Ensuring learning continuity everywhere: Seamless learning in the Netherlands

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ABSTRACT
Learning not only occurs in formal settings, such as schools, but in all environments in which people are intentionally and actively engaged. Framed by their direct experiences in environments they are interacting with, learners create new mental models, learn new skills and explore their own personal talents, behaviour and emotions. They thus actively construct meaning, either individually or collaboratively.

Currently, (potential) learning environments learners move through are still separated in many ways. Gaps can not only be found across learning environments, but also within learning environments. For example, in formal education we see gaps, as different topic domains are often learned separately and without learners knowing how acquired knowledge can be integrated, applied and become useful in the real world. To summarize, opportunities to facilitate continuity in learning (and support) processes and cross-boundary learning are currently left unexploited.

In this paper we describe how we, through ‘Seamless learning design’, in the Netherlands strive to bridge gaps and phase out boundaries between various daily learning environments a learner moves through, by facilitating the construction of connections between them through designed (pedagogical and mobile technological) affordances and (individual and collaborative) learning scenarios. By looking at Dutch seamless learning scenarios in various educational sectors (from primary until higher education) we identify rationale(s), key components, processes and mechanisms of the Seamless learning design paradigm. Furthermore, we reflect upon the current state of adoption and implementation and outline strategies to enhance further and future uptake in the Netherlands.

Author Keywords
Mobile Seamless learning; Learning design; Technology-enhanced learning; Experiential learning; Situated Learning

INTRODUCTION
Different environments and settings afford different experiences and opportunities for individual and collaborative learning (Kim, Hung, Jamaludin & Lim, 2014). Framed by the environment or setting, learners create new mental models, learn new skills and explore and become aware of their own personal talents, behaviour and emotions. They thus actively construct meaning and contextualize their experiences (Dourish, 2004; Westera, 2011). ‘Context’ is here conceptualized as the mental model humans create of the setting of an event, statement, or idea through their interaction with objects, ideas, instruments, processes and actors (people) in an environment (Wager & Atlas, 2015; Westera, 2012). Context thus arises from human activity. It is not just ‘there’, but is actively produced, maintained and enacted (Dourish, 2004) and also dependent on the inner state of the person constructing the mental model at a specific moment and in a specific setting (Wager & Atlas, 2015).

Key to ‘contextualized learning’ is that learning does not happen in a vacuum, but can be linked to objects and experiences ‘in the real world’, thus becoming meaningful to learners (Westera, 2011). Contextualized learning not only occurs in formal settings, such as schools, but also in informal and professional environments in which people are actively engaged. Contextualized learning helps to relate concepts and principles with their counterparts in the real world. Learners can also experience non-‘language-related’ information which is implicitly interwoven (e.g. smells, weight) with an activity. This can contribute to learning ‘unconsciously’ (Schank & Cleary, 1995 in Westera, 2011; Greeno, 1998).

Currently, learning environments and settings a learner moves through are still separated in many ways (Wong & Looi, 2011). The creation of connections and the construction of an overarching context between different learning experiences and environments, e.g. in-and-outside school, is predominantly not facilitated yet. For example, learners do not make a connection between a nature field trip they had over the weekend (non-formal learning) and the biology classes at school (formal learning). Thus, chances to benefit from linking and relating various types of learning experiences across environments, and thus strengthening learning processes, outcomes and possibly retention, are currently neglected.

Gaps in potential continuous learning processes can not only be found across present learning environments, but also within them. For example, within formal educational settings different topic domains are often learned separately. Learners often
fail to learn how knowledge from various subject domains can be integrated, applied and prove useful in the real world. Additionally, complex generic skills, such as e.g. collaboration, information literacy and self-regulation, are not explicitly and structurally taught and developed in school. Furthermore, learners are only sparsely supported in relating their personality and talents to their potential future (private, social and professional) identity. To summarize, opportunities to support continuity in learning processes and cross-boundary learning (Bronkhorst & Akkerman, 2016) are currently left unexploited.

