Introducing the smart education framework: core elements for successful learning in a digital world

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Abstract: The purpose of this article is to identify crucial elements that are prerequisites for successful experience in a technology-supported environment. Technological advances as well as interdisciplinary insights demand a new perspective on education. This article reflects on these developments and based on this proposes a theoretical framework of smart education for evaluating learning, as well as for guiding educators to design learning activities in technology-supported environments. The proposed framework identifies three core elements, respectively teacher presence, learner presence and technology presence. On the individual level, these elements are subdivided and specified. Teachers presence incorporates student-centred, personalised, and collaborative pedagogical models to design learning in technology-facilitated environments, facilitating the learning process by promoting.

Keywords: smart education; smart education framework; smart pedagogy; smart learner.

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1 Introduction

Recent movements in the field of educational technology and related disciplines all direct at a global educational reform. The educational landscape, increasingly influenced by technological advances (e.g., online learning, learning analytics, utilisation of mobile devices), is rapidly and permanently transforming the way in which teachers provide instructions and students learn, and thus merely disqualify purely traditional educational practices. Besides that, interdisciplinary studies stipulate on the increasingly global awareness of the ‘myth of the average student’. Evidence directs towards individuality in learning and suggests education reformers to personalise learning. Insights from educational psychology, cognitive neuroscience and biology indicate the importance of individuality in learning, illustrated by cognitive preferences and dynamic learning paths (Fischer and Daley, 2006; Siegler, 2007; Fischer et al., 2010). On the pedagogical level, education is further transformed. New approaches, such as the flipped classroom and creative community, fundamentally change the way education is organised and how students themselves participate. Within these innovative educational practices, they are encouraged to proactively explore content and partake in creative thinking as well as critical reflection, whereas their teachers are converted to consultants, providing tailored guidance. In this, technology functions as an educational catalyst, empowering both teachers and students via digital learning power and thus overcoming traditional obstacles as e.g., time constraints and stimulation and guidance that are collective directed towards on average mindset – and therefore fail to address individual talent and potential. Another important evolution, considering students and their learning, are changing demographics. The last decade gave birth and rise to digital natives – students that are born in a technological world and intuitive use technology in daily life (Palfrey and Gasser, 2013), although their digital dominance is critically debated (Bennet et al., 2008). Their presence further substantiates the urge for new educational practices. Together, these demographic, pedagogical and technological developments, accompanied by interdisciplinary evidence for individuality in learning and personalised learning paths, all direct at educational reform. The introduction of a new and, considering its multidisciplinary foundations, comprehensive approach in learning. One that facilitates personalised learning incorporates innovative technology and encompasses dynamic features in such a way, that its pedagogical applicability transcends the exponential developments of these technologies. A new educational paradigm that is based on all relevant perspectives, embraces the future as well as the past, and provides clear guidelines for intelligent education in a smarter world: a smart education.

Technological advances and accompanied educational innovations – such as internet accessibility, portability of devices (e.g. smartphones, tablets) and seamless learning services – have permanently changed the way in which education is provided, tough with one constant element: a further integration of technology in the educational landscape. Advocates of ubiquitous computing have long been documenting the classroom benefits of student interaction with mobile technology (e.g. laptops and in recent years also tablets and smartphones) (Banister, 2010). And in a world penetrated by technology, it only seems logical that our educational systems would be similarly deploying a utilising technology for learning purposes.

Since the rising of the first tablet schools – such as the IPad-schools and e-schoolbag project –, schools worldwide have been exponentially embracing tablet-technology for educational purposes. Although the utilisation of the functionality still is considered
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limited, the type of education is already breaking with traditional educational in many ways (examples).

With the rise of big data, educators see themselves equipped with innovative analytics such as educational data mining and learning analytics, enabling them to cost-effectively empower, support and facilitate practice and critical research, although this young discipline still needs many guidelines in ensuring optimal inclusion in education. One of the criticised ‘bonuses’ of the big data analysing is ethics (Mayer-Schönberger and Cukier, 2013; Eynon, 2013).

