree, 1988),
- Goal orientation, that is the motivational approaches persons use to reach goals, namely learning orientation (i.e., mastery orientation) and performance orientation (i.e., grade orientation).
- Implicit beliefs (e.g., agency) about one's academic potential and one's perception of what leads to school performance outcomes affect study and learning behaviour.
- Intent to persist (Carroll, 1963) or perseverance is the time and effort that the learner is willing to spend in learning.
- Self-efficacy refers to a student's belief that she/he can successfully engage in and complete course-specific academic tasks such as achieving course outcomes, demonstrating competency skills used in or needed for the course, satisfactorily completing assignments, passing the course, and meeting the requirements to continue.
- Self-esteem reflects a person's overall evaluation or appraisal of her/his own worth.
- Stress which has a U-shaped association with learning performance and coping strategies to handle stressful situations.

Social factors, finally, is important at the meso-level (class, school, community). It refers to the interaction between the learner and her/his colleague learners and other potential relevant peers, her/his collaboration network or teacher/tutor. It "refers to characteristics of the psychosocial environment of educational settings. Interpersonal relationships, student–teacher relationship, peer relationships, teachers' beliefs and behaviours, teachers' communication style, classroom management and group processes are themes that can be considered to be included in the concept of the social climate of learning environments. Other concepts relevant for the study of social climate in learning environments are self-efficacy, self-concept, trust, goal structures and values, cooperation and competition, participation and exclusion, hierarchy and democracy" (Allodi, 2010, p. 89-90).

Leading research questions

The leading questions in this theme are:

- What biological and psychological factors are relevant for effective and efficient learning (i.e., which factors are true determinants of learning)?
- What are the relations between those determinants?
- Are the determinants age and/or gender related?

- How can we best positively influence those determinants to improve learning and study success?

Theme 4: Assessment for Learning (AfL)

Problem statement

Assessment in education has traditionally been limited to testing (i.e., summative assessment). For effective, efficient and enjoyable learning, it is necessary to research, design, test and implement other methods of *assessment for learning* (AfL: also known as formative assessment). In addition, as an increasing number of educational institutions are making a move from paper-based assessment to computer-based assessment, primarily by either mapping the paper-based forms to the computer screen or by applying cognitive and design theories underlying learning and learning materials to the assessment situation. What we actually need to understand - as we have for learning - how to design and implement valid and reliable computer-based (multimedia) assessment for formative and summative purposes.

Theoretical contribution

AfL is, theoretically, strongly related to social interaction in an educational relationship between student and teacher or students themselves (Bennett, 2011) as well as to self-regulated learning (Black & Wiliam, 2009; Clark, 2012; Nicol & Macfarlane-Dick, 2006; Sadler, 1998). Clark (2012) goes so far as to describe AfL as a function/promotor of self-regulated learning. The research here focuses on effective methods, like rubrics or self and peer assessment and the way AfL and assessment of learning (AoL) should be balanced to increase effective learning (see for example Sluijsmans, Joosten-ten Brinke, & Van der Vleuten, 2013). This also includes different forms of feedback to stimulate learning (Hattie & Timperley, 2007).

With the increased use of technology in education, *computer-based assessment* (CBA) – both formative and summative - is also increasing, allowing the use of multimedia (e.g., videos, animations, etc.) and the implementation of adaptive assessment (i.e., tailored to specific needs and level of the person assessed). Technically there are no restrictions to the use of multimedia in CBA, but from an educational perspective there are still many open questions on how to optimally design such assessments. Unfortunately, there are no guidelines or theories on how to design computer-based multimedia assessments (CBMAs). Preliminary research has shown that learning and assessment differ to such an extent that the guidelines for designing multimedia learning (Mayer, 2005; Van Merriënboer & Kirschner, 2013) cannot simply be applied to assessment (Jarodzka, Janssen, Kirschner, & Erkens, 2014a; Jarodzka & Kirschner, 2014) as the goals of the two differ significantly. For example, if the aim of an assessment is to see if a learner can filter relevant information out of much irrelevant information by him- or herself, then the extraneous load has to be large and reflect this challenging real life scenario. Well-ordered information would be too simple and thus hamper assessment. As this is a very new field, empirical research is needed to develop design guidelines for multimedia assessment and build a Cognitive Theory of Multimedia Assessment (Jarodzka, Kirschner, Brünken, Park, & Malone, in prep.).

In collaboration with the TELI focus and related to FEEEL Theme 1 (Adaptivity), we are looking at how to make use of learner data (e.g., correctness of response, time of response, cognitive load, future success, etc.) to make AfL more differentiated and personalised (Taminiau, Kester, Corbalan, Kirschner, & Van Merriënboer, 2014).

Leading research questions

The leading questions in this theme are:

- How can assessment optimally foster learning (i.e., which factors are true determinants of learning)?
- How and when should different forms of AfL be implemented in the learning process?
- What are the elements of a cognitive theory of multimedia assessment?
- How can we best implement computer-based multimedia assessment in the learning situation?

4.2 Technology Enhanced Learning Innovations for teaching and learning (TELI)

Focus and aim

The research programme on Technology Enhanced Learning Innovations for teaching and learning (TELI) addresses a rich blend of research fields, focusing on technology related aspects of learning design and open practice. It seeks to combine research and expertise that has a strong technology agenda with a deep understanding of social learning practices and cognitive learning processes. In order to advance both perspectives, research in the TELI-group is by its nature multidisciplinary and collaborative.

The TELI research group produces research results in the domain of Technology Enhanced Learning and related research fields. The technologies considered include tangible and ambient technologies, open data management and analytics, mobile and ubiquitous technologies, social media and social networks. Building on innovations in these technologies the research group focuses on questions concerning enabling humans for learning and teaching in personal and social contexts. The research results lead to qualitative new learning experiences through different forms of human-computer interaction, the seamless integration of technologies in learning processes and educational contexts, and the enhanced networked learning by merging of digital and social networks in mixed realities. All research of TELI is framed in the context of social innovation processes based on open practices and open innovation, its diffusion and sustainable integration in open practices. Therefore leading questions in the research process are:

- How can educational innovations be embedded in the primary processes and link learning, living, and working?
- How can sustainable educational innovation systems be built and made resilient?
- What is the added value of an innovation for which target group considering efficiency, effectiveness, and enjoyability of learning and teaching?

The research group works on different levels of Technology Enhanced Learning, on the micro-level it explores and researches new learning experiences in the direct integration of media and

computer-based learning support in the direct interaction, on the meso-level it researches seamless learning design of instructional media and on the macro-level it looks at mediated learning networks and their characteristics for best supporting learning. Underpinning these developments is the shared usage of linked and open data and computational models to aggregate, visualise, and provide learning analytics for educational stakeholders.

