The impact and reach of MOOCs: a developing countries' perspective

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Topic of Special Edition

Transforming Education through Innovation and Technology

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eLearning Papers aims to make innovative ideas and practices in the field of learning more visible by highlighting different perspectives involving the use of technology.

eLearning Papers

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eLearning Papers is part of the www.elearningeuropa.info portal, an initiative of the European Commission's Directorate-General for Education and Culture, aiming to promote the use of ICT for lifelong learning. The site provides access to extensive information on policy, activities and resources and act as a European platform for cooperation and dissemination of good and innovative practice in the use of multimedia technologies and the internet for improving the quality of learning.

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Editorial

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Learning anywhere - Opening up Education and the promise of MOOCs

Open technologies allow all individuals to learn, anywhere, anytime, through any device, with the support of anyone. Open educational resources, and especially MOOCs, provide alternative ways for students to gain new knowledge. They can also enhance learners' ability to think creatively to select and adapt a paradigm to solve the problem at hand. Production of good quality MOOCs requires a lot of work and expertise. The flipped classroom method benefits from the availability of open learning resources but requires change of attitude and new skills for teachers. Today's learners expect more personalisation, collaboration and better links between formal and informal learning. This calls for changes not only in organisation and leadership in education, but also in teacher education and professional development. Otherwise the most important benefits that technology in education can provide (being increased efficiency and equity) are not achieved.

Our perception of what constitutes a good learning environment has changed. We need to re-conceptualise, re-design and rethink the use of space. Schools and campuses need to be well connected with the surrounding urban fabric and society. Learning spaces should be inspiring and stimulating. They should encourage collaboration and embrace informal learning and serendipity by means of providing facilities for informal meetings and functioning extensions in cyberspace. It is generally recognised that the quality of design increases if the stakeholders' interests are considered in the design process. Not having learners and teachers participate in the design decisions concerning their learning and working environment would be beyond all reason.

Digital literacy is crucial for being able to confidently and effectively use digital media for the purposes of work, learning and leisure. It consists of the ability to access digital media and ICT, to search, understand and critically evaluate different aspects of digital media and media contents, and to communicate effectively in a variety of contexts. Without basic digital literacy, it is difficult to fully participate in society.

These are some of the topics that have been covered by eLearningPapers during the past year. We have selected twelve articles that we consider the most intriguing and inspiring for you to enjoy.

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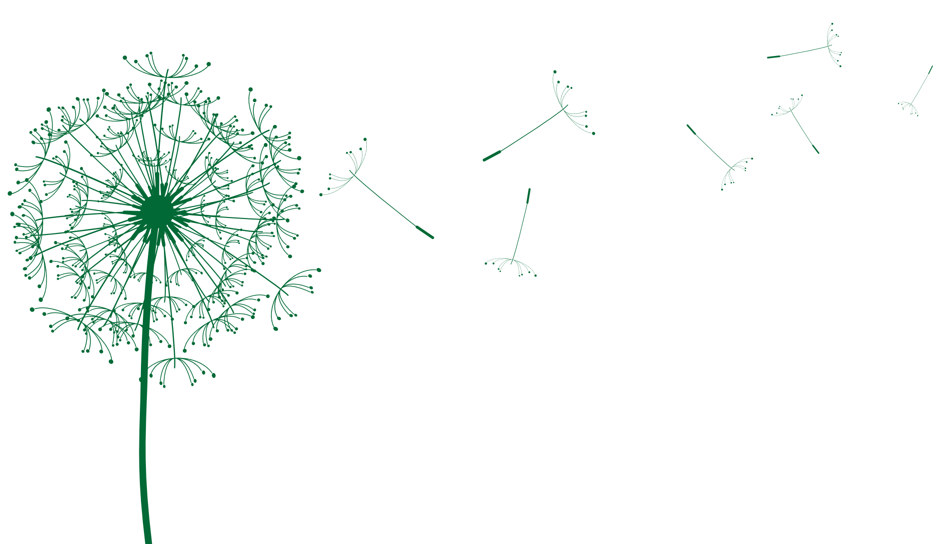

In-depth

Fostering analysis and discussion
on Learning trends in Europe

In-depth

DIGCOMP: a Framework for Developing and Understanding Digital Competence in Europe [▲]

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Summary

The paper describes the digital competence framework developed by EC JRC IPTS on behalf of DG Education and Culture with the overall aim to contribute to the better understanding and development of digital competence in Europe. Digital competence is one of the eight key competences for lifelong learning and is essential for participation in our increasingly digitalised society. It is therefore necessary to understand and define what digital competence is and consists of. The paper discusses various aspects of digital competence firstly differentiating it from other similar or overlapping concepts, then discussing the implication of the historic evolution of the term, finally detailing the digital competence framework in its constituting parts. The proposed digital competence framework consists of 21 competences divided in 5 areas. For each competence three proficiency levels are foreseen. Current and possible applications of the framework are discussed.

Tags

Digital Competence, Digital Literacy, Frameworks, Key Competences

1. Introduction

Information and communication technologies (ICT) brought many changes and challenges in everyday life (Silverstone & Haddon, 1996) and education is one of the fields where impact can be observed. New forms of teaching and learning are emerging (Redecker at al., 2011), new formats of educational resources have appeared and being used by teachers and students (e.g. digital resources, open educational resources, educational platforms). Concepts as lifelong learning, information society, knowledge society all emphasize the importance of ICT as a motor for greater social inclusion, quality of life and competitiveness in the labour market and economic growth.

The use of ICT in teaching and learning has become one of the key components in educational policies of developed countries and is increasingly becoming an object of scientific research. The concept of digital competence occupies a strong position in European policy documents, actions and initiatives (examples include: Digital Agenda, Communication on rethinking education, Opening up education, Grand coalition for digital jobs).

Already in 2008 ICT cluster set up under the Education and Training 2010 Work Programme released the following message: "Lifelong learning strategies need to answer to the growing need for advanced digital competence for all jobs and for all learners. Learning digital skills not only need to be addressed as a separate subject but also embedded within teaching in all subjects. Building digital competence by embedding and learning ICT should start as early as possible, i.e. in primary education. This includes learning to use digital tools critically, confidently and creatively, with attention paid to security, safety, and privacy. Teachers need to be equipped with the digital competence themselves, in order to support this process." (EC ICT cluster, 2008)

Digital competence is a universal and basic need for all citizens for working, living and learning in the knowledge society. In many European countries, digital competence is now considered to be of great strategic significance in both the public and private lives of citizens (EU Skills Panorama, 2012). As discussed by Ala-Mutka (2011), digital competence benefits many aspects of our life e.g. social, health, economic, civic, cultural, societal.

It is doubtless that we live an e-permeated society (Martin & Grudziecki, 2006), where 'being digital' (Negroponte, 1995) equals to being functioning (Gilster, 1997) and integrated. Digital competence is nowadays conceived as an essential requirement for life (Bawden, 2008), or even as a survival skill (Eshet-Alkalai, 2004). Notwithstanding this central role, literature and surveys warn against the inadequate digital literacy levels of both the younger (Newman, 2008) and the older population (European Comission, 2010a). Digital competence is a transversal key competence which enables acquiring other key competences (e.g. language, mathematics, learning to learn, cultural awareness). It is related to many of the so-called 21st century skills which should be acquired by all citizens, to ensure their active participation in society and the economy.

The concept of digital competence is a multi-faceted moving target, covering many areas and literacies and rapidly evolving as new technologies appear. It is moreover at the convergence of multiple fields. Being digitally competent today implies the ability to understand media, to search for information and be critical about what is retrieved, and to be able to communicate with others using a variety of digital tools and applications. All these abilities belong to different disciplines and traditions. Analysing the repertoire of competences related to digital literacy requires an understanding of all these underlying conceptualisations.

2. Scanning the horizon: digital competence among related terms

Establishing what digital competence is (and is not) is easier done than said. The concept is a highly debated one, at least in the academic and policy arenas: while some speak about digital competence (Krumsvik, 2008), others refer to digital literacy (Bowden, 2001; Eshet-Alkalai, 2004), or prefer the notion of e-skills, or again strongly argue for computer literacy (Oliver & Towers, 2000; Reed, Doty, & May, 2005). There are those who defend the fact that digital competence is part of media literacy, and those who on the contrary believe that media literacy belongs to the wider domain of digital competence (Bawden, 2001; Buckingham, 2003; Hartley, McWilliam, Burgess, & Banks, 2008; Knobel & Lankshear, 2010; Livingstone, 2003). All these positions create a proliferation of terms that can sometimes hardly be differentiated. In the following lines we will provide a brief overview of some selected terms that are associated with digital competence and summarise how they are conceived in academic and EU policy contexts.

Digital Literacy

In the European Commission working paper (European Commission, 2008) digital literacy was defined as "the skills required to achieve digital competence. It is underpinned by basic skills in ICT and the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet". The definition indicates that digital literacy comprises of basic ICT skills, which lead to digital competence. However, in the academic field, digital literacy is used as a synonym for digital competence. Moreover, Anglo-Saxon scholars tend to prefer term 'digital literacy'.

e-Skills

E-skills is used by DG Enterprise and industry1 and focuses mainly on skills at the workplace.

There is a differentiation between three groups of users:

a) ICT practitioner skills are the capabilities required for researching, developing, designing, strategic planning, managing, producing, consulting, marketing, selling, integrating, installing, administering, maintaining, supporting and servicing ICT systems.

b) ICT user skills these represent the capabilities required for the effective application of ICT systems and devices by the individual. ICT users apply systems as tools in support of their own work. User skills cover the use of common software tools and of specialised tools supporting business functions within industry.

At the general level, they cover "digital literacy": the skills required for the confident and critical use of ICT for work, leisure, learning and communication.

c) e-Business skills (also called e-leadership skills) These correspond to the capabilities needed to exploit opportunities provided by ICT, notably the Internet; to ensure more efficient and effective performance of different types of organisations; to explore possibilities for new ways of conducting business/administrative and organisational processes; and/or to establish new businesses.

One of the outcomes of this policy line is the eCompetence framework (EC 2010b), which is a reference framework for ICT practitioners and ICT business contexts.

In the academic context, the term 'e-skills' is mainly used when referring to the above-mentioned policy activities.