The birth – and success – of new educational approaches such as, among others, the flipped classroom, clearly illustrate the emerging innovation in global education. The flipped classroom is regarded as a form of blended learning in which students learn content online by watching video lectures before they physically meet in the classroom (Zhang et al., 2012). Subsequently homework is done in class with teachers and students discussing and solving questions. Teacher interaction with students is more personalised and rather perceived as (participative) guidance than (passive) lecturing (Lage et al., 2000; Baker, 2000). In the flipped classroom didactics, the crucial component is that the students study before going to school, instead of after school and thus swaps the arrangement of knowledge imparting and knowledge internalisation compared to traditional education (Zhang et al., 2012). Confronted obstacles can thus be distilled from the work and later on analysed in the classroom. This tendency to practice problem based education directs at personalised learning via addressing specific problems with the guidance of the teacher in the form of a consultant, sharing specific knowledge and expertise focused on the inquiries.

Recent studies address the relevance of the flipped classroom in the different educational settings (Butt, 2014; McLaughlin et al., 2014). A comprehensive survey of the research on the flipped classroom by Bishop and Verleger (2013) show that students overall are positive on this unorthodox learning approach, although it must be said that their data show mixed results. Anecdotable evidence directs at improved learning results, however the authors state that currently little investigating that aims at objective learning outcomes have been realised (Bishop and Verleger, 2013). Although these studies clearly indicate that the flipped classroom method can be beneficial towards learning, there are also reports indicating no effects on e.g., learning outcomes in terms of examination scores (Zhao and Ho, 2014). In their review of utilising the flipped classroom in higher education, O’Flaherty and Phillips (2015) state that evidence on improved student performance and their perspectives is emerging, although primarily indirectly, however that long term learning ability effects needs to be proven over time.

Interdisciplinary studies demonstrate the importance of individuality in learning, dynamic and personalised learning paths (Fischer and Daley; Siegler, 2007). Traditional education fails to facilitate optimised learning for each individual. Research indicates that only a small percentage of the students in traditional education experience a match based on cognitive ability, learning preferences and the provided instruction (Fischer and Daley, 2006; Fischer et al., 2010).

These elements all motivate towards a new perspective on learning and education. A smart perspective, in coherence with the demanding of a smarter world. Smart education as an educational principle has been conceptualised by Zhu and He (2012) as “The essence of smarter education is to create intelligent environments by using smart technologies, so that smart pedagogies can be facilitated as to provide personalized learning services and empower learners to develop talents of wisdom that have better
value orientation, higher thinking quality, and stronger conduct ability”. This study therefore proposed a new framework on smart education. Based on the changing educational perspectives and methodologies, transforming pedagogies as well as technological advances, a study on the foundations of learning in a smarter world is considered. Building on existing models and theories, this paper proposes a new framework in education: smart education framework.

2 Smart education framework

The purpose of the smart education framework is to describe essential elements in a technology-facilitated environment that on the one hand helps learners to achieve higher thinking quality and leads to innovation and creativity and on the other hand enables teachers to personalise learning. The three essential elements in a technology-facilitated smart education environment are teaching presence, technological presence, and learner presence. The teaching presence, consisting of three components, is shared by both the instructor and students. It describes the teaching role in a smart education system as instructional design, facilitation and direct instruction, and technological support. The learner presence is defined by learners’ abilities to being autonomous and collaborative learners as well as efficient users of technologies. The technological presence concerns to what extent technologies can create connectivity, provide ubiquitous access to learning resources and adapt to personal needs. Although the technological presence is not directly connected to learning, it provides a foundation for learning to occur.

2.1 Teaching presence

2.1.1 Teacher’s roles in technology-facilitated environments

The teacher plays an essential role in traditional classrooms. The teacher’s role in a technology-facilitated environment, however, has been continuously explored by researchers. Berge (1995) proposed four roles of an online moderator, including managerial, social, pedagogical, and technological. Similarly, Paulsen (1995) and Mason (1991) conceptualised three major roles of teacher in online conferences: organisational, social, and intellectual.

Based on these models, Garrison et al. (1999) describe the teaching presence in the community of inquiry framework, which is one of the commonly accepted frameworks in computer-mediated learning. This framework was originally proposed in the context of higher education, and has been used beyond higher education as time goes on.