Theme 1: New Learning Experiences (NLX)

Problem Statement

New technologies continue to emerge in an ever-increasing pace. While none or at best few of these technologies are directly aimed at education or learning they do have a strong impact on society and **therewith** on education. In the sense of Marc Weiser's vision of *ubiquitous computing* today we already live in a world of augmented physical objects in which daily activities are tracked and used for personalisation and contextual interaction (Weiser, 1999).

While the upcoming of new technologies is often associated with great enthusiasm and potential there is only little empirical evidence on the effects of ubiquitous and ambient learning support and the role of new forms of interaction on the processes of learning and knowledge building. New forms of multimodal, embodied, tangible interaction, augmented human-object interaction and situated displays researched within this theme aim to have an impact on motivation, meta-cognitive skills and self-efficacy in learning. In that sense this theme looks at the micro-loop of human-computer interaction and researches the effects of different forms of interaction and their design parameters as also their effects on primary and secondary variables important for learning and teaching.

Background and theoretical models

The educational background of this research comes from research on *feedback* (Hattie & Timperley, 2007; Mory, 2004), *awareness* and *situation-awareness* (Endsley, 2000), *self-efficacy* and *self-directed learning* (Butler & Winne, 1995) and instructional design of *immersive* and *augmented media* (Van Merrienboer & Kirschner, 2007, Specht, Ternier, & Greller, 2011).

According to the work of Hattie & Timperley (2007) effective feedback is one of the most powerful influences in learning. Awareness is one of the key concepts of informal learning support (Syvanen, Beale, Sharples, Ahonen, & Lonsdale, 2005) that can be used as an instrument to acquire information relevant (e.g., about tasks, concepts, or the workspace) for the learner within the ubiquitous learning environment (Ogata, 2009). The instructional perspective for learning experiences considers the concept of situational awareness (Endsley, 2000). Endsley defines situational awareness as "the perception of elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future". Context-aware computing builds on this paradigm and uses the "context of use" (Oppermann & Specht, 2000) to help users in filtering information, sequencing activities, and support interaction in context. Computer Science background of this theme comes from Human-Computer-Interaction (Norman, 2002, Heer, Shneiderman & Park, 2012), adaptive educational systems (Brusilovsky, 1996), context-aware computing (Zimmermann, Specht, & Lorenz, 2005), multi-modal interfaces, sensor-based interaction, and ambient displays

for learning (Börner, Kalz & Specht, 2013). Likewise language technologies are accepted as technology to enhance interaction or to analyse text, its role in education ought to be investigated.

Embodied and augmented interaction in mixed reality

Physical and virtual objects are increasingly being enriched with content and functionalities, thus becoming service interfaces for digital media (Sterling, 2005). Towards an *Internet of Things* (Dodson, 2003) states that these links are used to integrate physical and virtual objects into existing networks of people or even create networks of things by giving the objects an identity. Carrying this idea further leads to the fusion of physical objects with digital information. This notion of blending the real and digital world is connected to the concept of mixed reality, where physical and digital objects co-exist, interact and enhance each other. In a world where information is widely distributed and highly contextualised, ambient systems incorporating the mixed reality concept can be used to enable the access to digital content that is available in a real world context, building on the links between people, objects, and data.

Towards multi-modal and embedded learning experiences

The constant change of interaction modalities is closely connected to the ongoing technical development and the related computational models. An interaction approach that goes beyond conventional graphical user interfaces for personal computing is the use of ambient media in the periphery of the user. Associated with a more tangible and social interaction, corresponding systems make use "of the entire physical environment as an interface to digital information. Instead of various information sources competing against each other for a relatively small amount of real estate on the screen, information is moved off the screen into the physical environment" (Dourish, 2001; Wisneski et al. 1998).

Seen another way, this more *embodied interaction* and the rather situated than individualised design approach triggered by embedding information technology into the physical world extends the digital world beyond the desktop, thus becoming an "ambient social infrastructure" (McCullough, 2005). This goes hand in hand with the call for engaging user experiences, "where technology is designed to enable people to do what they want, need or never even considered before by acting in and upon the environment" (Rogers, 2006).

Leading research questions

- How can we design embedded feedback loops for human learning in ubiquitous learning environments?
- How can real-time sensor feedback be used in learning support?
- How can application scenarios and showcases be developed to involve and activate teachers to trial and adopt new technologies in the "classroom" (classroom being their students not necessarily in a physical classroom)?
- How can technology or data created by technology be used to support the validation of technology enhanced learning in general and new technologies in particular?

Theme 2: Seamless Learning Design (SLD)

Problem Statement

In 2014, there will be more mobile communication devices on earth than humans! The personal devices and technologies used in educational settings range from smartphones, over tablets in all sizes, to digital whiteboards. Additionally, increasingly specialised devices and cloud-based services play a role in content management and ubiquitous learning support. Researchers have explored pervasive learning opportunities to take into account any technology surrounding the users in their environment extending the strong focus on mobile phones with ambient displays or artefacts from the Internet of Things. This requires the orchestration (Dillenbourg, 2013) of different digital services and learning support in multi-device scenarios. Exemplary scenarios in this context are connections between formal and non-formal learning, the use of personal learning environments or inquiry-based learning.

One of the most important challenges for educational research is the design and evaluation of learning opportunities that are relevant and that connect to real-world problem-solving situations. A large part of formal education today is not adhering to these basic requirements and learning in these environments often leads to inert knowledge (Whitehead, 1967) and the transfer of learning from one context to the other is often not supported (Barnett & Ceci, 2002). Several educational theories and methods focus on addressing this problem.

Background and theoretical models

The research in this topic is based on educational theories like *situated learning* (Brown, Collins & Duguid, 1989; Lave & Wenger, 1991), *anchored instruction* (Bransford, Sherwood, Hasselbring, Kinzer & Williams, 1990) and *seamless learning* (Wong & Looi, 2011). *Situated learning* is a knowledge acquisition theory that Lave & Wenger have proposed to describe the learning processes of adults. The main question for effective learning experiences based on this theory are related to the social and cultural context suited to learn a specific skill or become a professional in a field. Herrington & Oliver (2000) transfer this into design recommendations for situated learning scenarios. According to the authors, learning environments should be based on authentic contexts, should confront learners with authentic tasks and offer multiple roles and perspectives. The *anchored instruction* theory (Bransford et al., 1990) is a dynamic approach whose effectiveness has been confirmed in several meta-reviews. Anchors are problems that require the learner to deal with active acquisition of knowledge and information to seek for strategies to solve the problem or propose possible ways to address them. It is especially relevant for the design and development of location-based learning scenarios. These educational theories are extended by recent visionary approaches like the *seamless learning* paradigm (Wong & Looi, 2011). Seamless learning is focusing on offering solutions to address the several seams that exist between different learning contexts and learning experiences.

Leading research questions

- Mobile Content: How can we design, evaluate and implement new types of mobile content (eBooks, mobile access to MOOCs, mobile video formats) that increase motivation and learning gain for lifelong learners?