Media literacy

By European Commission, Media literacy is considered an important overall skill in everyday life and at every age. At the end of 2007, the Commission adopted a communication on media literacy - A European approach to media literacy in the digital environment.

Media literacy is defined as: "… the ability to access the media, to understand and to critically evaluate different aspects of the media and media contents and to create communications in a variety of contexts." (EC, 2007).

There is a long academic tradition on studies in media literacy. Media education is typically concerned with a critical evaluation of what we read, hear and see through the media, with the analyses of audiences and the construction of media messages, and the understanding of the purpose of these messages (Buckingham, 2003). Its closeness with semiotics and social studies kept media literacy away from the more technical, tool-related ICT literacy. Even nowadays, university courses and school curricula keep a distinctive split between these two disciplines (Sefton-Green, et al., 2009).

Digital competence

European Parliament and the Council (2006), based on the Communication of DG Education and Culture, have approached digital skills and competences2 from the lifelong learning point of view, defining Digital Competence as one of the 8 Key Competences :

1 http://ec.europa.eu/enterprise/sectors/ict/e-skills/index_en.htm

2 See website http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:394:0010:0018:EN:PDF

Digital competence involves the confident and critical use of Information Society Technology (IST) for work, leisure and communication. It is underpinned by basic skills in ICT: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet.

In the academic context, digital competence is mainly used by Scandinavian scholars (Krumsvik, 2008).

3. Unrolling a recent past: Digital competence yesterday and today

Leaving the theoretical and semantic debates aside, digital competence (or literacy, or other related competences and literacies) could be defined tautologically as the ability to use digital technologies. If we assume this definition as an obvious and consensual one, we should nevertheless recognise that the digitalisation of society implies changes in the connotation of the expression 'digital technology'. Twenty years ago, digital technology was often understood as a synonym for 'computers', whereas nowadays it embraces media, mobile phones, leisure tools as television sets and video game consoles. In 1997, Glister's influential definition of 'digital literacy' speaks about the ability to use computers. In more recent times, the upsurge of concepts as 'multimodality' (Kress, 2003, Walsh, 2009) underlines how digital competence covers a plethora of tools, modes of transmission/communication, and semiotic resources. Furthermore, the term 'technology' does not only refer to a wider set of devices and modes than it did for our parents, it moreover implies a number of adapted, new, and fast-changing practices: we do things in a different way than before, and we do things we did not use to do. Examples include buying products online (thus facing risks related to personal information and security or to bogus products) and tagging information (thus requiring an ability to organise and retrieve the information we come across).

Some considerations on the meaning of 'literacy' and 'competence' are probably due. The notion of literacy (the ability to read and write) refers to a basic life skill and is traditionally associated with books and printed matter. It also denotes a decoding and encoding process. Certainly, the ability to read and write in today's society includes digital texts. Moreover, there is a strong encoding and decoding (if not of straight coding) component in several digital tasks. Nevertheless, as technologies are not just computers, digital literacy/competence is not only about coding, even if understood as 'deciphering'. Although 'literacy' is often used nowadays as an umbrella word to indicate a wide fan of abilities, it should not be forgotten that the term brings a core meaning that deviates from the matter. Instead, 'competence' refers to the categorisation of a discipline in a series of intertwined knowledge, skills and attitudes, the three learning domains envisaged by Bloom (1956). Therefore, a discussion on competence rather than literacy brings the focus on the constituting elements of the term, while taking it away from a highly contextualised notion as 'literacy'. In particular, it underlines the fact that having the 'know how' (i.e. skills, i.e. the ability to do something pragmatically) is not enough. A very basic example: are you able to format a word text? You certainly are, on your computer with your default programme. You know you have to click on a certain icon, choose an option from a scroll-down menu, you perfectly know the path you have to follow (even if probably without a computer in front of you, you will not remember it by heart). But then, one day you find yourself having to use a different computer (or a mobile phone or other device to accomplish the same task), or maybe the technology company updated the software to a higher version, and in doing so you find yourself faced with a different graphic, different menus, different paths. At this point the ability to format becomes as useless as the lack of it. What one needs in this situation is the ability to understand how a programme works, what it can do for you, and how you can find your way around it (or whom to ask eventually). It can be argued that what is foremost needed today are the right attitudes – for instance, adaptability – rather than the right skills.

In-depth

As we were arguing before, we have witnessed a paradigmatic change on the use and adoption of technologies. However, in our opinion this change is not reflected in the way we conceive the competences that are needed in the digital domain. Until the 80s, technologies were the tools of a minority of professionals. From the 90s, with the shift from programming languages to graphical user interfaces, technologies became more available to society. At the same time, there was a change in the type of knowledge that was needed to use them, as it was no more necessary to be able to programme and code but to operate specific applications. Technological shifts and the spill-over effects on the related competence change they entail can be seen as a spiral of unknown end. Technologies keep becoming user-friendlier, and therefore more pervasive, and therefore more needed than ever before. Technological changes bring about renewed sets of competences, as in the case of Web2.0 uptake, its implications on citizen's privacy, and the need to know how to protect one's privacy. The upsurge of new tools and practices reshape digital competence, which has been recognised from earlier on (Glister, 1997) as a 'mind set' enabling the user to adapt to new requirements set by the evolving technologies. However, there is a tendency to promote, develop, and assess a certain notion of digital competence that does not necessarily take into account the evolving nature of technologies and their adoption. In 2004, the Department of Education of Ireland reported that many approaches to digital competence did not take into account higher order thinking skills, which are so fundamental, for instance, when judging the validity of the information on the Internet. A more recent analysis suggests that while approaches tend to include critical and thinking competences, the main focus still remains on operational, application-oriented skills. If 50 years ago technologies were for a specialised few, and the shift from professional courses to mass certification schemes was made, now there is a need to make a new shift to promote and grasp the 'reflective' side (Erstad, 2010) that is needed for taking advantage of the current technology use.

In a nutshell, educating people in becoming digitally included and competent has to shift away from the consolidated tradition of teaching them how specific software works (thus fomenting operational skills) and to move towards educating for competence, thus fomenting skills together with knowledge and attitudes. This implies the need to be critical and reflective on what we do with technologies, aware of the possibilities and the risks that technologies offer, and ready to move along technological changes in order to keep up-to-date with the latest developments. It is with this aim and along this philosophy that the DIGCOMP framework has been created.

4. The DIGCOMP study method and structure

In order to create a consensus at the European level about the components of Digital Competence, the DIGCOMP study was launched by JRC-IPTS IS Unit under an Administrative Agreement with DG Education and Culture with the aim to contribute to better understanding of digital competence and to develop Digital Competence framework in Europe. The aim of the project was to identify exhaustive but conceptual descriptors of Digital Competence.

In the context of this work, digital competence is to be understood as the set of knowledge, attitudes and skills needed to take an active part in digital environments and to reap the benefits of technologies for everyday life. It is a basic competence for lifelong learning and can be considered as a continuum, ranging from partial digital inclusion to mastery at professional level. The digital competence of individuals depends on each person's needs, interests, and context, and has therefore to be adapted to those. Digital competence depends as well on technological availability and users' adoption practices, therefore its detailed definition is likely to change over time. As a consequence, being digitally competent means to be able and willing to keep abreast with new technological developments and practices.

The DIGCOMP framework can serve as an umbrella or meta-framework where other current existing frameworks, initiatives, curricula and certifications can find themselves. Therefore, even if the framework is exhaustive in collecting all the possible competences that are needed nowadays to be fluent in a digital environment, it allows for these competences to be applied in different ways and degrees so that, on the one hand, current curricula can be tracked onto the framework and so that, on the other hand, curricula or initiative developer can have the freedom to interpret the given competence and apply it according to their own context.

The project was being carried out between January 2011 and December 2012, following a structured process: conceptual mapping, case study analyses, online consultation, experts' workshop and stakeholders' consultation. After a first data collection phase, aimed at collecting competences as building blocks from different sources (academic literature and policy documents, existing frameworks, opinions of experts in the field), a draft framework was proposed and submitted to a number of experts for reiterative feedback and consultation. Over 150 stakeholders actively contributed to the building or refinement of the final output. The framework was presented at different stages of development at about 10 different conferences and seminars. Feedback from questions and comments of participants to these events were taken into account.

The structure of the DIGCOMP has been taken and elaborated from the eCompetence framework for ICT professionals (eCF).3

The decision is based on two arguments:

the eCF uses clear structure that has received extensive stakeholders support;

the use of the same shell will allow both projects to be cross-referenced.

Another framework that was used as a good example for the elaboration of the DIGCOMP proposal was the Common European Framework of Reference for Languages (CEFR). The CEFR provides a self-assessment grid built on three proficiency levels (each of them is then split into two sub-levels). The CEFR self-assessment grid is also supported by a more extensive toolkit that sets the standards for the evaluation of learning outcomes of foreign languages. The structure of the CEFR can be seen in particular in the phrasing of the proficiency levels.

5. The DIGCOMP framework

The DIGCOMP framework consists of five areas of digital competence and 21 competences. Competences are detailed in three proficiency levels. The framework is presented in a tabular form. It is a matrix which consists of different dimensions and that can be presented in several ways. In the original framework (Ferrari, 2013), for every competence there are examples of knowledge, skills and attitudes and also examples on how the competence can be applied for two different purposes (namely: learning and employment).

Figure 1 shows an example of a competence table. The reader is referred to the DIGCOMP final report for consulting the complete framework.

Five areas of digital competence were identified and can be summarised as follows:

1. **Information:** to identify, to locate, to retrieve, to store, to organise and analyse digital information, judging its relevance and purpose.
2. **Communication:** to communicate in digital environments, to share resources through online tools, to link with others and to collaborate through digital tools, to interact with and to participate in communities and networks, cross-cultural awareness.
3. **Content-creation:** to create and edit new content (from word processing to images and video); to integrate and re-elaborate previous knowledge and content; to produce creative expressions, media outputs and programming; to deal with and apply intellectual property rights and licences.