Garrison et al. (1999) conceptualised teaching presence as one of the three essential elements in a community of inquiry. The community of inquiry framework assumes that learning occurs in a computer-mediated environment when teaching presence, cognitive presence, and social presence interact with each other. Garrison et al. (2001) proposed three components of teaching presence: instructional design and organisation, facilitating discourse, and direct instruction. The technological component was not included in the teaching presence because Anderson et al (2001) argued that teacher’s technological support role would fade as students were getting familiar with the online environment.

Empirical evidences on the existence of teaching presence have been found in 55 online courses in a US university (Arbaugh, 2007). In addition, extensive research has
been conducted to explore the role of teaching presence in a community of inquiry. Studies indicate that teaching presence is essential to support higher order thinking in a computer-mediated environment (Garrison et al., 2010; Akyol and Garrison, 2008). The absence of teaching presence in an online learning environment would prevent students to achieve the integration and resolution phases of cognitive presence (Kanuka et al., 2007; Pawan et al., 2003).

2.1.2 Teaching presence in the smart education framework

While the existing models tend to describe teacher’s roles in computer-mediated learning environments, most of them have constrained learning environments to online courses and computer conferences. The use of technologies in classrooms, however, is not limited to online environments. The development of mobile technologies has removed the boundaries of time and space and taken the technology-facilitated learning beyond computers (Looi et al., 2010). In addition, the emergent of new pedagogies and teaching models have provided various ways of using technologies other than online courses and computer conferences.

Thus, in the smart education framework, we define teaching presence as using student-centred, personalised, and collaborative pedagogical models to design learning in technology-facilitated environments, facilitating the learning process by promoting interactions and providing feedback/direct instructions, and supporting learners to use technologies. We conceptualise teaching presence in the smart education framework as having three major components: instructional design, facilitation and direct instruction, and technological support.

2.1.2.1 Instructional design

The instructional design is an essential element in both traditional and technology-facilitated learning environments, which includes setting up learning objectives, organising learning activities, and providing rules and guidance. Studies indicate that proper instructional models and course designs has positive impacts on helping students to develop higher order thinking abilities and to achieve higher levels of cognitive presence (Garrison and Cleveland-Innes, 2005; Kanuka et al., 2007).

With the increasing use of technology in education, various new instructional models have emerged, such as flipped classroom, seamless learning, and maker education. In addition, technologies are used to facilitate traditional teaching models, such as problem-based learning (PBL) and collaborative learning. The use of technologies in the classroom is continuously developing as new technologies emerge. Thus, we do not constrain the instructional design component of teaching presence in the smart education framework into a specific instructional model or structure of teaching. Rather, we describe its major characteristics as student-centred, personalised, and collaborative.

The student-centred teaching approach emphasises students’ initiatives and ownership of learning (Brandes and Ginnis, 1996; Roger, 1969). Roger (1969) argued that the major responsibilities of teachers were to create an environment for learning to happen, rather than providing direct instructions. The student-centred teaching approach has been wildly accepted and adapted in technology-facilitated learning environments (Hannafin and Land, 1997; Sandholtz, 1997). Hannafin and Land (1997) stated that technologies helped
to overcome barriers in creating student-centred learning environments that supported problem-solving and critical thinking.

Personalised learning is another important characteristic in the instructional design component of teaching presence in the smart education framework. Recent studies in physiology and neurosciences indicate that learning is an individual process, which recommends personalised learning paths (Jonassen and Grabowski, 2012; Siegler, 2007). In the traditional classroom, learners’ characteristics and differences cannot be met all the time because of the limited class time and resources. With the development of technologies, researchers have developed various learning systems such as web-based learning system (Chen, 2008) and interactive e-book (Huang et al., 2012) to provide personalised learning paths to students.

Collaborative is the third characteristic of the instructional design component. We have adapted this characteristic from the knowledge building community (Scardamalia and Bereiter, 1996, 2003; Scardamalia, 2002). The knowledge building community focuses on problem solving and collective knowledge building rather than passing on knowledge (Scardamalia and Bereiter, 1996), which shares the same goal of the smart education framework. Scardamalia and Bereiter (2003) argued that knowledge building leaded to creation and invention, and the knowledge building process was contributed by every member of the community, who shared a same goal and had the ownership of knowledge.