- Contextualised Learning: How can we adapt learning processes on different context parameters to reach more effective learning scenarios?
- Seamless Learning Support: How can we connect different learning situations and contexts in which educators and learners are active? Which feedback and support services are effective to increase retention, achievement of learning goals and sense of agency and self-efficacy?
- Augmented Learning: How can we develop cost-effective augmented learning scenarios that decrease inert knowledge and increase transfer of learning?

Theme 3: Mediated Networked Learning (MNL)

Problem Statement

Networked learning can be characterised as a process of 1) developing and maintaining connections with learning resources (e.g., with other learners, through learning arrangements, with learning materials, supported by media) and 2) fostering interactions between resources that support knowledge co-creation, value creation (Wenger, Trayner, & De Laat, 2011, Tsai & Ghoshal, 1998) and the innovation of practices and other developmental outcomes. These connections are mediated by designed elements (like devices and platforms) and through the social configurations that shape networked practices (e.g., pedagogical designs). The research theme is concerned with the design parameters and characteristics of learning networks, as they constitute learning spaces for self-organised and self-directed learning, and explore what kinds of learning (or open practices) develop within these learning spaces.

Theoretical background

The research draws on several theoretical frameworks (McCormick, 2003), for instance on *activity theory* (Engeström, Miettinen, & Punamäki, 1999), *actor network theory* (Matthewman, 2013), *practice theory* (Schatzki, 2005), *communities of practice* (COP's) approaches (e.g., Wenger, 1998), Socio-constructivist (Hodson & Hodson, 1998; Atwater, 1996, Winner, 1993) and Socio-cultural (e.g., Koschmann, 1999) theories of learning. Research in this theme builds on the principles of networked learning (e.g., De Laat, Lally, Lipponen & Simons, 2007; Dirckinck-Holmfield, Jones, & Lindström, 2009), learning networks (Fetter, Berlanga, & Sloep, 2011; Sloep & Kester, 2009; Sloep, 2007; 2009) and the use of social(ised) media (Shum & Ferguson, 2012) for teaching, formal and informal learning, and professional development.

Socialising media for networked practices is becoming increasingly important for learning. Goodyear, Banks, Hodgson, & McConnell (2004, p. 1) define networked learning as: "learning in which information and communication technology (ICT) is used to promote connections: between one learner and other learners; between learners and tutors; between a learning community and its learning resources". This definition emphasises the facilitative nature of ICTs for making learning connections. Research into the role that technologies play in the networked learning process suggests ways in which (designed) technologies *act* upon the behaviour of learners (Hemmi, Bayne, Land, 2009.; actor network theory; Latour, 2005), thereby changing the nature of the learning process. At the same time, networked learning emphasises

the networked learner as clearly agentic in their own, social, learning process. Just as technologies can be purposefully designed to support social learning, media which were initially not clearly meant for a social purpose can be socialised (Shum & Ferguson, 2012) into supporting connectivity. The tension between intentional design versus enabling social agency is growing even more complex in cross-contextual learning settings and by ubiquitous access to technologies. The current definitions of networked learning do not yet sufficiently mirror this ubiquitous nature of learning, which is now being supported to a greater degree through e.g., mobile technologies.

Learning networks define a space for learning, a space of which the boundaries are not clearly drawn. Research into the, so called, social configurations and architecture of learning networks provides insight into how these networks of (learning-)practice come to be, how they function and how they can be sustained (e.g., Schreurs, Van den Beemt, Prinsen, De Laat, Witthaus & Conole, 2014). Learning networks display their own particular types of (open) practice and it is crucial to understand them in order to develop new theoretical models. The kind of practices that best support value- and knowledge creation, or innovation in a domain of work are currently under investigation.

Leading research questions

- What kind of networked practices best support value- and knowledge creation, or innovation in a developing domain?
- Which kinds of participation (and thus, learning) are necessary to shape the transition to more open practices?
- How, and through which interactions between 'actors' do structural characteristics of learning networks emerge?
- What constitutes a (productive) interaction between learners (with specific characteristics and experiences) and other available resources, or in what constellation are the best outcomes produced?
- How do structural and compositional changes in the network and changes in networked practices translate into changes of the social capital?

Theme 4: Open Data and Learning Analytics (OLA)

Problem Statement

In the last decade the amount of user and usage data and the development of open and linked data sources has created new challenges for society. *Learning Analytics* (LA) is a research field that aims at understanding the potential and limitations of big data for learning support. Despite the great enthusiasm currently surrounding LA, there are substantial questions for research. Along with technical research questions such as the compatibility of educational datasets, the comparability and adequacy of algorithmic, and appropriate visualisation technologies, there are also other problem areas that influence the acceptance and the impact of LA. Among these are questions of data ownership and openness, ethical use and dangers of abuse and the demand for new key competences to interpret and act on LA's results.

Background and theoretical models

LA is based on the affordances of the massive aggregation, mining of data and the interactive visualisation of this. Recently much research has been dealing with the state-of-the-art in Learning Analytics, its processes, frameworks, definitions, impacts or challenges (see Clow, 2012; Drachsler & Greller, 2012; Duval, 2011; Elias, 2011; Ferguson, 2012a; Ferguson, 2012b; Greller & Drachsler, 2012; Siemens & Baker, 2012). New data technologies, data standards, open interfaces for aggregation, combination and linking distributed data sources enable endless possibilities for data analytics and visualisation. Therefore, LA research must be guided by educational scenarios and stakeholder needs to be successfully adopted and integrated in educational practice. Most current frameworks stress the importance of a holistic perspective including multiple stakeholders, available data sources and standards, technologies for tracking and visualisation, as also ethical and privacy considerations. Greller & Drachsler (2012) have identified six critical dimensions of LA, which need to be covered by the design to ensure an appropriate exploitation of LA in an educationally beneficial way, and proposed a model.

In the group's research, the main goals are increased awareness and situational awareness, fostering reflection in and about action, sense-making and knowledge building for individuals and groups, and monitoring educational processes and organisational development. Endsley (1995, 2000) has described situational awareness as a three level process consisting of the perception of elements in the current situation, the comprehension of the current situations and the projection of a future status. Those three steps have to be seen as a prerequisite for making decisions and effectively performing tasks. Once people are aware of their situation, they can reflect on their actions, possibly adapt their behaviour and engage in a process of continuous learning and reflection (Schön, 1983). Fostering awareness and with this reflection (Govaerts Verbert, Duval, & Pardo, 2012; Verpoorten, Westera, & Specht, 2011) or recommending further steps in a learning scenario are important application scenarios for Learning Analytics (Manouselis, Drachsler, Verbert & Duval, 2012).