The ‘Seamless learning’ paradigm looks into how these ‘gaps’ can be bridged and boundaries between different learning environments can be phased out or profited from, by facilitating the construction of connections between them through designed (pedagogical and technological) affordances and learning scenarios. ‘Seamless learning’ is about connecting and relating (learning) experiences and activities that learners experience in various environments and settings through technology-supported learning scenarios using mobile/wireless/handheld devices, thus supporting, improving and enhancing learning-and support-processes (Wong & Looi, 2011). Each environment has its specific characteristics that and in the design of a seamless learning experience this is recognized and reckoned with (Tan, Rusman, Firsova, Ternier, Specht, Klemke & So, 2018). The purpose is twofold, namely learners (1) are facilitated to experience a continuity of learning across environments and settings (natural versus designed combinations of locations, technologies and social practices) at different times (adapted from Sharples et al., 2012; p.24; Wong, 2012) and (2) make the most of their experiences within specific environments. Based on Bronkhorst & Akkerman (2016), the concept of ‘continuity of learning’ is here further defined as ‘learners are connecting and relating their experiences in various contexts of participation (e.g. by making sense, translating, contrasting, integrating or actively introducing elements from one practice into another) so that these experiences become part of an intentional, consistent, coherent, non-disrupted and prolonged learning and development process of (reflection on) action and interaction over time’. Discontinuity happens when learners (Bronkhorst & Akkerman, 2016, p.20) ‘come to face differences in various participations and perspectives they try to connect...what one experiences and learns in one context cannot be related to, and may even be in conflict with what one experiences and learns in another context.’ Discontinuities require learners either to learn and change perspective or leave them troubled (Akkerman & Bakker, 2011), thus hampering their learning process across time and space (Bronkhorst & Akkerman, 2016).

The mentioned overall surplus value of ensuring ‘continuity of learning’ varies. Continuity and variability of experiences in various contexts may enhance and enforce learning effects (e.g. in terms of transfer and retention, Van Merrienboer & Kirschner, 2017), may impact learners’ motivation by making learning more personal and meaningful (Lave & Wenger, 1991) and facilitate a state of ‘flow’ (Csikszentmihalyi’s (1990) in Sharples, 2015). Practically, it can increase time spent on a learning journey (Pegrum, Oakley, & Faulkner, 2013) and facilitate involvement of third parties in learning processes (e.g. parents, experts, stakeholders, alumni). More specific learning outcomes mentioned are insight in the applicability of (conceptual and procedural) knowledge (Westera, 2011, p.201); awareness of different perspectives on the world; behavioural changes of individuals and groups; the acquisition of complex (generic) skills; support of personal growth and sustainable motivation of a person; and enhancement of social meaning making processes (Scardamalia and Bereiter, 1999, 2005).

Key in the ‘Seamless learning’ paradigm are design decisions made on how to facilitate continuous, non-disruptive contextualized learning and support processes, by whom these decisions are made and how learning support is implemented with the help of wireless/handheld devices and technological tools. Seamless learning is the ‘design’ perspective on the facilitation of continuous learning across boundaries. Boundaries are sociocultural differences leading to discontinuity in action or interaction (Akkerman & Bakker, 2011) between various practices learners engage in. When learners are (en)able(d) to bring experiences in various contexts together in their learning process, learners “may be able to experience a flow state of continual engagement with a topic, regardless of the passing time and changing surroundings” (Csikszentmihalyi, 1990 in Sharples 2015, p.43). However, as Sharples (2015) states, based on the work of Kuh (1996), in order to enable a whole and continuous learning process, learning experiences must be somehow “bound” together. This “binding” can be either realized by the learner, a teacher, technology or a combination of these enablers. From boundary crossing theory various ‘binding’ mechanisms can be distinguished: 1) (conscious) boundary crossing, 2) boundary objects and 3) brokers. Akkerman & Bakker (2011) state (p.133) ‘boundary crossing usually refers to a person’s transitions and interactions across different sites (Suchman, 1994), boundary objects refers to artefacts doing the crossing by fulfilling a bridging function (Star, 1989)’. Brokers (Bronkhorst & Akkerman, 2016) are actors capable of (deliberately) shifting between contexts through a good understanding of different expectations and rules applicable in different socio-cultural practices. Brokers can facilitate others in taking stances and changing perspectives, thus contributing to their learning processes. All these mechanisms can be found in implemented and envisioned Seamless learning scenarios. However, they are often named differently, for example (learning or support) activities and processes, resource(s)/co-created objects or instruments or coaches/mentors/facilitators.