2.1.2.2 Facilitation and direct instruction

All three characteristics of the instructional design component emphasise learners’ ownership of learning. Thus, the instructor plays a role of facilitator in the smart education framework. The responsibilities include but not limited to promote interactions among students, encourage participation, and facilitate discourses. Besides facilitation, direct instruction, similar to any context, is another component in teaching presence of the smart education framework. The direction instruction component is when “teachers provide intellectual and scholarly leadership and share their subject matter knowledge with students” [Anderson et al., (2001), p.8].

2.1.2.3 Technological support

Besides the instructional design and the facilitation and direct instruction, providing technological support to students is another component in teaching presence. Studies has showed that students expect to get technological supports from the teacher (Buzzard et al., 2011), and the teacher’s confidence on the use of technology has a positive effect on implementing technologies in the classroom (Hartnell-Young and Vetere, 2008).

2.2 Learner presence

Important learning theorists such as Pavlov, Cattell, Vygotsky, Skinner, Watson and Piaget significantly influenced they way we perceive learning and our current understanding of learning still heavily relies on frameworks constituted by these scholars. However, given the recent shift towards a focus on individuality in learning and personalised education as well as the emerging power of educational technology, their
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traditional perspectives are now considered limitative and are thus reiterated in the context of the digital age.

When discussing learning we address the acquiring of new knowledge and skills where new information and impressions influence existing knowledge, skills and behaviour. More specific, it is claimed to be the act of acquiring new, or modifying and reinforcing, existing knowledge, behaviours, skills, values, or preferences and may involve synthesising different types of information. Traditionally, this process was predominantly perceived as a passive process, where on the one hand the teacher – as a source of knowledge – facilitates the learning material, and where the learner on the other hand, merely consumes this presented stimuli. Passively and based on constant repetition. The smart education perspective dramatically changes this, in line with interdisciplinary indicators as described in the introduction.

Over the past decades, the learning paradigm has been constantly shifted, or adjusted, to, more precisely, connect with learner demands and in classroom results. Learning transitions changed mere repetition into inquiry style techniques and procedures. The PBL perspective viewed learning as a proactive process where the learner is confronted with a problem – a gap between the current and the goal state (Robertson, 2008) – and he or she is instructed to proactively bridge the gap via problem solving, rather that content mastering (Boud and Feletti, 1998). Here the role of the learner clearly disqualifies the passive role and aims at utilising personal learning ability in learning. Others have pointed out to the process and contextual determinants of learning. They consider learning a process (Lachman, 1997) that occurs in an active environment (Grabinger and Dunlap, 1995), depending on situated factors, such as contextual and cultural influencers (Brown et al., 1989; Lave and Wenger, 1991). More recently, insights from neurobiology and cognitive psychology and – neuroscience have indicated that learning is an individual process, again changing the collective passive perceptive and urging personalised instructions and learning paths (Fischer and Daley, 2006; Jonassen and Grabowski, 2012; Siegler, 2007). Scholars point out to indicating which learner characteristics are diagnostic in performance and behaviour. Developments in the field of the cognitive neurosciences may assist in identifying relevant learner characteristics and may provide insight as to how and why these characteristics are predictive of learner ability and behaviour. Although some scholars argue that using insights from this field have not yet matured enough to be used to explain concrete learner behaviour (Bruer, 1997; Klahr, 2011), evidence to the contrary has been reported as well (Goldstein and Naglieri, 2014).

We conceptualise learner presence in the smart education framework as consisting of three major components: autonomous learner, collaborative learner and an efficient technology user.

2.2.1 Autonomous learner

Individuality is becoming key in education. The average student perspective is increasingly accepted as highly flawed and disregarded in favour for the perspective of individuality in learning and with individual learning preferences and abilities. Learners are now perceived as individual learners with personal talents and interests and that learning is optimal when these factors are considered. Learners need a match in their cognitive system and what is being provided within the educational setting. In the light of this personalised learning, teaching strategies are less rigid and learners more free in their learning based on personal preferences and abilities. As a consequence learners need to
show ownership of learning. Their passive role is replaced with proactive participation, driven by personal abilities, desires and needs. Their overall learning behaviour needs to be proactive and their participation directed at intentional interactivity, focused on the incorporation of new information in existing mental heuristics and aimed at consolidating knowledge. Interest functions as a motivational catalyst and creativity is fostered.