3 See: http://www.ecompetences.eu/

In-depth

Dimension 1 Name of area	**Information**		
Dimension 2 Competence title and description	**1.2 Evaluating information** To gather, process, understand and critically evaluate information		
Dimension 3 Proficiency levels	A - Foundation	B- Intermediate	C- Advanced
	I know that not all online information is reliable.	I can compare different information sources.	I am critical about the information I find and I can cross-check and assess its validity and credibility.
Dimension 4 Knowledge examples	Can analyse retrieved information Evaluates media content Judges the validity of content found on the internet or the media, evaluates and interprets information Understands the reliability of different sources Understands online and offline information sources Understands that information sources need to be cross-checked Can transform information into knowledge Understands power forces in the online world		
Skills examples	Is able to deal with information pushed at the user Assesses the usefulness, timeliness, accuracy and integrity of the information Can compare, contrast, and integrate information from different sources Distinguishes reliable information from unreliable sources		
Attitude examples	Recognises that not all information can be found on the Internet Is critical about information found Is aware that despite globalisation certain countries are more represented on the Internet Is aware that search engine mechanism and algorithms are not necessarily neutral in displaying the information		
Dimension 5 Application to purpose			
Learning	I have found some information from different sources about society in the 1500s, but I'm not sure how to judge its value.	I have found a range of different sources about society in the 1500s, and I've looked for the origins of the material as a way to judge their value.	I have found a range of different sources about society in the 1500s, I've looked for the sources they originate from, I've removed some because the academic nature of the sources is not clear, and I've checked details across the sources to see how valid they may be.
Employment	I have been asked to look at sales of certain products, but I'm not sure how reliable the figures that I've obtained are.	I have been asked to look at sales of certain products, and I've checked the sources of figures that I've obtained so I have an idea of how reliable they may be.	I have been asked to look at sales of certain products, I've checked the sources of figures that I've obtained so I have an idea of how reliable they may be. I've taken out those that appear to be unreliable, and I will check with colleagues or experts about the likely validity of those that appear to be more consistent.

4. Safety: personal protection, data protection, digital identity protection, security measures, safe and sustainable use.

5. Problem-solving: to identify digital needs and resources, to make informed decisions on most appropriate digital tools according to the purpose or need, to solve conceptual problems through digital means, to creatively use technologies, to solve technical problems, to update own and other's competence.

It should be noted, that all five areas are of equal importance, nevertheless information, communication and content creation are rather linear while safety and problem solving are more transversal. This means that while areas 1 to 3 deal with competences that can be re-traced in terms of specific activities and uses, areas 4 and 5 apply to any type of activity that is carried out through digital means. Although each area has its own specificity, there are several overlapping points and cross-references to other areas. For instance, the creation of content implies at some point competences related to communication – when sharing the knowledge and content that has been produced.

For each of the above listed competence areas, a series of related competences were identified. Competences in each area vary in number from a minimum of 3 to a maximum of 6. Competences in the framework are numbered, however the progression does not refer to a different degree of attainment. The first competence in each area is the one that includes more technical aspects: in these specific competences, the knowledge, skills and attitudes have operational processes as a dominant component. However, technical and operational skills are also embedded in each competence.

Further we present the framework more in detail. For the scope of this paper, each area is presented separately and briefly discussed. In order not to exceed the scope of the paper, only areas, competences and levels are presented.

1. Information

The area information comprises three competences: 1.1) Browsing, searching & filtering information, 1.2) Evaluating Information, 1.3) Storing and retrieving information.

'Information' is certainly at the core of digital competence, and has been so since the beginning: Glister's definition (1997) is in fact centred on information. However, the way we deal with digital information is no more the same: nowadays, for instance, searching for information is as important as being able to filter it.

As already mentioned, some competences are more technical and linear, while other are more transversal and interrelated. While browsing, searching and storing information are more technical competences, evaluating information is more transversal and includes higher level of understanding and critical thinking. According to CRAAP test, there are 5 criteria, to evaluate information: Currency (the timeliness of the information), relevance (the importance of the information found), Authority (the source of the information), Accuracy (the reliability, truthfulness, and correctness of the informational content) and Purpose (The reason the information exists).

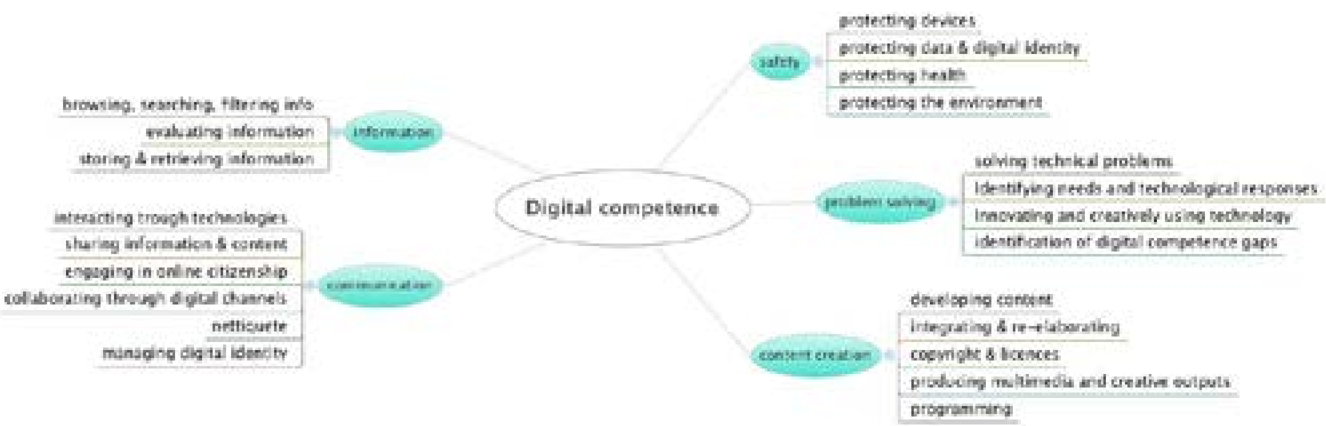

Table 1: Area 1 – Information

Area	**1 Information**		
Competence title and description	**1.1 Browsing, searching & filtering information**		
	To access and search for online information, to find relevant information, to select resources effectively, to create personal information strategies		
	A - Foundation	B - Intermediate	C - Advanced
Proficiency levels	I can do some online searches through search engines. I know that different search engines can provide different results.	I can browse the internet for information and I can search for information online. I can select the appropriate information I find.	I can use a wide range of search techniques when searching for information and browsing on the Internet. I can filter and monitor the information I receive. I know whom to follow in online information sharing places (e.g. micro-blogging).
Competence title and description	**1.2 Evaluating Information**		
	To gather, process, understand and critically evaluate information		
Competence title and description	A - Foundation	B - Intermediate	C - Advanced
	I know that not all online information can be trusted.	I can compare different information sources.	I am critical about the information I find and I cross-check and assess its validity and credibility.
Competence title and description	**1.3 Storing and retrieving information**		
	To manipulate and store information and content for easier retrieval, to organise information and data		
Proficiency levels	A - Foundation	B - Intermediate	C - Advanced
	I know how to save files and content (e.g. texts, pictures, music, videos, and web pages). I know how to go back to the content I saved.	I know how to save, store or tag files, content and information and I have my own storing strategy. I can retrieve and manage the information and content I save or stored.	I apply different methods and tools to organise files, content, and information. I can deploy a set of strategies for retrieving the content I or others have organised and stored.

2. Communication:

The area comprises six competences: 2.1) Interacting through technologies, 2.2) Sharing information and content, 2.3) Engaging in online citizenship, 2.4) Collaborating through digital channels, 2.5) Netiquette, 2.6) Managing digital identity.

This area is certainly the one more associated to Web 2.0 practices, social media and participatory web. The listed competences are of equal importance despite numbering and the fact that some are more technical in nature. It can be argued that competences 2.1 and 2.3 are very similar, however, 2.1 emphasises the technical skills and knowledge (being familiar with different possibilities, e.g knowing which applications allow VoIP and screen sharing at the same time), while 2.3 supposes collaborative skills.

Table 2: Area 2 – Communication

Area	**2 Communication**		
Competence title and description	**2.1 Interacting through technologies**		
	To interact through a variety of digital devices and applications, to understand how digital communication is distributed, displayed and managed, to understand appropriate ways of communicating through digital means, to refer to different communication formats, to adapt communication modes and strategies to the specific audience		
Proficiency levels	A - Foundation	B - Intermediate	C - Advanced
	I can communicate with others using technologies (e.g. mobile phone, or VoIP, or chat, or email).	I can use several digital tools to communicate with others (e.g. mobile phone, VoIP, chat, email).	I am engaged in the use of a wide range of tools for online communication (emails, chats, SMS, instant messaging, blogs, micro-blogs, SNS). I can adopt digital modes and ways of communication that best fit the purpose. I can tailor the format and ways of communication to my audience. I can manage the different types of communication I receive.
Competence title and description	**2.2 Sharing information and content**		
	To communicate with others the location and content of information found, to be willing and able to share knowledge, content and resources, to act as an intermediary, to be proactive in the spreading of news, content and resources, to know about citation practices and to integrate new information into an existing body of knowledge		
Competence title and description	A - Foundation	B - Intermediate	C - Advanced
	I know how to share files and content with others through simple technological means (e.g. sending attachments to emails, uploading pictures on the internet, etc.)	I know how to participate in social networking sites and online communities, where I pass on or share knowledge, content and information.	I can actively share information, content and resources with others through online communities, networks and collaboration platforms.