The value of visualising data is a possibility to gain insight to large amounts of data in a very efficient and effective way (Fekete, Wijk, Stasko & North, 2008). While some research deals with milestones of data visualisation (Friendly, 2009), the state-of-the-art (Post, Nielson & Bonneau, 2003), its theory and practice in science education (Gilbert, Reiner & Nakhleh, 2008), application in learning and instruction (Winn, 1982) or its definitions and rationales (Owen, 1999), others present specific approaches to and examples of (Friedman, 2007, 2008) or online tools (Lurie, 2014) for data visualisation. With regards to LA, Verbert, Duval, Klerkx, Govaerts & Santos (2013) compiled a collection of 15 currently available dashboards for learning. Heer, Shneiderman and Park (2012) have created a taxonomy of interactive dynamics for visual analysis consisting of three high-level categories with four tasks each: (1) data and view specification (visualise, filter, sort, derive), (2) view manipulation (select, navigate, coordinate, organise), (3) analysis process and provenance (record, annotate, share, and guide). A key to success for visualisations is their potential for user engagement (i.e., if a visualisation cannot grab and keep a viewer's attention, it is worthless; Viegas & Wattenberg, 2011). Visualisations that expose something new are deemed best as they allow users to understand underlying

patterns to make good decisions (Steele, 2012) or stimulate cognitive dissonance (Festinger, 1957).

Leading research questions

- How can a value-based design in terms of ethics and privacy be defined for Learning Analytics research in Europe?
- How can LA data be used to create valuable/useful tools for educational stakeholders (teachers, students, parents, managers)?
- How can the stakeholders be supported with personalised information based on the LA data?
- Do educational stakeholders (teachers, students, parents, managers) need additional competences to deal with the affordance of LA tools?
- How can LA information be combined with existing Instructional Design Methods?
- What kind of data models are most supportive for educational research and practice?

4.3 Teaching and Teacher Professionalisation (T2)

Focus and aim

This programme is about improving education. The quality of education depends greatly on the quality **o**f the teacher (Diepstraten & Martens, 2013, Hattie, 2005; McKinsey & Company, 2007). Teachers are vital, not only for the quality of education but also for the success or failure of educational innovation in the school. So improving education cannot be done without taking a close look at the role of teachers. Because the role of teachers is expanding, we can also refer to the expanding role of 'educators'. The key question in the research group Teaching and Teacher Professionalisation (T2) then becomes: How can teachers and other educators best be supported in their professional activities?

T2 focuses on the *professional development* of all those involved in teaching situations. This primarily relates to current and future teachers in all forms of education (i.e., training of teachers is at the lever of higher education, though their actual teaching often is not), but may also involve other professionals such as company trainers and principals/headmasters.

In addition, professional development is viewed in broad terms, by looking at different forms of learning. As stated earlier in this programme, a distinction is made between learning as formal, non-formal and informal learning. *Formal learning* is regulated by law, meets agreed content and quality requirements, and it can be completed with a nationally recognised degree or certificate. *Non-formal learning* is intentional, organised education that may or may not be concluded with the award of a certificate of competency, but it is not regulated by law or nationally recognised. *Informal learning* is generally neither intentional nor organised; instead it takes place during daily activities related to workplace functioning and boundary-expanding experiences. This form of learning and professional development is the most important (Martens, 2010; for an overview) but it is also consistently heavily underestimated (De Laat, 2012) and often not valued by school management. So to improve formal learning in schools we need to look at the informal learning of the main actors themselves, the teachers. Since good

informal learning is required to make formal learning a success, we will primarily focus on the research aiming and strengthening this informal learning.

The next sections present the most import research themes. As will be shown, many of which in some way or another have to do with the search for balance between autonomy and control.

Addidtional remarks

To strengthen this complex and multi-facetted research, cooperative relationships have been established within the Faculty of Psychology and Educational Sciences (PenOW), especially within the 'Work & Organisational Psychology' sub-programme, part of the Psychology research programme.

Working on the professionalisation of educators very often implies that the complex work context of these professionals cannot be denied. In T2 a multi-method approach as described in the next section will be used. We are, for instance, currently investigating the usefulness of the PRECEDE-PROCEED model (see Kreijns & Vermeulen, submitted; Ransdell, 2001; Schuwer, Kreijns, & Vermeulen, 2014) from the health sciences (Lechner, 2007). This model is already widely used in the health sciences to set up large-scale national interventions to effect behavioural change. The appeal of this model is that it provides an ecological approach. In other words, the interaction of the environmental characteristics (micro, meso, and macro-level) with the behaviour of the target group (in this case the teachers) is explicitly included, and all stakeholders (here the pupils or students, school head teachers, foundation boards, provinces, and the government) are taken into account. The approach overlaps at key points with design-based research (The Design-Based Collective, 2003). It still concerns with points like constant coordination with things in 'practice,' iterations, keeping a finger on the pulse and linking a practical approach to science and theory formulation (McKenney & Van den Akker, 2005; McKenney & Reeves, 2012).

Theme 1: Expertise Development

Problem statement

Unfortunately, to date many doubt the professional quality of teachers and the expertise development throughout their professional career. In most cases this doubt or even criticism is based on ‘gut feeling’ rather than objective data on teachers’ expertise development. The problem is that the development of expertise or professionalisation is very hard to measure. Thus, the question at the core of research on this expertise development is: how do beginner, advanced, and expert professionals differ in performance, in the way the task is performed in a perceptual, cognitive and executive sense, and in the underlying knowledge structures? Specific subjects with respect to teachers’ expertise development are the use of ICT and self-directed learning (SDL), since with the increased use of ICT in education, SDL is expected to become more and more important. The use of ICT tools and all manner of internet technologies in today's information society has become commonplace. To date, however, the application of these tools and technologies in education is still lagging behind.

Theoretical contribution

Research on professional expertise can be placed in the context of innovation (such as new media), although this is not necessary. Even classical teaching skills such as classroom management, frontal instruction, storytelling, or providing feedback are examined in the research on expertise, especially when they form part of the proven success factors contributing to student learning (see Hattie, 2005). To advance insight and to contribute theoretically, depending on the specific question, expertise theories will be applied, such as those concerning 'deliberate practice,' but also curriculum theories or theories of knowledge acquisition. When it comes to research methods, a useful method appears to be combining eye movement registration with think-aloud protocols when viewing video recordings of classroom situations (Van den Bogert, Van Bruggen, Kostons & Jochems, 2013; Wolff, Van den Bogert, Jarodzka & Boshuizen, submitted; Van 't Zelfde, 2012).

As stated, the application of ICT tools and technologies in education is lagging behind. One reason for this is the professional's limited knowledge of how to combine pedagogical-didactic aspects with technology. Although many pilot projects have contributed research results in the field of ICT and education, thus far we have not succeeded in grouping these results and translating them into clear recommendations and guidelines for best practices as in a chain from theory to practice (Bastiaens, 2007), which connects the four aspects of theory, model, concept, and reality. Given that it is not easy to effectively implement SDL in teacher education curricula (Vrieling, Bastiaens, & Stijnen, 2010), a counselling approach has been developed consisting of an SDL model with seven points (Vrieling et al, 2010) and a diagnostic tool for SDL for both the educational institute (Vrieling et al, 2012a, b, c) and for the workplace (Vrieling, Kicken, Stijnen, & Bastiaens, submitted).