2.2.2 Collaborative learner

Although individual and individuality are becoming more dominant within the educational context, and standardisation is transformed in dynamic and personalised learning paths, the collective in learning still plays a fundamental part. Learners collaborate with each other to learn from each other. In addition to that, they gain socio-emotional benefits via collaboration. Also, collaboration not only provides immediate gains, such as the named model learning, sense of belonging and role identification, but also provides competences for future roles to play, such as partaking in a work team. Via educational technology, learners are able to enhance their collaboration roles and its accompanying effects (e.g., collaborative writing via online tools).

2.2.3 Efficient technology user

In order to fully participate in a smart education environment, the learner should be able to use technology in such a way that it provides the right climate for optimal learning to occur. This means that the learner utilises technology for specific learning goals, such as watching content online as mandatory in the flipped classroom. The new generation of learners, described by the international community as digital natives, are suggested to be more familiar with technology in daily life than their educational predecessors. They are suggested to show enhanced digital skills (Palfrey and Gasser, 2013), however some studies indicate otherwise (Bennet et al., 2008). Therefore, both teacher and learners should pay attention towards the developments of these skills, in order to empower them digitally and ensure optimal participation in education.

The intensified technology integration within learning requires learners to be competent technology users. This technology implementation has given rise to cognitive phenomena such as computer self-efficacy. Computer self-efficacy is defined as the “judgement of one’s capability to use a computer” (Compeau and Higgins, 1995) and it is considered to be the extent to which an individual values its own ability to interact with computers. Computer self-efficacy is considered to have a significant impact on an individual’s expectations towards using computers (Compeau and Higgins, 1995), its usage and performance in technology-based courses (Kinzie and Delcourt, 1991; Oliver and Shapiro, 1993).

2.3 Technological presence

Technological presence is a mediate element in the smart education framework. Although it does not connect to learning directly, the technology facilitates to create the environment for learning to happen. Based on the characteristics of teaching presence and learner presence, we conceptualise technological presence in the smart education framework as connective, ubiquitous, and personalised.
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- **Connective:** Connectivity is one of the important features that technologies provide to support education (Klopfer et al., 2002), which helps to facilitate the collaborative instructional design in the smart education framework. While interactions among students are limited to face-to-face in the traditional classroom, technologies create more ways for students to keep connected, both with each other and with the teacher. For example, Web 2.0 technologies provide students with both asynchronous and synchronous ways of communication.

- **Ubiquitous:** In recent years, the development of mobile technologies has changed people’s way of living and has great influences on education (Chan et al., 2006). The use of portable mobile devices and cloud computing technologies in education enable students to study whenever and wherever they want. Thus, the ubiquitous access to learning resources is another characteristic of technological presence in the smart education system, which is able to facilitate various instructional models.

- **Personalised:** With the help of big data and learning analytics, technologies are able to provide personalised learning experience to every learner. Personalised is the third characteristic of technological presence in smart education. It is expected that technologies that used in smart education would provide each student with personalised learning experience, and different learning paths.

The combination of teacher, learner and technology presence gives rise to the smart education paradigm. When all three core elements interact in a complementary way a smart education process will emerge, as Figure 1 is illustrating.