Competence title and description	**2.3 Engaging in online citizenship**		
	To participate in society through online engagement, seeks opportunities for self-development and empowerment in using technologies and digital environments, is aware of the potential of technologies for citizen participation		
Proficiency levels	A - Foundation	B - Intermediate	C - Advanced
	I know that technology can be used to interact with services (e.g.: government, hospital or medical centres, bank).	I can use online services (e.g.: government, hospital or medical centres, bank, eGoverment services, etc).	I am actively participating in online spaces. I know how to get actively engaged in online participation and I can use several online services.
Competence title and description	**2.5 Netiquette**		
	To have the knowledge and know-how of behavioural norms in online/virtual interactions, to be aware of cultural diversity aspects, to be able to protect self and others from possible online dangers (e.g. cyberbullying), to develop active strategies to discover bed behaviour		
Proficiency levels	A - Foundation	B- Intermediate	C- Advanced
	I know some basic principles for communicating with others through digital means	I know the principles of online etiquette and I am able to apply them in my own context	I can apply the various aspects of online etiquette to different digital communication spaces and contexts.
Competence title and description	**2.6 Managing digital identit**y		
	To create, adapt and manage one or multiple digital identities, to be able protect one's e-reputation, to deal with the data that one produces through several accounts and applications		
Proficiency levels	A - Foundation	B- Intermediate	C- Advanced
	I am aware of the benefits and risks related to digital identity	I can shape my online digital identity and keep track of my digital footprint	I can manage several digital identities according to the context and purpose, I can monitor the information and data I produce through my online interaction, I know how to protect my digital reputation

3. Content creation:

There are five competences in this area: 3.1) Developing content, 3.2) Integrating and re-elaborating, 3.3) Copyright and Licences, 3.4) Producing multimedia and creative outputs, 3.5) Programming

This competence area is fairly technical and linear. It is about being able to deal with different software, application and ability to code, nevertheless creative outputs presuppose collaboration, which can be also found in communication area, as well creating knowledge with technologies can also be part of the problem solving area.

Copyright and licences is a competence which emphasises attitudes and knowledge and is as well related to other competences.

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Table 3: Area 3 – Content creation

Area	3 Content creation		
Competence title and description	**3.1 Developing content**		
	To create content in different formats, to edit and improve content that s/he has created or that others have created		
Proficiency levels	A - Foundation	B - Intermediate	C - Advanced
	I can produce simple digital content (e.g. text, or tables, or images, or audio, etc.).	I can produce digital content different formats (e.g. text, tables, images, audio, etc.).	I can produce digital content in different formats, platforms and environments. I have expertise in the production of content using various multi-media application tools.
Competence title and description	**3.2 Integrating and re-elaborating**		
	To modify, refine and mash-up existing resources to create new, original and relevant content and knowledge.		
Competence title and description	A - Foundation	B - Intermediate	C - Advanced
	I can make basic changes to the content that others have produced.	I can edit, refine and modify the content I or others have produced.	I can mash-up existing items of content to create new ones.
Competence title and description	**3.3 Copyright and Licences**		
	To understand how copyright and licences apply to information and content		
Proficiency levels	A - Foundation	B - Intermediate	C - Advanced
	I know that some of the content I use can be covered by copyright.	I have an intuitive knowledge of the differences about copyright, copyleft and creative commons and can apply some licences to the content I create.	I know how different types of licences apply to the information and resources I use and create.
Competence title and description	**3.4 Producing multimedia and creative outputs**		
	To improve and innovate with ICT, to actively participate in collaborative digital and multimedia production, to express him/herself creatively through digital media and technologies, to create knowledge with the support of technologies		
Proficiency levels	A - Foundation	B- Intermediate	C- Advanced
	I can use some simple technology to create multi-media original outputs.	I can use a variety of digital tools for creating multimedia outputs.	I can produce original and creative digital and media output.
Competence title and description	**3.5 Programming**		
	To program applications, software, devices, to understand the principles of programming, to understand what is behind a program		

Proficiency levels	A - Foundation	B- Intermediate	C- Advanced
	I can modify some simple function of software and applications.	I can use some basic tools to program. I understand the different parts of a computer or device.	I can code and program in several languages, I understand the systems and functions that are behind programs.

4. Safety

There are four competences: 4.1) Protecting devices, 4.2) Protecting data and digital identity, 4.3) Protecting Health, 4.4) Protecting the environment.

Safety is an area, which is very transversal and interrelated to other competences. Some of the competences are already embedded into other areas (e.g. managing digital identity and netiquette) but all of the competences form safety area can be applied to almost all activities in digital environment.

It is also very much the "awareness" competence area – today it is important that people are aware of what kinds of threats exist on-line.

Table 4: Area 4 – Safety

Area	**4 Safety**		
Competence title and description	**4.1 Protecting devices**		
	To protect own devices and to understand online risks and threats, to know about safety and security measures		
Proficiency levels	A - Foundation	B - Intermediate	C - Advanced
	I can use basic steps to protect my devices (for instance: using anti-viruses, passwords, etc.).	I know how to protect my digital devices.	I frequently update my security strategies.
Competence title and description	**4.2 Protecting data and digital identity**		
	To understand common terms of service, active protection of own data, understanding other people privacy, to protect self from online fraud and threats and cyber bulling		
Competence title and description	A - Foundation	B - Intermediate	C - Advanced
	I know that I can only share certain types of information about myself or others in online environments.	I can protect my own online privacy and that of others. I have a general understanding of privacy issues and I have an intuitive knowledge of how my data is collected and used.	I often change the default privacy settings of online services to enhance my privacy protection. I have an informed and wide understanding of privacy issues and I know how my data is collected and used.
Competence title and description	**4.3 Protecting Health**		
	To avoid health-risks related with the use of technology in terms of threats to physical and psychological well-being		

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Proficiency levels	A - Foundation	B - Intermediate	C - Advanced
	I know how to avoid cyberbulling. I know that technology can affect my health if misused.	I know how to protect myself and others from cyberbulling and I understand the health risks associated with the use of technologies (from ergonomics aspects to addiction to technologies).	I am aware of the correct use of technologies to avoid health problems. I know how to find a good balance between online and off-line worlds.
Competence title and description	**4.4 Protecting the environment**		
	To be aware of the impact of ICT on the environment		
Proficiency levels	A - Foundation	B- Intermediate	C- Advanced
	I can take basic measures to save energy.	I understand the positive and negative aspects of the use of technology on the environment.	I have an informed stance on the impact of technologies on everyday life, online consumption, and the environment.

5. Problem solving

The area comprises four competences: 5.1) Solving technical problems, 5.2) Identifying needs and technological responses, 5.3) Innovating and creatively using technology, 5.4) Identification of digital competence gaps.

"Problem solving" is the most transversal competence area and the one where the need to bring a 'reflective' attitude is most evident. In the framework it is a stand-alone area, although elements of problem solving can be found in all competences. For instance, the competence area "Information" (area 1) includes the competence "evaluating information", which is part of cognitive dimension in problem solving. Communication and content creation include several elements of problem solving (namely: interacting, collaborating, developing content, integrating and re-elaborating, programming…). Despite including problem solving elements in relevant competence areas, it was seen necessary to have a dedicated stand-alone area about problem solving, as for the relevance this aspect has on the appropriation of technologies and digital practices. It can be noted that some of the competences listed in areas 1 to 4 can also be mapped into area 5.

Table 5: Area 5 – Problem solving

Area	**5 Problem solving**		
Competence title and description	**5.1 Solving technical problems**		
	To identify possible problems and solve them (from trouble-shooting to solving more complex problems) with the help of digital means.		
Proficiency levels	A - Foundation	B - Intermediate	C - Advanced
	I can ask for targeted support and assistance when technologies do not work or when using a new device, program or application.	I can solve easy problems that arise when technologies do not work.	I can solve a wide-range of problems that arise from the use of technology.

Competence title and description	**5.2 Identifying needs and technological responses**		
	To assess own needs in terms of resources, tools and competence development, to match needs with possible solutions, adapting tools to personal needs, to critically evaluate possible solutions and digital tools		
Competence title and description	A - Foundation	B - Intermediate	C - Advanced
	I know that I can only share certain types of information about myself or others in online environments.	I can protect my own online privacy and that of others. I have a general understanding of privacy issues and I have an intuitive knowledge of how my data is collected and used.	I often change the default privacy settings of online services to enhance my privacy protection. I have an informed and wide understanding of privacy issues and I know how my data is collected and used.
Competence title and description	**5.3 Innovating and creatively using technology**		
	To innovate with technology, to actively participate in collaborative digital and multimedia production, to express oneself creatively through digital media and technologies, to create knowledge and solve conceptual problems with the support of digital tools		
Proficiency levels	A - Foundation	B - Intermediate	C - Advanced
	I know that technologies and digital tools can be used for creative purposes and I can make some creative use of technologies.	I can use technologies for creative outputs and I can use technologies to solve problems (i.e. visualizing a problem). I collaborate with others in the creation of innovative and creative outputs, but I don't take the initiative.	I can solve conceptual problems taking advantage of technologies and digital tools, I can contribute to the knowledge creation through technological means, I can take part in innovative actions through the use of technologies. I proactively collaborate with others to produce creative and innovative outputs.
Competence title and description	**5.4 Identification of digital competence gaps**		
	To understand where own competence needs to be improved or updated, to support others in the development of their digital competence, to keep up-to-date with new developments.		
Proficiency levels	A - Foundation	B- Intermediate	C- Advanced
	I am aware of my limits when using technologies.	I know how to learn to do something new with technologies.	I frequently update my digital competence needs.

6. Conclusions

The DIGCOMP framework, developed by EC JRC-IPTS on behalf of DG Education and Culture, contributes to the ongoing discussion on the understanding and development of digital competence for all. The framework provides detailed descriptions of all the competences that are necessary to be proficient in digital environments and describes them in terms of knowledge, skills, and attitudes.

The framework as such has already been used as support to policy in the following instances:

It was endorsed by the EAC Thematic Working Group on ICT and Education which represents the Member States' Ministries of Education, as a guideline for curricula development and teacher professional development.

It was adopted as an input to Action 62: EU-wide indicators of digital competences of the Digital Agenda on proposing EU-wide indicators of digital competence.

It has also been accepted as a framework for e-skills indicators in Eurostat's household survey in the 2015 study.

The Commission will, within an action in the "Opening up Education: Innovative teaching and learning for all through new technologies and open educational resources" Communication and in cooperation with stakeholders and Member States, test the DIGCOMP framework as a digital competence framework with a view to supporting its full implementation and the future development of an EU self-assessment tool for digital competences. (EC, 2013).

When working on policy, DG Education and Culture will use this framework as the basis for the development of an EU Reference Framework, like the one that already exists for languages. It will therefore contribute to the future European Area of Skills and Qualifications4 that will propose several reference frameworks for different competences under one single access point.

It should be noted, that the framework should not be static – with quick changes in the digital world, there is a need for regular revisions and updates of the framework. Moreover, although this framework benefited from the opinions and feedback of a variety of stakeholders, up to now its applicability has not been tested yet. It is therefore likely that, once applied in real educational context, the different areas or descriptors will be subject to change.