In this paper several examples of seamless learning scenarios and implementations in the Netherlands are described. Based on these scenarios and literature, an analysis and overview of design rationales, design parameters, design elements, core continuous processes and design mechanisms of the seamless learning design paradigm is given. Furthermore the state of affairs of the overall adoption and implementation of the Seamless learning paradigm in secondary and tertiary education in the Netherlands is described and strategies to enhance further implementation and adoption are outlined.
MOBILE SEAMLESS LEARNING IN THE NETHERLANDS – EXAMPLE SCENARIOS

In this section, several seamless learning scenarios from different educational sectors, target groups and domains in the Netherlands are described, using the following structure (Rusman, Ternier & Specht, 2018; Rapp & Gommers, 2018): 1) target group, 2) (learning) objectives 3) locations/environments/settings 4) mechanisms facilitating continuous learning processes across environments 5) (individual and collective) learning activities and phasing 6) didactics: learning processes, control and support 7) technological tools and affordances and 8) evaluation and assessment.

‘Elena goes shopping’ - Early second language learning and adult involvement in a real-world context

The ‘Elena goes shopping’ scenario (Rusman, Ternier & Specht, 2018) addresses young children (aged 4-8 years). A location-based mobile game, thematically interlinked to online learning materials for independent language learning at school, was developed. The objective of the game was to spark children’s early interest in (geographically proximate) languages, to familiarize them with sounds, pronunciation and vocabulary of a language, to discover that the same objects can have different names dependent on languages, and to involve parents or other ‘out-of-school’ parties (e.g. scouting companions) in young children’s language learning activities. The link between the online learning materials and the location-based mobile game was made through thematic alignment (‘Elena goes shopping’) and linking the ‘abstract’ words within the theme to real-world objects in the supermarket. Children would first go through the online material and then play the game in a supermarket, in which they were engaged with various learning activities with a focus on contextualized interaction (e.g. search, find, collect, count, take a picture), a multi-sensory approach (taste, smell) and immediate feedback (e.g. by listening to own productions, getting automated feedback) and were thus guided to collect the ingredients to bake pancakes. No explicit linking between children’s experiences in the supermarket ‘back’ to the online material and learning activities at school was made in this implementation, apart from the thematic overlap. Children were supported through location-based instruction and direct feedback on their mobile device through a game developed in ARLearn (Ternier, Klemke, Kalz, Van Ulzen, & Specht, 2012). They could independently go through the learning activities, however could get assistance of an adult (e.g. (grand)parent) when needed, as they were playing the game while the adults were shopping. Children used specific functionality of their mobile device (e.g. camera, audio recording, audio playing) to complete the game. If they completed a learning activity successfully, they gained a ‘puzzle piece’, which together formed the complete puzzle, once all learning activities were successfully completed. Children were thus formatively evaluated, no summative evaluation or assessment took place as part of this learning design.