**Figure 1** Smart education (see online version for colours)

When examining these core values in greater detail a smart education framework can be constituted. Table 1 is showing the three elements of teacher, learner and technology presence and their specific functions, which can be used as guidelines for implementing smart education within the educational environment.
Table 1  Smart education framework

<table>
<thead>
<tr>
<th>Categories</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching presence</td>
<td>Instructional design: Use student-centred, personalised, and collaborative pedagogical models to design learning</td>
</tr>
<tr>
<td>Facilitation and direct instructions</td>
<td>Facilitate the learning process by promoting interactions and providing feedback/direct instructions</td>
</tr>
<tr>
<td>Technological supports</td>
<td>Support learners to use technologies</td>
</tr>
<tr>
<td>Connective</td>
<td>Support social interaction and collaboration</td>
</tr>
<tr>
<td>Ubiquitous access</td>
<td>Ubiquitous access to learning resources</td>
</tr>
<tr>
<td>Personalised</td>
<td>Adapts to personal needs</td>
</tr>
<tr>
<td>Autonomous learner</td>
<td>Self-directed learners</td>
</tr>
<tr>
<td>Collaborative learner</td>
<td>Abilities to be a collaborative learner</td>
</tr>
<tr>
<td>Efficient technology user</td>
<td>Abilities to learn how to use new technologies</td>
</tr>
</tbody>
</table>

3 Discussion

3.1 Combining the teacher, technology and learner

On the abstract level we could conceptualise that smart education distinguishes itself from traditional education via the principle of proactive participation. Where traditional education is primarily passive instruction – teacher providing knowledge-based instruction where students ‘listen and learn’ –, smart education emphasises proactive elements such as self-directed learning and creative ability. In smart education, the teacher is proactive in knowledge building, providing not only knowledge, but help learners recognise individual ability and stimulate personal talents and skills. The students also participate proactive e.g., in preparing learning material, critically reflect and contribute to the overall individual and collective learning (group learning et cetera). Technology helps facilitate this process. The teacher can use technology in personalised learning (e.g., ad hoc regulation via monitoring like with e-schoolbag, creating material for the flipped classroom method et cetera). The students use (adaptive) technology to personalise learning (dynamic).

3.2 The essential role of teachers

Although recently many claims are made on using technology to revolutionise learning, we still consider the teacher as the central pillar of learning. Students are increasingly considered autonomous in their learning (self-directed proactive learners) in technology-facilitated environments, but their knowledge building and skill developed still heavily relies on guidance and stimulation via a professional guider.

In the smart education framework, we propose three essential elements in teaching presence as instructional design, facilitation and direct instruction, and technological
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The teacher plays a role as instructional designer in a smart education environment, who are responsible for selecting proper instructional models, developing course materials, designing learning activities, and choosing proper technologies to facilitate learning. In addition, the teacher’s role as a facilitator is important in the proactive learning process. Although students are expected to be self-directed learners in a smart education environment, the teacher still takes responsibilities for promoting engagements, enhancing the sense of community among students, identifying students’ strength and weakness to provide direct instructions, and monitoring the learning process. Thus, we argue that it is the teacher who is in the leading role, rather than the technology, in a smart learning environment.

3.3 Student level

In this perspective we would like to stress the importance of the educational level on the hierarchy of influence as described. Primary school students – especially before they reach the first level of analytical reasoning, around the age of 11 – need different guidance and show different levels of proactive behaviour than secondary or even university level students. In addition to their cognitive abilities psychological influences such as computer self-efficacy also influence the claimed importance of the teacher and technology.

4 Future research

This paper presents a new framework for smart education. Based on technological advances, pedagogical developments and accompanying interdisciplinary perspectives and via the introduced core elements of teacher, learner and technology, smart education for learning in the digital age is presented. Although the presented framework incorporates multiple theories in respect to the core foundations of smart education, the framework is still limitative. Scholars are therefore invited to study the framework by validating its current elements and functions and/or extending it via additional functionalities. The following future research directions are proposed based on the smart education framework. First, future research is needs to find the empirical verification of the three presences in smart education environments. Although the characteristics of the teaching presence, the technological presence, and the learner presence are described in the present study, specific indicators for each characteristics in the practice still needs to be explored. Second, the relationships among the teaching presence, the technological presence, and the learner presence needs further research, such as how they support and affect each other. In addition, how the teaching presence, the technological presence, and the learner presence affect learning outcomes are still unknown. Third, case studies of smart education practice are needed, such as instructional models in smart education and technologies that can be used in a smart education environment. How a specific instructional model affects learning outcomes in a smart education environment and how to design a specific technology-felicitated learning environments are another future research direction of smart education framework.
References


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