Leading research questions

- How do beginner, advanced, and expert professionals differ in 'the quality of their performance' in the way the task is performed in a perceptual, cognitive and executive sense?
- How do these groups differ in the underlying knowledge structures?
- How can the expertise development of educators be enhanced in order to facilitate a gradual transition for devolving responsibility from teachers to students (SDL)?

Theme 2: Career Development

Problem statement

Teacher career development is a problem, because many young teachers leave education after only a few years and many 'older' teachers seem to stand still for many years from a career development perspective (e.g., Coonen, 2005). What are the causes of this? The point of departure for research on learning careers entails more of an HRD perspective, which focuses on the actual career development. The research is focused on the course of the career development of current and future teachers in the context of 'lifelong learning,' 'employability,' and 'identity development' (personal meaning) in relation to the guidance and learning and/or working environment that these require (Lodders, 2013; Winters, 2012). This environment then

mainly concerns organising the education, cooperation with the business community, the quality of the coaches and the leadership in the organisation. This line of research is linked to research on so called learning biographies.

Theoretical contribution

Teacher behaviour can be understood from the perspective of the teacher's needs and assigning meaning to their own career and development. Within T2, the *Person-Environment fit* (P-E fit) model is currently being developed and tested (Verjans, Klaeijsen & Jansen in de Wal, in prep.) in order to gain an understanding of those needs and meaning. The P-E fit model is based on the premise that individuals have certain needs and abilities - which change over time - and that these individuals operate within a socio-economic environment that can meet those needs, but in return the individual has specific requirements that may also change over time. An important axiom in this theory is that a state of relative harmony arises when individuals are able to create a balance between their needs and the supplies and opportunities of the environment on the one hand, and between their abilities and the demands of the environment on the other. Failure to establish this balance, or disruption to the existing balance will lead to strain, which in certain circumstances can even turn into illness. Conversely, balance encourages satisfaction and motivation.

According to their needs and abilities, individuals create their own 'niche' in the world: a relatively stable set of socially acceptable situations that are simplifications of the overwhelmingly complex environment. Individuals develop a number of such situations that are characterised by certain routines and semi-automatic procedures that enable them to function. These situations also involve a certain way of thinking, feeling, and acting, and therefore act as a kind of mental filter in the perception of the environment. The niche or mental filter can be understood as 'integrity of human functioning,' also known as 'integrity' or 'self-image' for short (Verjans, 2003).

Learning biographies refer not only to a research topic, but also to a related theoretical perspective. This theoretical perspective assumes that teachers only become motivated for and receptive to professional development if they have already experienced this development as 'biographically meaningful and relevant' (Diepstraten, 2006; Dominice, 2000). The learning biography approach entails narrative research into the meaning that people assign to their lives by creating a story. A story in which someone connects various life spheres (work, education, leisure, private: the life journeys in these spheres and the meaning that people assign to them) and life phases (past, present, future) into a meaningful 'plot' (Kohli, 1985).

Cross-linking micro, meso, and macro developments means that the biographical perspective is always a sociological perspective (REF). The specific theories employed depend on the 'to be determined' aspect of a learning biography. When, for example, examining the contribution of a social network to an individual's learning biography, network theories are used: see the section on personal social networks in this T2 research programme. If it is about the meaning of work, theories from a human resources development (HRD) perspective can be employed.

Leading research questions

- How can individuals and organisations discover, develop, and exploit qualities and passions for the work that must be done in light of political, economic, and scientific developments?
- What is needed to create a balance between educators' needs and the supplies and opportunities of the environment on the one hand, and between their abilities and the demands of the environment on the other side?
- What characteristics of teacher environments in schools influence teacher careers and how can these characteristics be improved?

Theme 3: Motivation

Problem statement

A third important topic within the T2 research group is the role of motivation in the success or failure of innovation and professionalisation projects and the effects of various interventions on education professionals' motivation. The reasons for this are twofold: teachers motivation is important since it influences the success or failure of education and educational innovation. And secondly, unfortunately teacher motivation often appears to be suboptimal (Jansen in de Wal, Van den Beemt, Martens, & Den Brok, accepted). Educational innovation is doomed to fail if the key actors of this innovation, are not committed to it, don not believe in it or do not experience it as a change that is in line with their personal believes. This topic aims to provide guidelines on the set up and implementation of such innovative projects to support and promote the motivation of teachers.

Theoretical contribution

There are many motivation theories and perspectives (De Brabander & Martens, 2014; Martens, De Brabander, Rozendaal, Boekaerts & Van der Leeden, 2010; Van Nuland, Dusseldorp, Martens, & Boekaerts, 2010). The foremost theoretical approach to this subject is the *self-determination theory* (SDT) (Deci & Ryan, 2000; Ryan & Deci, 2000), which is based on the premise that people are intrinsically motivated to learn by nature. This intrinsic motivation is predicted by how people perceive relatedness, autonomy and competence, which are considered to be the basic psychological needs (Ryan & Deci, 2000). Research has shown that teachers with more autonomous forms of motivation are more likely to both try out and implement education innovations (Klaeijsen, Vermeulen, & Martens, 2012; Lam, Cheng, & Choy, 2010; Schellenbach-Zell & Graesel, 2010).

This theme will try to gain insight into the many variables at play when educators make specific decisions related to their professionalisation, for instance on the use of tools and activities for their lessons and their own professional development. The research concerns, for instance, the motivation for the use of digital learning materials, participation in digital communities, and performance of practical research by teachers. Depending on the problem formulation, an aetiological model will be selected. This model describes behaviour, explanations and predictions. A second important theoretical starting point for this research topic is the reasoned-action approach of Fishbein and Ajzen (2010). Notwithstanding the

orientation on practical impact, part of the programme is also specifically theoretically oriented, for instance on the exact relations between variables in SDT and how they are best measured (Jansen in de Wal, Van den Beemt, Martens, & Den Brok, 2014) and the combination of some of the theories in the complex field of motivational science in order to increase the predictive power (De Brabander & Martens, 2014).

Leading research questions

The central research question is: what role do motivational processes play in teacher professionalisation? Many questions can be derived from this central research question such as:

- What is the role of perceived autonomy on teacher motivation?
- What teachers' motivational profiles can be distinguished and what are the effects of these profiles on professional behaviour?
- How can motivational profiles be altered?
- How are the basic needs that predict (intrinsic) motivation related and can these relations be modelled and theoretically understood?