Reflection support on ‘everyday life’ communication skills of children with language impairments

A digital reflection tool was developed by van den Broek (2019), based on work done by Suarez (2017). This reflection tool assists senior primary school students’ (aged 9-12 years) with specific language impairments to gain self-insight in and enhance their mastery of everyday life communication skills (Broek, van den, 2019). Students with specific language impairments often experience miscommunication conflicts in the various social environments they engage in (e.g. school, at home, at leisure). The reflection tool was designed to help students ‘capture’ both critical communication conflicts as well as successes across social environments through the creation of an artefact, in which they made the factual circumstances of a critical communication incident (both positive and negative) explicit by answering questions (e.g. who were there? what happened? What did you do? What did the other do? How was the conversation ended?). Children could eventually add photos and/or audio recordings to this artefact. An artefact can facilitate more concrete and explicit reflection on circumstances and causes of a specific event or incident (Mittendorff, 2004; Shute, 2008). In this setting, an artefact is defined as an artificial representation of a critical incident that aims to support memorization and makes implicit knowledge and skills that are bound to a certain situation explicit. A critical incident according to Measer (1985, in Lengeling & Mora Pablo, 2016) is an important event in students’ life’s that can evoke decisions, changes, actions and/or reflection with a lasting effect, as these moments are inherently contextualized, forceful and memorable (Lengeling & Mora Pablo). Vachon and LeBlanc (2011) describe that the thorough description and analysis of a critical incident can facilitate reflection, through the active involvement of students in the (re)construction of their knowledge, behaviour and role, leading to insight in and meaningful application of knowledge and skills. Critical incidents are not planned or consciously generated, but are happening spontaneously. It is important to describe them in a factual manner, opposed to opinions and impressions (Vachon &LeBlanc, 2011), as this facilitates analysis and reflection. In this factual report the situation, the (intended) actions, strived-for objectives, experienced emotions and consequences of an incident are described (Vachon &LeBlanc, 2011). This factual report forms the artefact (Mittendorff & Kienhuis, 2014) and physical stimulus to start a reflection process, structured through the reflection circle of Vos and Vlas (2000), across students’ daily social environments (Morin, 2011).

After creating an artefact of an incident, students were guided by the digital reflection tool to look individually at their own behaviour and role in the communication incident, with the help of a set reflective questions. The next step was to talk about and reflect on the incident with another person, with the help of the created artefact and students’ answers on the reflective questions as boundary objects. This person could be the teacher/coach, logopaedist, peers, parents or the person with which they experienced a (positive or negative) communication incident (e.g. at school, leisure, at home). They noted ‘tips’ (what could be improved) and ‘tops’ (what went well) together with this person and concluded how they would act and alter their behaviour the next time, in a comparable situation. Students could choose themselves which communication incidents they wanted to share with others. They were supported in their reflection process across social environments both
by the instruction and affordances of the digital reflection tool, as well as by teachers, logopaedist, peers and parents. Students used a combination of their mobile device and the online reflection tool to both ‘capture’ and store the communication incident for future retrospection. The tools were also used to share communication incidents and receive feedback on possible alternative reactions or solutions of various actors in (e.g. teacher/coach, logopaedist) and outside (e.g. ('conflicted’) peer(s), parents) school. The learning design facilitated formative evaluation, as part of the reflection cycle of Vos & Vlas (2000).