It is foreseen to continue along this research line with the development of digital competence indicators which would enable monitoring and assessment of levels of digital competence of citizens.

[4] http://ec.europa.eu/dgs/education_culture/more_info/consultations/documents/skills-back_en.pdf

Complete document can be downloaded at: http://ftp.jrc.es/EURdoc/JRC83167.pdf

The views expressed in this article are purely those of the authors and they should not be regarded as the official position of the European Commission.

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In-depth

Personal Learning Environments in Smart Cities: Current Approaches and Future Scenarios [▲]

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Summary

With the increasing number of the global population living in densely populated and technologically advanced urban spaces, the notion of smart cities is gaining importance, especially in view of *citizen engagement, learning and participation*. We propose to consider smart cities as learning spaces and call for innovative pedagogical approaches for using technologies embedded in physical environments to support **connected** and *ubiquitous learning* in **smart cities**. In this paper, we discuss smart cities as spaces for constructing Personal Learning Environments. Our special focus is on mobile and locative media, which open new possibilities of interaction with the surrounding environment. In technology-rich infrastructures such as smart cities, physical objects, including buildings, works of art or points of interest, can become part of the learning environment. When mediated through technologies, e.g. by means of mobile and locative media, the surrounding physical environment and the digital environment can be dynamically merged into *augmented, ad-hoc Personal Learning Environments*. In this paper we give a short introduction to smart cities, smart citizens and smart city learning, and go on to outline some innovative applications of mobile and locative media in urban spaces, including *open badges, smart glasses* and *mobile tagging*, and discuss their potential for learning. Followed by these examples, we discuss *educaching* as an approach to smart city learning and provide some practical examples based on the example of *etiquetAR*, a mobile, locative application that allows creating interactive tags to support augmented learning experiences. We then present the results of an international, explorative study on smart city learning, which we conducted with educators from Europe, North America, South America, Middle-East and Asia-Pacific. Based on the synopsis of current research and practice and the results of our study, we argue for an extended view of Personal Learning Environments which are not permanent, but created ad-hoc and adjusted dynamically by connecting virtual and physical spaces in smart cities.

Tags

smart city learning, urban computing, educaching, glocality, personal learning environments

Languages

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1. Defining Smart City Learning

The notion of "smart cities" has recently triggered a lot of technology-focused discussions and research, including the Horizon 2020 strategy of the European Commission. The Horizon 2020 strategy named several key concerns for the future of the European Union: smart, inclusive, and sustainable growth; security, citizenship and Global Europe; and stimulating interactions between societal challenges and the development of generic enabling and industrial technologies.(COM, 2011). In view of the "smart cities" agenda, Horizon 2020 focuses on smart urban applications enabling innovative solutions targeting energy efficiency (e.g. alternative energy sources), smart transport (e.g. new mobility concepts), and enabling technologies (e.g. nano-science, bio-science), but also understanding the social, economic and cultural issues that are involved in the transformation of urban centers into smart cities (COM, 2011, pp. 60-61). Eurocities, the network of major European cities bringing together over 130 of Europe's largest cities and addressing several policy areas related to living in cities, emphasises the role of smart cities as *living labs* for market, public, social and cultural innovations (Eurocities, 2012). Smart cities can be also viewed as smart learning environments, i.e. environments which exploit new technologies and approaches, such as ubiquitous and mobile learning, to support people in their daily lives in a proactive yet unobtrusive way (Mikulecký, 2012). In this sense, smart cities as smart learning environments utilize the idea of ambient intelligence by integrating diverse computation, information and communication resources into a united framework of an ambient intelligent space (Cook et al., 2009; Mikulecký, 2012).

Although smart cities can be approached from several dimensions, such as technological, human or institutional (see a complete review about these different approaches in Nam & Pardo, 2011), in this paper we adopt a human-centered perspective. Following the definition by Woods & Bloom (2001), we understand the concept of *smart cities* as "the integration of technology into a strategic approach to sustainability, citizen well-being, and economic development". From this perspective, smart cities can be viewed as complex ecosystems supported by technological infrastructures transforming *citizen engagement, learning and participation*. In our view, the notion of smart cities goes far beyond technologies and technological infrastructures. We argue that smart cities cannot be smart without *smart citizens*. In order to achieve sustainable societal changes we first and foremost need smart citizens who are knowledgeable and empowered to actively use technologies to transform living environments to smart spaces. As Horizon 2020 points out, building resilient and inclusive societies entails enhancing societal awareness and participation of citizens in decision-making (COM, 2011). We believe that it is necessary to refocus the strategy of smart cities from smart technologies and infrastructures to smart citizens. As Hill (2013) points out, the danger of the smart city vision predicated on feedback loops delivering information to influence citizen attitudes and behaviour is that citizens may become passive in response to technological infrastructure becoming active.

Refocusing the concept of smart cities from smart technologies to smart citizens is also closely linked to learning in smart cities. This issue has been just recently raised as a response to current smart city policies. The initiative on *Smart City Learning* and the related *International Observatory on Smart City Learning* are dedicated to the future of learning in smart cities and intend to foster a change in the current reflection on smart city learning (Giovanella, 2013). In this context, a number of articles propose new conceptualisations of smart cities: Giovanella et al. (2013) emphasize citizen involvement with the city and propose to consider cities as "open libraries" containing a huge number of resources, such as buildings or artworks, that can be used for learning; Calori et al. (2013) suggest to think about smart city learning as a navigation of trajectories in terms of space, time, roles and resources, which can be supported by connecting episodes across past, present and future experiences; Sintoris et al. (2013) propose the notion of "technology enhanced places", i.e. places with embedded technologies, supporting new kinds of learning, especially constructing contextual knowledge by moving and operating in an authentic environment; McCullough (2013) emphasises the importance of attention in the context of ambient urban computing. He proposes embodied cognition, making use of environmental features as building blocks for thought, as a framework for smart city learning.

Inspired by the concepts outlined above, we define **smart city learning** from a human-centered perspective as the learning experience of locally and globally interconnected citizens who use smart technologies to learn by using, sharing, remixing and co-constructing learning resources, and in this way actively contribute to solving societal, environmental, political and economic challenges. From this perspective, the "smartness" of the learning environment is determined primarily by the citizens and their uses of smart technologies rather than technologies themselves. Derived from the technological viewpoint of "smart" as expressed by Poslad (2009), we define *smart learners* as active, networked, autonomous and in control of own resources. The proposed conceptualisation of smart city learning is thus akin to *participatory urbanism*, i.e. uses of "emerging ubiquitous urban and personal mobile technologies to enable citizen action by allowing open measuring, sharing, and remixing of elements of urban living marked by, requiring, or involving participation, especially affording the opportunity for individual citizen participation, sharing, and voice" (Paulos et al., 2009). While participatory urbanism focuses on engaging in grassroots efforts including *citizen science*, smart city learning is a broader term and encompasses formal, informal and mixed learning experiences in urban spaces.

2. Extending the view of Personal Learning Environments

Technological advancements, such as positioning systems, wireless technologies, ubiquitous computing and the increasing adoption of mobile technologies, allow citizens to connect anytime and anywhere, linking remote places, resources and people. This pertains not only to urban but also increasingly to rural and remote areas. In smart cities, however, technological infrastructures and digital ecosystems build far more complex and advanced interconnections, opening new opportunities for constructing Personal Learning Environments. The rapid adoption of connected technologies, devices and networks across growing urban landscapes has been termed as *urban computing* (Paulos et al., 2009). With the ever increasing number of urban citizens (with approx. 75 % of the global population living in urban centres), the growth of digital infrastructures and the proliferation of interconnected personal digital tools such as smartphones and the recently emerging wearable computing, traditional physical constraints of time and space transcend and the notions of sociality, spatialization and temporalization have to be redefined (Golloway, 20014; Paulos et al., 2009).

Taking as point of departure Meyrowitz's concept of "glocality" and Cereau's concept of "practiced places", we propose a conceptualization of Personal Learning Environments (PLE) as permeable physical and virtual spaces, which are dynamically constructed through the subject's practice of movements across physical and virtual spaces. While understanding "space as a practiced place" (Certeau, 1988), new media and technologies expand our practice, or the "movements of everyday life" beyond the local. As our "practices" in physical and virtual spaces become interlaced, our spatial experience changes: "We live in glocalities, where the local and the global coexists" (Meyrowitz, 2005). However, no matter how sophisticated technologies are, "the localness of experience is a constant" (Meyrowitz, 2005, pp. 21). As human beings we cannot detach ourselves from our local, physical experience, but as we use technologies, the localness and the virtuality of our experience become tightly fused. This happens for example when we move in a physical place (e.g. city), which is a relational environment with different elements distributed in a coexisting relationship (Certeau, 1988), with a group of people (e.g. students) using mobile devices (e.g. smartphones, tablets) to interact with subjects (e.g. social media users) and objects (e.g. digital content) which are not within our immediate physical proximity. In this sense, PLE are constructed through the practice of "movement" across spaces. Sharples et al. (2009) differentiate between mobility in the physical space, mobility of technology, mobility in conceptual space, mobility in social space and mobility in time, as different types of movement in terms of "flows across locations, times, topics and technologies". We believe these notions are applicable to constructing Personal Learning Environments, especially with mobile and locative media. By moving across spaces, contexts, concepts and time we are able to capture and share our personal learning experiences in new ways. For example, from the perspective of *ubiquitous computing* encompassing smart devices, smart environments and smart interactions (Smart DEI), learners in smart cities are provided with enhanced mobility, interaction and control possibilities (Poslad, 2009), all enabling new forms of learning across *multiple contexts.*

In this respect, Pérez-Sanagustín et al. (2013) propose three central attributes of technologies capable of supporting smart city learning. These include *multi-channel, multi-objective and multi-context learning*. First, technologies for smart city learning have to support *multi-channel learning*, which is an active and participatory process engaging diverse agents and supporting multi-directional conversations in multiple channels in the smart city ecosystem. Second, technologies for smart city learning have to support *multiple-objective learning*, which supports learners in following personal, idiosyncratic objectives and learning patterns. Third, technologies for smart city learning have to support *multi-context learning*, which enables not only learning anywhere and anytime, but also combining physical and virtual spaces transforming urban elements into learning resources (Pérez-Sanagustín et al., 2013).