Theme 4: School Organisation and Learning Networks

Problem statement

Where the themes addressed in the sections above were primarily focussed on the individual teacher (micro-level) we must also look at the surroundings of these educators, for instance the informal network or the school organisation. These meso-level factors are also crucial for our understanding of educators' professionalisation. A very important aspect of this meso-level is the learning network (see below). The central problem is that up to date little is understood about the exact impact of the (school) organisation or the way teachers are organised is social networks. However, research does show that the impact from these meso-factors might be quite substantial an should not be neglected if we are to build a coherent understanding of teacher professionalisation.

Theoretical contribution

With this research topic, Welten Institute is primarily interested in exploring the cultural aspects of a school. What are the predominate stories (discursive practices) within the school organisation? Which behaviour of the teachers is valued or not valued? Subsequently, the culture and learning environments are also important (Evers, 2012; Van Woerkom, 2003). Are there sufficient contacts between the various teams and departments within the school organisation? Is sufficient time spent on collective reflection and learning from the experiences of other school organisations? Is there tolerance for dissent in the school organisation?

A closely related understanding can be described as *agency*. When we relate agency to the work of teachers, agency can be understood as the perception of control over the choices one makes in his or her work and the basing of this choice on personal goals, interests and motivations (Vähäsantanen, Hokka, Eteläpelto, Rasku-Puttonen & Littleton, 2008).

Next, over the last decade in educational practice and research, much attention has been devoted to the interaction of educators in groups as a stimulus for their professional development. We refer to this as *learning networks*. Evidence is building up that these networks

are crucial for professionalisation (De Laat, 2012, for an overview). Ongoing research, for instance, aims at mapping the social space of a learning network of teacher education professionals. Teachers develop not only within the school organisation, they also learn - consciously or not - within their own social network. This social network comprises the relationships teachers maintain within and outside their schools, thus providing them with access to resources that others possess, such as specific knowledge, contacts, and powers. The resources available in an individual's network and the way in which teachers tap into and deploy such resources are critical to their professional development.

As stated earlier in this section (and also in other themes) an important aspect is the autonomy that teachers are given with respect to their professional development. This is sometimes referred to as professional space. This is not just about the content, but also about the way they supplement their own learning process. We know from research that the professional development of professionals largely takes place in informal learning processes (Marsick & Watkins, 1990). Because formal learning integrates work with learning, the learning is often taken for granted and hidden from sight (Eraut, 2004). Informal learning takes place during daily activities when people solve work-related problems and assign meaning to their experiences (De Laat, 2012; Eraut, 2004; Marsick & Volpe, 1999). In informal learning, both the learning itself and the outcomes are difficult to identify, so learning is inherently disconnected from existing professionalisation policy (Boud & Hager, 2012, De Laat, 2012). Which is not to say, however, that there is no space for informal learning by teachers in school organisations. In our research, we therefore look at the way in which school leaders direct the formal and informal learning of teachers in the professional space.

The above has already made clear that the professional space a teacher experiences has a lot to do with school leadership. Currently the topic of transformational leadership is getting a lot of attention. This type of leadership entails having a vision for the future, inspiring teachers and encouraging them to optimally develop their talents and find deeper meaning in their work.

A final topic in theme this has to do with *social learning*. Based on a literature review of team learning, community learning, and network learning (Vrieling, Van den Beemt, & De Laat, accepted), there are four dimensions (i.e., practice, domain and value creation, solidarity, organisation) that contain eleven defined indicators of social learning. These indicators do not provide a value judgement of the teacher groups, but do describe the position of the group.

Ongoing research aims at mapping the social space of a learning network of teacher education professionals, student teachers, and primary education teachers. Based on this analysis, it is examined how to facilitate the social learning of the group, which is in keeping with the goals of the group. Also a tool (guideline for interviews) will be developed whereby the basic framework of dimensions and indicators will be leading.

To make sense of the role of the individual social network, different theoretical HRD traditions surrounding social networks are employed. More specifically, the tradition in which social networks are understood as an individual's social capital: the amount and type of resources that are present in a person's network and are accessible via network connections. Concepts such as the number of connections, heterogeneous and homogeneous networks,

linking, bridging, and bonding all affect a teacher's social capital. The Actor Network Theory (ANT, Latour, 2005) provides another complement to social capital theory.

Many of the ideas described above regarding distributed leadership and networked learning come together into one current, real-world topic: the ability of teachers to innovate.

Where previously teaching required a combination of pedagogical and professional competencies, the current insistence is on the importance of research skills and innovation capability as an essential part of modern teaching (Van der Klink, 2012).

Leading research questions

- How can teachers influence their school as a learning environment, thereby shaping their own learning and career paths?
- How can school leaders manage the formal and informal learning of teachers within the professional space?
- Which social configuration helps current and future teachers successfully participate in blended learning networks?
- Which factors (workplace and organisational level, personal characteristics) explain variations in the innovative behaviour of teachers?
- To what extent and in what way does the innovative behaviour of teachers, in addition to other factors, explain the development and introduction of innovations in educational settings?

5 Complimentary multi-method research methodology

As stated, Welten Institute focuses on the ecology of education and its constituent elements, namely the educator, the learner, and the technology and media. As a consequence, learning and teaching in technology-enhanced learning environments and the way in which learners and teachers develop new digital technology skills must be considered holistically. Research will be carried out which brings together the different perspectives and research methodologies as well as discussing and dealing with stakeholder problems in a holistic way. Of importance are the stakeholders' problems. They should be addressed and further elaborated to define the central research questions and research methods must be chosen appropriate to answer these questions in close collaboration and co-creation with the partners. To this end, research carried out at Welten Institute requires integrating the full scale of qualitative and quantitative methods used in the different fields of the Educational and Learning Sciences as well as those used in Computer and Information Science Research.

Research at Welten Institute strives to carry out mixed methods research which can be broadly defined as research making use of 'research designs using qualitative and quantitative data collection and analysis techniques in either parallel or sequential phases' (Tashakkori & Teddlie, 2003, p.11). Such a multi method, pragmatic approach (Creswell, 2010) takes into account development and implementation in the complex Ecological Edu-niche, while also strongly embedded in robust educational science.

Welten Institute employs a wide variety of methods in its trans-disciplinary research (i.e. multi-method research). These methods vary from small-scale, empirical, quantitative and qualitative research in 'the laboratory' to ecologically valid, quasi-experimental research in realistic settings which develops into design-based research within the education sector. Some of the methods and their role are:

- *Observational/Descriptive studies*: In an observational study the research draws inferences about the possible effect of a treatment in situations where assignment of participants into a treated or a control group is outside the control of the researcher (e.g., children in large classes versus small classes). Descriptive research is used when it is necessary to describe a population or a phenomenon being studied. It is used to answer the what question (e.g., what happens in a small class as opposed a large class) and not questions about how something happens, when it happens or will happen or why something happens. Such research usually precedes hypothesis or explanatory research.
- *Design research studies*: Educational design research involves the study of designing, developing and evaluating educational interventions (e.g., programmes, teaching/learning strategies, materials, products, systems) as solutions to complex educational problems, while advancing knowledge of the characteristics of the interventions and the processes of designing and developing them (Plomp & Nieveen, 2009).