**Supporting an integrated approach to individual and collaborative inquiry-based science learning**

An integrated inquiry-based approach to science learning was developed to increase first year pre-university secondary school students’ (aged 12-13 years) motivation for science, to develop their collaboration, presentation, information literacy and problem-solving skills and to learn how to apply domain knowledge to real world problems, thus developing their (applicable) domain knowledge (Rusman, Firsova, Janssen & Specht, 2015; Bidarra & Rusman, 2017). Different science domain perspectives (e.g. biology, chemistry, physics) had to be combined to solve a complex and extensive ‘real-world’ task, namely the ‘design of a colony on Mars’. Formerly separated scheduled hours per domain were combined in a block of 4 hours, in which teachers of the different disciplines jointly supervised students’ inquiry activities. Students first worked individually and then in groups of 5 to 6 on the task. Field and company trips (e.g. to Space expo museum in Noordwijk) were combined with guest lectures and counselling sessions with experts (e.g. (parent) energy expert, (pensioned) maquette builders), to facilitate students’ information gathering and a feasible design of a Mars colony. The inquiry activities were structured with the weSPOT inquiry based learning model and online tool and a mobile personal inquiry manager (PIM) (Protopsaltis et al, 2014; Suarez, 2017) (Figure 1a,b &c). This technology-enhanced inquiry-based learning process facilitated continuity between various environments students’ were engaged in, in and outside their secondary school. The following phases were distinguished: 1) Formulating questions (first individually, then collaboratively) 2) Operationalization of concepts 3) Collecting information from different sources (e.g. internet, newspapers, guest lectures, visits to companies/museums), 4) Analysis and selection of information 5) Interpretation and discussion and then 6) Communication and presentation of findings (to classmates, teachers and 3rd parties involved). Reflection was interwoven with each phase of the inquiry-processes and contextualized through a specific (design) task and environment, in this case a Colony on Mars. Students not only designed ‘on paper’ but developed a maquette, with the assistance of (pensioned) expert maquette designers. To develop an appropriate design, they applied and integrated theory from various science domains (e.g. photosynthesis for the provision of food, gravity for the development of a shelter). Students self-and co-regulated their inquiry process, by generating their own questions until finding feasible solutions, supported through this process by the tools. They were also assisted by an interdisciplinary team of ‘domain-related’ teachers, who coached both on content as well as on the inquiry process. The design and development of the technology-enhanced learning environment decisions was based on the affordances and strengths of each specific technology. For instance, the online environment facilitated the overall individual and collaborative inquiry-process and specific activities within each phase (e.g. mind mapping) were supported with dedicated widgets. An initial pre-selection of domain knowledge was given in various media formats (e.g. audio, video) through an i-book reader. A portlog, a combination of an information-and decision tracking logbook with a portfolio (collections and reflections), was kept to facilitate reflection. The mobile personal inquiry manager (PIM) tool was mainly used to gather information ‘in the field’ and to communicate (text-message) with group members during their inquiry process ‘on the spot’. Both formative and summative assessment was part of this learning design. Feed-up on skills was given through rubrics, feedback and feedforward through structured recommendations (with help of rubrics) by teachers, peers and experts on the various skills and through formative online multiple choice knowledge domain tests, with answer models as feedback. Weighted summative assessment included 20% in an interdisciplinary domain knowledge test, 30% portlog, 20% scale model and presentation, 10% for contribution to collaboration (through contributions in environment and assessment by peers) and 10% by teachers and the involved experts.

**Figure 1a, 1b, 1c: WeSPOT inquiry based learning model supporting an inquiry on a ‘Colony on Mars’**
Tracking and monitoring ‘time on study’ behaviour to increase self-regulation and time management skills

To support adult students in higher distance education with gaining insight in their study behaviour and to support their acquisition of self-regulation and time management skills, Tabuenca, Kalz, Drachsler & Specht (2014, 2015) developed a mobile study-time and study-behaviour tracker. With this mobile tracker-app, called LearnTracker, installed on their personal mobile device, students could define learning goals and activities, estimate time needed for these tasks, get notifications with self-regulation and time-keeping tips and (personalized) feedback, track the factual ‘time spend on task’ in various environments (with a NFC tracker) and receive feedback on their actual behaviour in the form of visualized statistics (learning analytics). This was done to foster learners’ awareness of their learning objectives and learning moments across daily learning environments. Learners could individually and autonomously track their learning activities in relation to their learning goals at various locations, with various materials and at different moments (number, length, sequence, frequency), e.g. writing a blog entry at work, reading material during waiting time; listening/watching podcasts/books/videos during (car/train transitions). The tracking, feedback and reflection processes were supported through the LearnTracker-app on their personal mobile device. This worked as a boundary object, as learners carry their personal devices during all scattered daily learning moments and learning contexts. Individual visualizations of learning analytics were given as feedback on the percentage of time invested on each learning goal; distribution of learning moments along the day and a comparison of their estimated versus realized time spend on the acquisition of a learning goal (Tabuenca et al. 2014). Additionally, social learning analytics contrasting the time devoted by the student with the time devoted by peers as well as the time initially estimated by the teacher (Tabuenca et al. 2015).