Thus, we can think of constructing Personal Learning Environments in smart cities as *blending spaces* that together create opportunities for learning in networked and integrated urban infrastructures (Sharples et al., 2013). In smart cities, personal resources may be augmented with infrastructures and data embedded in the city by using personal devices such as *smart phones, smart watches* or *smart glasses*, all capable of enhancing our interactions with both physical and digital world. Based on the key principle of Personal Learning Environments, it is the learner that becomes the main actor in such augmented spaces. In smart city learning, learners may transform multiple spaces into a personal environment for learning by both interacting with the environment and connecting to other learners in order to receive, share, remix and co-create information.

As the "Innovating Pedagogy 2013" report points out, the new emerging learning experiences take on diverse pedagogical forms (Sharples et al., 2013). Thereby, seamless learning, crowd learning, geo-learning or citizen inquiry seem to be especially relevant in the context of smart city learning. Seamless learning describes an emerging pedagogical practice of connecting learning across settings, technologies and activities. As a pedagogical method, seamless learning aims at creating a seamless flow of learning experiences across such contexts as formal education and daily life. *Seamless learning* results from learners extending their personal technologies for learning across times and locations, blending learning with everyday life (Sharples et al., 2013). *Crowd learning* focuses on harnessing the knowledge of many people and utilizing "the power of the masses" to support learning experiences. By applying mobile technologies in crowd learning, the information flows between the crowd and the learner, and the expertise of the crowd can be accessed anytime and anywhere on learner's personal device. In this sense, crowd learning transfers ownership of the learning process to the learner but at the same time requires tools and mechanisms to guide learners, recognise their progress, and reward contributions (Sharples et al., 2013). *Geo-learning* refers to learning in and about locations. *Geo-learning* can take placeboth indoors and outdoors, and utilizes context-aware and position-based technologies for mixing physical and digital elements. In geo-learning experiences, the technology is used to add interactive points and layers of digital information to physical spaces, which offers the possibility of interconnecting locations and social settings, as well as facilitating the exchange of information across contexts. Connecting contexts may be seen as a way of stimulating seamless learning, for example by moving themes explored in the classroom to outdoor settings and flowing back to the classroom to enrich lessons (Sharples et al., 2013). Finally, *citizen enquiry* as a pedagogical approach combines inquiry-based learning and citizen activism in order to support creative knowledge building, citizen investigations and scientific practices of social value (Sharples et al., 2013).

These and other new pedagogical approaches may be applied to support smart city learning. Since any moment in the city can become a "learning moment", in which people can relate their knowledge from different contexts, constructing Personal Learning Environments becomes *ad-hoc* and *dynamically adapted* by the learner to the current context rather than pre-designed to equip the learner with necessary tools to cope with upcoming situations. From this perspective, *ubiquitous learning*, i.e. detecting and identifying the surrounding context to provide guidance, resources and collaborators for learning (Yang et al., 2009), provides new reference points for conceptualising Personal Learning Environments in context of smart city learning. These include but are not limited to mobility, location awareness, interoperability, seamlessness, situation awareness, social awareness, adaptability and pervasiveness (Yang et al., 2009).

3. Smart City Learning Practices

Given the new technological opportunities and pedagogical practices, this section outlines some of the current applications of emerging media in urban spaces. Then, the results of an international, explorative study which aimed at eliciting educational scenarios in context of smart city learning are presented and discussed from the perspective of constructing Personal Learning Environments.

3.1 Digital Badges

3.1.1 Open Badges

Badges are symbolic representations of an accomplishment, skill, quality or interest (Knight & Casilli, 2012). Digital badges have become popular due to geolocation services such as Foursquare, which award users with badges for check-ins at different locations. More recently, Open Badges, an initiative of Mozilla and MacArthur Foundation, have explored badges as elements of learning and applied badges to set goals, stimulate motivation, recognise and represent achievements, and communicate learning success across contexts, supporting open credentialing and accreditation for formal and informal learning (Knight & Casilli, 2012). Open Badges are designed to build a badging ecosystem with badges being issued and displayed across different contexts and learning environments to form living transcripts of learners' skills and competencies (Knight & Casilli, 2012). As such, Open Badges offer a flexible mechanism not only for motivating learners or recognising achievements but also for communicating personal accomplishments, skills and evidence of learning across diverse learning spaces. In this sense badges can be viewed as *boundary objects*, crossing boundaries between existing divisions such as formal and informal learning or academic and professional achievement (Buchem, et al., 2011). With tools and infrastructures for badging constantly improving, there is yet much room for educators to explore new approaches to using badges for learning (Sharples et al., 2013).

3.1.2 Example: Chicago Summer of Learning

Among numerous examples of supporting motivation and recognising achievement in online learning environments (Santos et al., 2013), there have yet been few examples of using badges to merge the physical and virtual learning spaces in the context of smart city learning. The first citywide implementation of a badge ecosystem was the Chicago Summer of Learning (CSOL, 2013). In 2013 the City of Chicago incorporated badges to support learning in the city building on partnerships with youth-serving organizations, museums and cultural institutions, philanthropists, businesses and citizens. Young people in Chicago could explore, play and learn with the different organisations and citizens by following exploratory challenges, making own projects, developing skills and earning badges throughout the smart city learning experience. The Summer of Learning in Chicago focused on Science, Technology, Engineering, Arts and Mathematics (STEAM) and enabled young people in Chicago to gain learning and work experiences using the city as a learning environment. By earning badges, participating citizens could unlock citywide challenges which supported the development of new skills by connecting to people, building real-world artifacts and communicating achievements across learning contexts by publicly displaying badges. Chicago Summer of Learning with its applications of mobile and locative media allowing for embedding learning in smart cities, supported learners in constructing Personal Learning Environments on-the-go. Students could construct their Personal Learning

Environments ad-hoc, by combining online and in-person experiences as well as using technologies for collaboration and recognition of learning and achievement through Open Badges. Partnering with schools, enterprises, families and community organisations and allowing students to create and navigate multiple learning pathways, allowed to blur traditional divisions between formal and informal learning and to explore new learning opportunities by connecting physical and virtual learning spaces.

3.2 Smart Glasses

3.2.1 Google Glass

Google Glass is one of the most popular augmented reality (AR) wearable computing products. With augmented reality applications becoming commonly available to the general public, mainly due to technological advances in mobile computing and sensor integration, educators and learners can seize new opportunities for learning (FitzGerald et al., 2012). For example, AR browser applications, including Wikitude, Layar or junaio are used by smartphone users to explore the surrounding environment, such as finding new, interesting places, events and activities in close proximity. Other AR applications, such as the Google Goggles application for smartphones that enables search based on visual recognition, and Google Glass including an AR view with overlaid contextual information, enable users to search, record and share what they are seeing in the surrounding environment. These and other AR applications rely on the *context* as a critical aspect of supplementing or augmenting the physical surroundings through additional, overlaid information, thus blending reality and virtuality into what is called *mixed reality* (FitzGerald et al., 2012). Mobile uses of AR allows the blending of physical and virtual environments based on an ever changing geographical position of the user, serving as a mechanism for personal or individual experiences. As such, mobile AR may enhance not only spatial but also temporal mobility, enabling learners to use resources on-the-fly, at a time and place convenient and relevant to them (FitzGerald et al., 2012). While AR applications have been used in such fields as medicine or mechanics, only recently educators have started to explore educational uses of wearable technologies based on AR. Wearable AR, such as Google Glass, enable learners to take the learning experience outdoors, such as in smart city learning, allowing for situated learning including situative embodiment as proposed by the *embodied cognition* approach (Barab et al., 2007).

3.2.2 Example: STEMbite

The Google Glass device as a wearable technology operated by voice commands enables the user to connect to internet services, contacts and social networks, record video and display information in a hands-free mode. Google Glass may provide educators and learners with new possibilities for hands-free perspective media capture and augmented networked learning experiences (Hayes, 2012). Some of the first explorations of Google Glass in education is STEMbite by Heuvel (2013), an educator selected as Glass Explorer by Google, teaching live physics lessons using Google Glass. As part of this teaching experience - STEMbite - a YouTube channel with a series of bite-size videos have been set up to show the math and science of everyday life from a unique first-person perspective (Heuvel, 2013). It is the shift in perspective, from watching a lecturing teacher, to seeing as if through the eyes of a teacher, that allows for new teaching and learning experiences. Another example includes the transmission from the Large Hadron Collider at CERN in Switzerland to students in the USA.

This type of educational transmission from an eye-level perspective allows both educators and learners to capture the surrounding environment and participate in real-time activities. In this way, learners can construct Personal Learning Environments by linking physical and virtual learning spaces and participating in glocal learning activities, including virtual field trips with embedded communication with both local and remote peers, educators and experts.

3.3 Mobile Tagging

3.3.1 Educaching

Thanks to such technologies as Global Positioning Systems (GPS) or tag-based augmented reality technologies including Quick Response (QR) codes, physical spaces can be transformed into digitally augmented spaces where the digital and the physical merge. These technologies, in combination with the software on mobile devices detecting the position of the user and providing context-aware learning depending on the location, offer new opportunities for learning based on the principles of geocaching. Geocaching appeared as a treasure hunting game with a GPS-enabled device in a physical space in the late 1990s. Geocaching has been played throughout the world by adventure seekers equipped with GPS devices, called geocachers, who locate hidden containers, called geocaches, in physical outdoor settings and then share their experiences offline and online (Zecha, 2012). In the recent years, geocaching has developed as an approach to designing localised learning activities, which utilize the benefits of ubiquitous computing in outdoor settings. The geocaching concept, methods, and tools have been making their way into education under the name of *educaching* (Dobyns et al., 2007). Educaching encompasses a range of applications and scenarios, such as providing learning content in caches which can be found with the help of location services, also in form of mobile learning games, linking physical surroundings to digital learning content.