- *Precede-proceed model:* Going some steps further than Educational design research, co-creation and collaboration with educational institutes as a way to increase the valorisation, require an evaluation framework for situational analysis and planned systemic interventions based on scientific knowledge and in turn advancing both scientific knowledge and educational practice by solving real world educational problems. Although these educational problems or challenges are the starting point of this type of research, they need to be translated into scientifically sound research questions. A specific instantiation of this research method, that is derived from the field of health education and health promotion, is the precede-proceed model (Schuwer, Kreijns, & Vermeulen, submitted).
- *Controlled laboratory experiments*: A laboratory experiment takes place in a well-controlled environment – not necessarily a laboratory – and therefore accurate controls and measurements are possible. Generally speaking, the researcher decides where, when, with whom and in what circumstances etcetera the experiment will take place. Participants are usually randomly allocated to each independent variable group.
- *Quasi-experimental field experiments*: Quasi-experimental field experiments are usually carried out in the everyday educational or learning environment (i.e., real life) of the participants, but the scale and design is such that the experimenter has the possibility of manipulating the independent variable. Because it is a real-life setting, the experimenter cannot easily control extraneous variables that may influence the research or its conclusions. As there are often no real control conditions here, there are specific designs that alleviate this problem (see Campbell & Stanley, Experimental and quasi-experimental design for research, 1963 and further).
- *Uncontrolled real-world experiments*: Often also referred to as natural experiments, these experiments are conducted in the everyday educational or learning environment (i.e., real life) of the participants. Here, the experimenter often has little to no control over the independent variable as it occurs naturally in real life.
- Other research approaches that can and will be used are: survey research, observational studies, literature/desk research, secondary analyses, retrospective studies, ...

Learning Innovation Laboratory (LILab)

The *Learning Innovation Lab* (LILab) fulfils a core function for enabling an open innovation process together with stakeholder groups from higher education and other sectors of education, society and the economy. It supports different development and research methodologies as early innovation scouting, technology potential studies, stakeholder workshops and participatory design studies, contextual requirement studies and case studies, formative and experimental evaluation studies, as also building a repository for best practices and open innovation. Amongst others, the following research methods will be used in the LILab:

1. *Technology Scouting and Innovation Workshops*: A first step in approaching educational problems and scenarios with the usage and integration of new technologies and ICT is certainly the technology scouting and monitoring process of technological

developments. To reflect these technological innovations and their potential the research regularly organises innovation workshops with different stakeholder groups. This follows approaches of technology acceptance research and participatory design studies.

2. *Agile Development of Educational Technology*: Developing customised prototypes for embedding and relevancy for educational settings is essential for the acceptance and integration of technology innovation in stakeholder contexts. An environmental analysis of the targeted application scenario and case are therefore used for identifying the main added value of an innovation in an application setting. This is often combined with agile development methods and prototyping to develop tangible working prototypes as early as possible in the innovation process. Different types of technology artefacts will be developed in this context in cooperation with the TWO group in the Faculty of Psychology and Education. This includes Spike and Scouting Solutions, Experimental Software and Showroom Solutions, and Open Source Products.
3. *Usability and User Centred Design Studies*: Usability evaluation is usually applied when the researcher/developer needs to take important decisions about the design and logic of the technology artefact. This step can be applied before an actual evaluation is conducted or at a later stage. Formative studies are used in combination with prototyping approaches to evaluate the structure and integration of an innovation in a formative way, i.e., to identify weaknesses and strengths as also key barriers for the adoption and positive confirmation of an innovation. Field studies often focus on the actual educational value as also on return of investment studies and embed an innovation in an actual educational setting, therefore enable for so called ecological validity of the outcomes.
4. *Eye Tracking and Sensor-Data Studies*: To enable researchers to investigate processes underlying learning with new technology, the LILab provides facilities, such as eye trackers, biofeedback sensors, and mobile activity-trackers. These LILab facilities are used for both internal and external joint research projects. Research activities include eye tracking studies for research and usability and bio-sensor research studies making use of experience sampling and activity logging techniques.
5. *Roadmapping and Expert Concept Mapping*: Expert Concept Mapping has been applied a number of time in different educational design and policy studies and has developed into a mature service in the final years of CELSTEC (Stoyanov & Kirschner 2004; Wopereis, Kirschner, Paas, Stoyanov & Hendriks, 2005). It provides a structured participative conceptualisation approach to identify clusters of ideas and opinions generated by experts for a given domain aspect. The result is a set of visual maps representing the generated idea and opinion statements as well as emerging statement clusters and thus important domain concepts. Expert Concept Mapping enables the mapping of a potential solution and action space onto an educational problem or question considering different criteria as feasibility and potential. The methods used ensure a high success chance for investments in educational systems or paths of most

feasible actions to be taken. This is important for embedding educational technologies in a policy context.

6 Relevance of the programme

The programme of the Welten Institute will contribute to meet the above challenge for education; especially in higher education and more specific for the OUNL. The relevance for the OUNL and for higher education will be elaborated, but also the spin off to the broader educational community will be addressed. Furthermore the distribution and dissemination of scientific knowledge is of importance and thus the relevance for the scientific community will also be described.

The Open University of the Netherlands

The research programme will contribute to the realisation of the goals of the new educational concept of the OUNL as described in The *New Educational Model* (Het nieuwe onderwijsmodel). In accordance with the trends just described, this educational concept stresses the design of with technology enriched learning environments and the importance of a "state-of-the-art" electronic learning infrastructure. In essence the concept can be describes as online active learning and emphasises the social nature of learning facilitated by using new technologies, supports study behaviour and transfer of knowledge and skills by using authentic learning settings and provide students with a well-structured online delivered curriculum and guidance by a tutor and mentor. Moreover, the research programme will pay attention to the development of 21st century skills and its pedagogical implications (i.e., didactics for fostering higher-order skills), the use of new media to support online active learning, cognitive and motivational support and guidance for (distance) learners, methods for assessment of complex performances, and the professionalisation of teachers – aspects that play a central role in the new educational concept.

The Dutch Higher Education System

The research programme will also contribute to the innovation of Dutch higher education. Like the OUNL, many institutes for higher education are making the switch to the design of more online education and focussing on flexible learning environments. In addition, they aim at enrichment of their curricula with new technologies, yielding combinations of traditional teaching with technology enhanced learning in *blended learning* approaches, but also invest in, for instance, MOOCs, games, the use of the huge amount of information on the Internet, and learning analytics. One of the main problems that educational institutes encounter in their reorientation is related to implementing the necessary changes in designing these with technology-enriched environments. The proposed research programme will develop practical guidelines and tools that may help teachers to do so, and will also focus on valorisation activities to contribute to the innovation of higher education.