THE ‘SEAMLESS LEARNING’ DESIGN PARADIGM

Looking at the Dutch examples from a system and process perspective and at international literature in the domain, an attempt to describe the distinctive characteristics of the ‘Seamless learning’ concept, from a learning design perspective, is made here. Seamless learning can be looked upon from various perspectives, e.g. as an individual process a learner moves through, or a process that is supported in various manners (e.g. by use of technology, teacher-support), however it can also be seen as a design paradigm, part of the broader family of instructional and learning design paradigms. Looking from this stance, what are the distinctive features of the ‘Seamless learning’ design paradigm in terms of its rationales, criteria guiding design decisions and design elements, processes and mechanisms? Table 1 provides an overview of the identified characteristics of the Seamless learning paradigm.

<table>
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<tr>
<th>Factors of the design space</th>
<th>Attributes</th>
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| Design Rationales and characteristics | - Facilitating ‘cross-over’ and continuity of learning in, from and between environments, boundaries and (social) practices, making most of the characteristics of each environment to enhance (situated) learning, in order to reach a specific set of learning objectives, e.g.: develop applicable knowledge (link theory and practice); awareness of alternative perspectives on the world (e.g. looking from various domains at the same phenomenon) and own identity; development of skills (e.g. self-regulation-, collaboration-, inquiry-, … skills)  
- Facilitating personally meaningful learning, through contextualized, active, socially-embedded and experience-based learning, tapping into and reckoning with personal identity, experiences and talents, emotions/states, phases, ability, behaviour and characteristics of learners  
- Increase differentiation and flexibility of learning and support processes, through time, pace, space/place and practice (in)dependent learning, spanning both formal and informal learning environments  
- Optimizing learning processes (more effective, efficient and enjoyable) across environments and settings through the well-considered use of (a combination of) personal mobile devices and digital technology |
| Design Parameters and dimensions | - Degree of continuity of learning process  
- Pedagogy and didactics  
- Degree of authenticity/contextualization  
- Degree of Technology-enhancement  
- Time (Sequenced or not sequenced, paced, spaced, phasing, frequency, )  
- Space/place (digital and/or physical, synchronous and/or asynchronous)  
- Level of control and ownership of control/agency  
- Level of (un) structure |
Individual and/or collaborative/networked

### Design Elements
- **‘Trigger’**: Cause/reason to start learning activities (e.g. a learning objective, (emerging) question, interest, ‘spark’ or ‘wonder moment’, critical incident, need to solve a problem/take a decision, a personal concern, …)
- **Intent**: Determination and specification of a specific goal or objective
- (Set of ) goal-oriented/intent-driven activities (designed or emerging) and interactions:
  - Learning, monitoring and organizational activities
  - Support, supervision/monitoring, facilitation and (formative/summative) assessment activities
  - Emerging exchanges between actors (e.g. communication, collaboration, (co-)construction); between actors, instruments and objects (e.g. feedback) and between instruments and environments
- **Nudges**: suggestions/recommendations based on activities and environments actors engage with or move through, e.g. dependent on a learners learning path or location
- **Actors**: A person in a specific role, which is not fixed and (ex)changeable across practices (e.g. learner, coach, teacher/instructor, expert, friend)
- **Objects/artefacts**: a natural or designed/(co-)constructed (set of) item(s) with a specific individual or social function that is available in the real and/or virtual world. Objects can be either available (just there) or be co-constructed. E.g. a book, the Eiffel tour, a car, a collection of documents, a collectively written report
- **Instrument**: something with which a person can influence and alter the state of the (real or virtual) world
- **Environment**: Virtual or physical spaces and places
- **Acknowledgement**: a sign of fulfilment of an intent or objective, based on a (formative/summative) evaluation/assessment against a set of quality criteria (e.g. badge, diploma, grade, feedback report, benchmark, points/credits)