3.3.2 Example: etiquetAR

etiquetAR is a web-mobile-based application for generating interactive tags to support the design and enactment of mobile learning experiences (Pérez-Sanagustín et al., 2013). etiquetAR is based on the idea that digital tags, e.g. QR codes, can work as digital layers of information that extend and transform physical spaces into digitally augmented learning spaces. The etiquetAR application includes a set of functionalities that are especially suitable to support smart city learning. First, etiquetAR allows users to create own tags with the image of a QR code linking physical objects to multiple digital resources. Users can create interactive tags linking with one or a list of resources, all associated with a particular profile that learners can select when creating tags. The profile functionality allows users to adapt their learning path according to own needs or interests. Second, tags generated with etiquetAR can be read with any QR code reader, allowing users with diverse devices with different operating systems to participate in learning. Third, etiquetAR tags can be commented on, which enables users to contribute new ideas and opinions about resources associated to a particular code. The comment functionality allows for micro-blogging and in this way supports conversations as part of smart city learning. Since anyone can generate tags attachable to any urban element, urban spaces can be transformed into blended spaces, which at the same time can be extended by anyone in the city. etiquetAR can be used as a service for generating indoor and outdoor learning experiences based on educaching and analysing the type of scenarios that emerge from its usage. In this context, etiquetAR tags act as geocaches that are distributed and attached to objects in the city. Tags can be generated, personalized and commented on by any user, allowing for the generation of communities of knowledge associated to particular urban spaces. In this way, etiquetAR can support multi-directional conversations through multiple channels allowing learners to engage in multiple communications and follow multiple learning paths.

3.3.3 Constructing Personal Learning Environments

Most educaching scenarios, such as environmental education (Zecha, 2012), involve the uses of GPS technology to situate the geocaches and guide the learners along the interactive adventure. However, the potential of tag position-based technologies such as QR codes or near field communication (NFC) tags for educaching experiences in closed places such as museums has not yet been fully explored. Moreover, compared with other position-based technologies such as GPS that directly show resources when the user is positioned in a particular location, tag position-based technologies are especially interesting in learning situations in which a voluntary user-information interaction is expected. In this context, tags can be seen as digital layers of information allowing for an ad-hoc construction of Personal Learning Environments. By enabling learners to discover different places and dynamically constructing learning spaces, educaching promotes ubiquitous, playful and exploratory learning in both outdoor and indoor settings. As such educaching can be seen as an approach to constructing Personal Learning Environments (PLE) by connecting local and global perspectives (glocality) and moving across different physical and virtual places (spaces). In educaching experiences, learners construct their knowledge by solving game-like challenges and creating game-like challenges for other learners, using various tools to localise physical objects and relate digital information to these objects, as well as by interacting with other educaching participants, both within and outside of physical proximity. Based on the understanding of Personal Learning Environments (PLE) as self-directed uses of technology by the learner to support own learning (Buchem et al. 2011), educaching involves appropriation of tools and resources by the learner, who constructs own spaces for learning by selecting, aggregating and creating resources from physical and virtual spaces.

4. Exploring Scenarios for Smart City Learning

In order to understand how educators envisage constructing Personal Learning Environments in context of smart city learning, we conducted an international, exploratory study with educators from around the world. Altogether 16 educators from different higher education institutions in countries in Europe, North America, South America Middle-East and Asia-Pacific participated in the study and contributed their ideas and visions on smart city learning. The study consisted of two parts, both based on an online survey, in which educators were invited to reflect about possible smart city learning scenarios. In the first part of the survey, related to possible uses of etiquetAR for educaching in context of smart city learning, five selected educators were asked to describe (1) a use case scenario using etiquetAR, including its main objectives, who would participate and what activities they would perform, (2) how learners would create their PLE in their scenarios and (3) what the personal environment would be composed of. Three exemplary scenarios elicited in the first part of the survey are presented in Table 1.

We analyzed all five educaching scenarios proposed by the educators as summarized in Table 1 in relation to three research question related to smart city learning addressed in the first part of the explorative study, i.e.: (1) What types of educaching scenarios can support smart city learning? (2) What types uses of tag-based technologies can support construction of PLEs? (3) How can etiquetAR provide guidance for PLE construction in educaching scenarios?

Regarding the first question about the type of educaching scenarios designed to support smart city learning, we could derive three main characteristics of smart city learning scenarios:

1. Smart city learning scenarios combine *exploratory learning activities* carried out in informal or non-formal outdoor and indoor settings, combining both open and closed physical locations with online environments. Such exploratory learning activities occur in several spatial locations in which learners can freely explore mediated interactions.
2. Smart city learning scenarios promote *discussions and reflections* about physical spaces with the learning objectives being to actively interact with other ideas and context of other learners, such as contributing comments to proposed tags. Discussions and reflections aim at making learners aware about physical objects in different locations by providing information adapted to individual profiles.
3. Smart city learning scenarios are *learner-centered*, where the learner plays an active role in each learning activity with teachers acting as facilitators in the activity. Learners play the role of contributors adding comments and ideas to complement information provided by peers.

Regarding the second question related to the uses of tags supporting the construction of Personal Learning Environments, we could see that teachers propose the construction of PLEs composed of social media tools in combination with the use of interactive tags, as created with etiquetAR. Especially, educators view tools such as Facebook and Twitter as part of educational scenarios, followed by uses of Learning Management Systems, wikis and other web 2.0 tools.

Regarding the third question about the type of guidance provided by tools such as etiquetAR for supporting PLE construction we could identify three different generic strategies, i.e.:

1. **Constructing PLEs by interacting with people**, mediated by technologies, such as tags, as a communication channel to receive and leave information. An example of this type of strategy is the scenario proposed by Educator 2, in which visitors to a trade fair learn by connecting to other visitors and exhibitors, e.g. by leaving comments about different exhibits.
2. **Constructing PLEs by interacting with objects**, mediated by technologies, such as tags, adapted to user profile. An example of this type of strategy is the scenario proposed by Educator 4, in which students receive information in different languages about an object in the city.
3. **Constructing PLEs by interacting with tools**, mediated by technologies, such as tags, in combination with other web-based tools. An example of this type of strategy is the scenario proposed by Educator 1, in which students can use complementary tools integrated in a MOOC.

In the second part of the survey, we invited selected educators to describe their visions of future smart city learning scenarios with emerging technologies, including badges, augmented reality and wearable computing. Several exemplary scenarios elicited in the second part of the survey are presented in Table 2.

The analysis of the second part of the survey reveals some key technologies envisaged by educators to play a central role in supporting smart city learning. These include pervasive technologies, augmented reality, mobile tagging including QR codes and geotagging, digital badges, mobile social media, smart objects and wearable computing including Google Glass. To sum up, the first exploratory results about possible smart city learning scenarios together with the educaching designs proposed by educators, are the first evidence indicating that a wide range of emerging technologies, going far beyond web 2.0 or social media, may be used to support learners in constructing their Personal Learning Environments in the context of smart city learning.

Discussion

Current technologies allow the transformation of smart cities into augmented spaces for learning in which constructing Personal Learning Environments is happens ad-hoc and is adjusted dynamically to individual learner's context. The challenge is to understand how Personal Learning Environments may be constructed as part of smart city learning. In this paper, we have reviewed some of the current techno-pedagogical approaches and practices in the field and presented our understanding of smart city learning. Based on the preliminary results of our international, explorative study we could identify three key generic strategies for constructing Personal Learning Environments in context of smart city learning. These include constructing Personal Learning Environments by *interacting with people, objects and tools*. The review of current literature and the results of our explorative study suggest that the conceptualisation of Personal Learning Environments in the context of smart city learning has to be extended to the view of PLEs as merged physical and virtual learning spaces which are constructed ad-hoc as learners move across spatial, temporal and conceptual contexts. To support learners in constructing their Personal Learning Environments in context of smart city learning, we need to understand what pedagogical strategies and technological uses could be most effective to do so. In this paper we have introduced educaching with a mobile tagging service etiquetAR as an example of a combination of pedagogical approach and technological application supporting smart city learning. This paper is just a preliminary exploration of smart city learning. We intend to elicit further scenarios across various educational contexts to understand what emerging technologies and pedagogical approaches could be employed to support learning in smart cities.

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The Impact and Reach of MOOCs: A Developing Countries' Perspective [▲]

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Summary

Massively Open Online Courses (MOOCs) are a recent but hugely popular phenomenon in the online learning world. They are hailed by many as a solution for the developing world's lack of access to education because MOOCs can provide learning opportunities to a massive number of learners from anywhere in the world as long as they can access the course through Internet. However, a close consideration of the ability of learners from most developing countries to make use of MOOCs seems to contradict this rhetoric. This paper discusses features of MOOCs and looks at them from a developing countries' perspective to conclude that due to a complicated set of conditions ('access', language, computer literacy among others) prevailing in developing countries, MOOCs may not be a viable solution for education for a large proportion of people in these areas of the world. The paper further shows the need for more data on the demographics of MOOC participants from developing countries to form a better understanding of MOOCs role in educating people from developing countries.

Tags

MOOCs, developing countries, connectivism, online learning

1. Introduction

Online learning has taken a new turn with the introduction of Massively Open Online Courses (MOOCs) (Liyanagunawardena, Adams, & Williams, 2013), a recent addition to the range of online learning options. Today MOOCs are offered by many institutions; the three main MOOC portals (Coursera, EdX and Futurelearn) have between them 91 institutions as of March 10th 2013, while many more institutions are exploring the possibilities of such endeavours. The potential of MOOCs to deliver education around the globe has created a great interest not only in academic circles but also in the news, making MOOCs a contemporary buzzword (Daniel, 2012). The growing global demand for higher education places, especially in India where 40 million additional university places are estimated to be required by 2025 (Everitt, 2013), provides a strong

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case for MOOCs as an alternative to in-person university education[1].

Education researchers have classified the pedagogical underpinnings of MOOCs into cMOOCs (connectivist MOOCs) and xMOOCs (a more institution oriented MOOC model) (Daniel, 2012; Rodriguez, 2013) or cMOOCs and AI Stanford like courses (Rodriguez, 2012). According to Rodriguez (2012), "AI-Stanford like courses [xMOOCs] fall predominantly into the cognitive-behaviourist category (with some small components from social constructivism) and the c-MOOCs into the connectivist". Furthermore, he concludes that "c-MOOCs establish a many to many relation to develop massive interconnectedness. AI [Standford like courses] establishes a one to many relationship to reach massive numbers". cMOOCs use multiple learning spaces, tools and technologies as opposed to xMOOCs where it is conducted around a specific selected platform.