The educational community

In many countries there is a pressure on universities to increase their impact on society, often referred to as *valorisation*. Also in the Netherlands there has been a strong plea for increased emphasis on the valorisation of science. This programme has a focus on valorisation, by doing educational research in close collaboration with educational partners, using for multi-method approaches. Results of research will be of importance of the direct partners of projects and together with these partners focus will be on working solutions and the implementation of these solutions. But we will also use all kinds of valorisation activities to make this results and emerging guidelines for education available for others, using for instance learning networks principles, and using new media (e.g., online master classes).

The scientific community

Last but not least, the research programme will contribute to *state-of-the-art theoretical advancements* in the field of technology-enhanced learning, instructional design for effective, efficient and enjoyable with technology enriched learning environments and the field of teacher professionalisation. This theoretical contribution will be elaborated in the next section.

7 Programme Organisation

The programme will be carried out by three research groups (FEEEL, TELI, T2). Each group is headed by a programme chair (NL: vakgroepvoorzitter). The chair (full professor/core professor) is responsible for thematic leadership, content-related interpretation and validation, the quality, quantity and valorisation of the research in her/his group and the determination of the strategic and scientific challenges that the group will focus on.

Within each group, themes are defined which are headed by a theme leader (minimally at the associate professor level) who is responsible for managing, developing and deepening of the theme by defining new projects and services, expanding the network, generating exposure, acquiring new funding and achieving agreed upon output. Together with the theme leaders the programme chairs produce an annual plan dealing with how the general goals in the current document will be realised. These plans are, as is natural in the described ecology, adaptable to internal and external circumstances, such as changes in staff, university/government policy and the 'market'. The Welten Institute Management Team (WI-MT) consists of the three programme chairs and the chair of the institute and is responsible for the approval and coordination of the separate plans. Based upon these plans, the scientific staff (full professors, associate professors, assistant professors, post-doc researchers, and PhD candidates) are allocated to the themes on a semi-permanent basis taking into account available expertise, career ambitions and project requirements.

For coordination of the three groups various mechanisms exist. At the level of research (support of the research process), lab activities (apparatus and support activities), software development and valorisation, separate coordinators are responsible for the alignment and tuning of activities, shared policies and shared procedures. Programme chairs and co-ordinators have quarterly meetings chaired by the chair of Welten Institute. When appropriate the faculty Director of Operations attend these meetings.

The organisation of the programme goes hand in hand with different types of meetings. The participants, agenda, length and frequency of those meetings are given in Table 1.

Table 1. Meeting Structure of the Programme

Meeting	Participants	Agenda	Length	Frequency
Welten Institute Management Team (WI-MT)	Chair of the institute and programme chairs	Strategies, policies, managerial issues and all other relevant issues for the institute.	2 hours	Monthly
WI-MT plus	WI-MT plus research, lab, software develop-ment and valorisation coordinators	Strategies, policies and procedures concerning the coordinated topics.	2 hours	Quarterly
WI plenary	Welten Institute staff	All relevant topics for the institute	90 min	Monthly

Research group management	All senior staff (i.e., those with project management tasks)	Strategies, policies, approval of projects and proposals, co-ordination, staffing, acquisition, publicity, facilities, external relationships	2 hours	Every six weeks
Research group plenary	All scientific staff members	All relevant topics for the Programme	90 min	Monthly
Theme meeting	Theme leader and members	Projects, activities, proposals	1 hour	Monthly
Yearly strategy meeting	WI-MT plus and theme leaders	Strategy, policies and preparing yearly strategy document	2 days	Yearly

Projects

The programme is organised in projects, which begin on the basis of an approved project proposal, which clearly describes the planned input (i.e., human labour), throughput (i.e., people, processes, activities, resources), output (i.e., publications, tools, prototypes, instruments, valorisation activities) and project management (i.e., deadlines, finances, quality control, information dissemination, project organisation). For each project a project team is formed consisting minimally of a project leader and project member, which can be member of the Welten Institute but certainly also partner in the educational field.

Special Interest Groups

To strengthen and implement the interdisciplinarity of complex research questions in the ecology of education Welten Institute facilitates Special Interest Groups and Integrated Projects across all three research groups. SIGs enable the cooperation on topics of special temporary interest on to which the multi-disciplinary perspective approach of the Welten Institute brings new light and insights.

Staff allocation

In 2014 the Programme will be run by 72 full time equivalents (fte) scientific staff. Within that staff 60% of the fte (43 fte, with about 33 fte PhDs and 10 fte PhD-students) is financed by the OUNL's direct funding, and 40% by external resources. For the coming years, the programme aims at changing this ratio in such a way that 50% of the scientific staff is financed by the OUNL's primary budget and 50% by external resources, taking into account that the directly funded PhD-students will be reduced to 6 in the upcoming years. This shift of 10% from direct to external funding in year 6 (2014) will be realised, on the one hand, by maintaining the current amount of research funding, and, on the other hand, by extending contracts. The latter will mainly be realised by activities related to valorisation. The basic assumption underlying this plan is that a stable core staff of internally funded 38 fte is needed to run the programme

successfully. Table 2 presents the yearly staff allocation and percentage of funding for the duration of the programme.

Table 2. Staff Allocation for the Programme Period

Scientific staff	Year 1		Year 2		Year 3		Year 4		Year 5		Year 6	
	fte	%€	fte	%€	fte	%€	fte	%€	fte	%€	fte	%€
Internally funded	43	60	40	58	39	56	39	54	39	52	39	50
Externally funded	29	40	29	42	31	44	33	46	36	48	39	50
Total	72	100	69	100	70	100	72	100	75	100	78	100

8 Concluding remarks

This document briefly described the Welten Institute research programme 2014-2019. This programme provides a research framework and sets boundaries for research projects that may be performed as part of the programme. First, new research projects must be coherent, built on a common set of theoretical assumptions, and must contribute to theories of the described areas of interest. Second, research projects must be relevant for the realisation of the new educational model of the OUNL, the innovation of Dutch higher education, and the scientific community. And third, research projects within this programme will stand in the tradition of a linking science (Dewey, 1900) because they interconnect educational theory and practice. In this way, the research programme will be able to provide valuable output for both the practical field of education (i.e., via innovations, practical guidelines, tools, and publications in professional journals) and the international scientific community (i.e., via publications in SSCI journals of high-quality), thus bridging the gap between educational research and educational practice (Commissie Nationaal Plan Toekomst Onderwijswetenschappen, 2011).

This document clearly illustrates the challenges that this programme faces: on the one hand it needs to lead to scientific output, thus stressing generalisability and advancing educational scientific theories; and on the other hand address the problems in educational practice.

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