### Learning and support processes
A specific set/selection of learning and support activity patterns, supporting:
- Individual and collective/group (meta)cognitive processes (e.g. knowledge (co-)construction, self-co- and collaborative- regulation, reflection)
- Individual behavioural processes (e.g. flow, reflection, skills development, practicing)
- Individual and collaborative interactive processes (between actors, objects and instruments in an (overarching) environment and between environment(s) (e.g. communication, organization, feedback, collaboration, coaching, facilitating, personalisation, differentiation)
- Individual and collective specific/dedicated intentional processes (e.g. inquiring, designing, (co-)creating, experimenting, networking, discovering (e.g. talents), deciding, problem solving)

### Design mechanisms
Mechanisms to support continuity and/or benefit from contextualization:
- **Broker**: facilitate others in taking stances and changing perspectives, thus supporting learning processes
- **Boundary crossing activities**: a person’s (conscious) transitions and interactions across different social practices and settings
- **Discontinuity**: what a person experiences and learns in one context cannot be related to or is in conflict with what (s)he learns in another context.
- **Boundary objects**: artefacts fulfilling a bridging function to assist a person to make a mental connection between their experiences in different social practices and settings, thus enriching and enforcing their mental model
- **Framing/alignment (e.g. thematically, contextually)**: conscious selection of a task with a specific purpose in a (set of) specific environments, facilitating a limited (but effective) number of interactions
- .... (to be elaborated upon)

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<th>Table 1: Distinctive characteristics of the Seamless Learning Design paradigm</th>
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CURRENT STATE OF ADOPTION AND IMPLEMENTATION OF SEAMLESS LEARNING IN THE NETHERLANDS

Between 2010 and 2015 quite some attention was devoted to the concept of ‘mobile’ learning in the Netherlands. However, looking at a SURF (Dutch organization for the advanced use of ICT in higher education) report of that period (SURF, 2013), the example use case scenarios mentioned are mainly focused on lectures in formal educational settings, e.g. to access online study material, check time tables and schedules or to ask a question during a lecture. No essential change and innovation towards alternative (seamless) learning scenarios took place. Although the coverage of mobile devices at that time (2013) already was 100% for a regular mobile phone and between 80 and 100% for a smart phone amongst students in (lower and higher) vocational education and higher education (SURF, 2013, p.42), whether ‘bring your own device’ was acceptable in education was still a topic of discussion. Some occasional scenarios and tools were developed and implemented, e.g. to assist field work in geographical or archeology domain, however remained an exception. Only sporadic implementation of seamless learning scenarios took place and are, until today, still rare. Surely one cannot speak of widespread adoption and implementation of seamless learning throughout educational sectors and at a national level.

Kennisnet (Schouwenburg & Kappert, 2019), a Dutch public organization for Education & ICT in primary, secondary and vocational education and training, recently identified four main key areas and trends in educational innovation with technology. These four areas (Schouwenburg & Kappert, 2019, p.8) were derived from interviews with school leaders, teachers, educational advisers and experts, both in and outside the Netherlands. First, facilitation of authentic learning, with the expectancy that learners learn better in situations which are close to or resemble reality, leading to perceived relevancy of learning (content). Second, support flexible learning, with the expectancy that learning and support activities (educational offer) better match to what individual learners need at a specific moment. Third, to enhance insight in learning (processes), with the expectancy that teachers, students and parents can, e.g. through formative assessment, better monitor what and how learners are learning and that this visibility can improve learners’ learning processes through feedback and reflection. Fourth, a shift of attention towards learning skills, with the expectancy that learners become well-prepared for (lifelong) learning, living and labouring in the future, reckoning with the continuous tension between knowledge, skills and attitudes.

The overlap between these recently identified key drivers of current educational innovation with technology (Schouwenburg & Kappert, 2019) and the design rationales of the seamless learning design paradigm is striking. Therefore, the question is why widespread adoption of the seamless design paradigm and accompanying technological tools nevertheless is currently still faltering in the Netherlands?

An answer may lay in the fact, as indicated in the preview of the latest Horizon report (2019, p.8) that creating a quality mobile learning experience takes a lot of effort, and therefore remains in the early stages of adoption. Indeed, implementation of the Seamless learning paradigm not only requires effort at the level of an individual teacher, but would require change at various levels of an educational institute, as was also indicated by Dutch (secondary school) teachers (Rusman, Tan & Firssova, 2018). They expressed benefits, realistic influences as well as barriers they perceived to broad and sustainable adoption of mobile seamless learning. Out of statements of teachers factors affecting adoption and implementation at three levels were identified, namely that it would require changes in the 1) organization of decision processes at organizational level (e.g. expected benefits of the ‘seamless paradigm’ weighted positively against expected risks), 2) the way organizational change was organized (e.g. broader support of idea by teachers and parents, professionalization and support of teachers, and 3) organization of the design and implementation process in daily educational practices at classroom level (e.g. change of assessment processes, facilitation of learning in-and-outside school, awareness and further development of network and involvement of 3rd parties).

To facilitate these multi-level and complex changes, involvement of stakeholders at various levels is needed. According to Fullan (2006), a complex change challenges current ways of thinking; involves new ways of doing things; implies that outcomes are unpredictable, impacts a number of groups of people and its success depends on generated influence and motivation. Fullan (2006) states that real and persistent complex changes can only be accomplished through effective premises to change and action, namely (p.8-13) a 1) focus on motivating stakeholders, as change is influenced by the thoughts and feelings of those affected, 2) capacity building, with a focus on results, as nothing will change unless people develop new capacities; 3) learning in context, as the process of cultural change depends fundamentally on modeling new expected values and behavior to replace existing ones; 4) changing context, stating that the larger infrastructure must change if success is to occur; 5) a bias for reflective action, as we “do not learn by doing only, but we learn by thinking about what we are doing. It is the purposeful thinking part that counts, not the mere doing” (p.10); 6) tri-level engagement, promote mutual interaction and influence within and across school, regional and national level and 7) resilience – persistence plus flexibility in staying at course. Looking at the future and further implementation and adoption of Seamless learning in the Netherlands, all these premises need to be taken into account coherently.

CONCLUSION AND DISCUSSION

Looking from a system and process perspective at various Dutch seamless learning scenarios and international literature various coherent and distinctive characteristics of the Seamless Learning design paradigm could be identified and further described in terms of 1) Design rationale (s) and characteristics, 2) Design Parameters and dimensions, 3) Design Elements, 4) Learning and support processes and 5) Design mechanisms. As this analysis is grounded in a (limited) set of Dutch
example scenarios and literature, this analysis can be considered as an outset for further (inter)national research collaboration on the Seamless Learning design paradigm, to further define and refine the design space as well as develop knowledge on the effectiveness of implemented designs. Additionally, this paper contained an overview of the current state of adoption and implementation of seamless learning scenarios in the Netherlands. Although the identified design rationales and distinctive characteristics of the Seamless learning paradigm align well with recent envisioned innovations within Dutch education, uptake is still occasional and rare and often only situated at an institutional level. Several causes for this faltering adoption and implementation of the seamless learning paradigm were identified, indicating it would require change strategies and actions at various levels to attain further and future widespread adoption and implementation.

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