2. MOOC Participation

Available details on the locations of MOOC participants show that a large majority is from North America and Europe (Liyanagunawardena, et al., 2013). There is very limited participation from Asia and even less from Africa. For example, Miller & Odersky (2013) show the participant distribution in the MOOC 'Functional Programming Principles in Scala' graphically, both as number of participant per country and as number of participant per country relative to countries' population, which clearly illustrate the lack of participation from Asia and Africa. On the other hand there were a large proportion of participants (relative to countries' population) from Norway, Sweden, Finland and Switzerland in the MOOC. In describing MobiMOOC participants' geographic distribution, Koutropoulos, et al. (2012) state that "there was a large concentration of participation in Europe and North America with little participation in South America, Africa, Asia and Oceania". There are a variety of possible reasons for this distribution, discussed below. But it is possible that the ready 'access' to digital technologies in the Scandinavian countries encourages participation while in Africa and Asia it inhibits participation. The demographic data on participants that has been made available[2] has been insufficient to identify participants' locales (for example, capital city, other urban areas, rural villages, etc.) or the form of access they use for MOOC participation (for example, their own computer, a telecentre, friend's computer, etc.). In developing countries, while there are often pockets with good infrastructure, usually the capital city and a few other major urban areas, many of the towns and almost all of the rural areas will have hardly any significant infrastructure (often no, unreliable or part-time electricity supply for example, let alone Internet connectivity), which would typically make it difficult for participants to engage in a MOOC. In Sri Lanka, for example, Colombo (the capital) and most other cities have high speed broadband Internet connectivity provided through ADSL (Asymmetric Digital Subscriber Line), which many users consider a 'good connection'; on the other hand, the surrounding areas, in some instances less than 5km away from a city centre, have to rely on more expensive mobile broadband services, which users perceive to be less satisfactory; there are also rural villages that have coverage from

1 Udacity (www.udcity.com) and Peer to Peer University (www.p2pu.org) also offer alternative models of free to enrol higher education (or at least higher education-like) courses.

2 It is likely though not certain that most of the data collected has been made available in at least aggregated form.

neither landline nor mobile services (Liyanagunawardena, 2012).

A recent qualitative study of 29 MOOC participants by Milligan, Margaryan & Littlejohn (2013) has shown that confidence, prior experience in learning in a MOOC and motivation were important determinants of engagement in a MOOC. They also found that there were some students who were frustrated and dissatisfied with the MOOC, because these students "failed to see the inherent value of learning through the network" (Milligan, et al., 2013). The literature on learner experiences in MOOCs has also shown that digital literacy, English language proficiency[3], structure of learning, the delivery environment, the perceived value of learning and critical literacies to efficiently evaluate large quantities of information play a key part in shaping a learner's MOOC experience (Fini, 2009; Kop, 2011; Kop & Fournier, 2011).

3 MOOCs so far studied have been in English. However, the recent expansion of Coursera to include the University of Tokyo and other primary non-English language teaching places suggests that MOOCs are likely to be offered in other languages in the near future. As of March 2013, Coursera offers MOOCs in five languages (English, Chinese, Italian, French and Spanish).

3. Completion and Participant Retention

So far MOOCs have reported very low completion rates. The website www.class-central.com, a MOOC aggregator from top universities such as Stanford, MIT, and Harvard reports that as of March 10th 2013, 132 MOOCs had been made available and completed their process (note that some of these were repeated iterations of the same basic course, with perhaps some alterations to content between iterations and with new enrolments each time though generally no limitation on re-enrolment). The breakdown of these courses according to discipline is as follows: 61 Computer Science, 21 Business and Management, 14 Humanities, 13 Science, 12 Health and Medicine, 8 Mathematics and Statistics and 3 Engineering. Out of these MOOCs 92 were offered by Coursera (www.coursera.org) while Edx (www.edx.org) offered 9 and OpenLearning (www.openlearning.com) offered 7; the MOOCs ranged from 3 weeks to 15 weeks in length. Data on completion rates of these MOOCs are not readily available. However, Jordan (2013) collated completion rates for 24 MOOCs (as of March 11th 2013), which shows that the highest completion rate achieved was 19.2% on 'Functional Programming Principles in Scala' offered by Coursera in 2012 (Sept – Nov) (Miller & Odersky, 2013). The majority of MOOCs had completion rates of less than 10%.

Participant retention is a challenge for MOOCs and there is very little known about the experiences of non-completing MOOC participants (Koutropoulos, et al., 2012). In the authors' experience of a recent MOOC (as participants) showed that there is an overwhelming amount of information available to MOOC participants. Taken together the learning materials provided by the MOOC creators and discussions and posts by the massive number of participants create floods of information. As there are participants from all around the world the MOOC discussion threads never seem to stop but keep on growing 24 hours a day, making it very difficult for one to maintain full engagement. Combining this with ones' daily activities and work place commitments, it becomes an increasing challenge to be on top of things. This may be why critical literacies to efficiently evaluate large quantities of data become vital for the successful participation in a MOOC. Prior experience in participating in a MOOC may have allowed learners to develop strategies to cope with the information overload helping them to cope better in following MOOCs. However, relying on learners to develop their own idiosyncratic approaches by trial and error requires a level of perseverance that many may not have, so the development of background advice or even a 'MOOC-survival' MOOC might be highly beneficial for learners and MOOC operators.

4. Developing countries' perspective

4.1. Access to Digital Technologies

The word 'access' is used with different meanings according to the context in which it is being deployed. Here we consider 'access' in a wide perspective to cover the motivational, physical, skills and usage access to digital technologies (van Dijk, 2005). It is argued that:

> "*meaningful access to ICT comprises far more than merely providing computer and internet connections. Access to ICT is embedded in a complex array of factors encompassing physical, digital, human and social resources and relationships. Content and language, literacy and education, and community and institutional structures must all be taken into account if meaningful access to new technologies to be provided* (Warschauer, 2003, p6)".

Even though there are few success stories of minimally invasive learning such as the 'hole in the wall' experiment by Mitra (1999), there are many people who fear even touching a computer unless they get support. For example, Liyanagunawardena (2012, p251) reports of a 25 year old female teacher from Badulla, Sri Lanka who admitted "I have facilities [computers and connectivity to Internet] but don't know how to use." Therefore building digital literacy among the public is as important as providing them with physical resources.

Computer literacy levels in developing countries is still in infancy; for example, Sri Lanka one of the best performers in basic education with an adult literacy rate of 91% in 2010 (UNICEF, 2013) has only achieved 20.3% in computer literacy (Department of Census and Statistics Sri Lanka, 2009). There are different definitions of computer literacy; for example the Sri Lankan government conducted a pilot study in 2004 to estimate the computer literacy of the country. This survey considered one to be computer literate:

> "*if he/she could do something on his/her own using a computer. For example, if a child of 5 years old could play a game using a computer on his/her own, he/she was considered as computer literate*" (Satharasinghe, 2004).

Satharasinghe (2004) offered justification for this definition of computer literacy, arguing that using a definition of computer literacy from a developed country, where computer usage is much higher, does not suit Sri Lanka. This very basic ability to use computers is neither sufficient for knowledge work (which includes searching, filtering and assimilating knowledge from multiple sources), nor for participation in daily activities (such as online shopping, banking, online learning and social networking). In 2009, with the same definition for 'computer literacy', only 20.3% of Sri Lankans reached even this very basic level (Department of Census and Statistics Sri Lanka, 2009).

As discussed already, many cMOOCs use multiple learning spaces (Rodriguez, 2012); users can select and participate in learning spaces that suits them. While multiple learning spaces may appeal to experienced computer users, it may put off people who are struggling with online learning as they may have to register and learn to use different learning spaces. Some novices may even think that they will fail if they do not participate in all the learning spaces suggested. One could argue that by learning to participate in multiple learning spaces will increase a student's computer literacy levels. Conversely, if there is insufficient support available for novices learners it could depress learners' motivation as they keep struggling with each and every activity on different learning spaces, possibly leading to disengagement.

4.2. Infrastructure

Learners from developing countries come from geographical locations with various levels of infrastructural facilities. While there are places where the digital infrastructure facilities are comparable or exceeding that of modern developed cities, the vast majority of locations suffer from poor digital infrastructure:

- Liyanagunawardena (2012) describes of a female undergraduate from Sri Lanka who took two bus-rides taking 45min (one-way) to travel to an Internet access centre. On the other hand, the same study reports of students, from the capital Colombo, having high speed broadband access and do not realize that there are people in Sri Lanka facing difficulties in accessing Internet.

- In Burundi, a land locked country in the African continent, 97% of the population live without electricity (Legros, Havet, Bruce, & Bonjour, 2009); those who have access to electricity only get it on certain days of the week.

- A study on browser-loading times of web pages conducted in 12 Asian countries reported loading times that were 4 times slower than generally accepted (10 seconds (Nielsen, 1993))with frequent page-load failures (Baggaley & Batpurev, 2007).

Consider the case of Mala from Sri Lanka who endures 2 bus rides for 45 min (one-way) to go to the Internet access centre. In order to try to ensure fair distribution of resources, these facilities often impose restriction on access times, hence restricting the times Mala can use computers and access the Internet. Also consider the case of Sebesthian from Burundi who has home Internet access but has limited access to electricity. If they were to participate in a MOOC such as the "Learning Design for a 21st Century Curriculum" or OLDSMOOC offered by the Open University, which has scheduled activities for all seven days of the week (learners can engage in these activities at their own phase) it would be challenging to keep up with the course.

The download speeds of Internet connections in many of the developing countries are not sufficient to download large files or viewing streaming videos. For example, Liyanagunawardena (2012) discusses issues faced by Sri Lankan students in downloading video lectures while accessing the Internet from Internet cafes; a recent technology audit that examined the use of technology by members of a voluntary organization in 145 countries reported that for a number of people downloading a document took a considerable amount of time (Williams, Spiret, Dimitriadi, & McCrindle, 2012). While MOOC providers take lot of effort to produce high definition videos to satisfy developed countries' participants with high expectations, these videos add to the challenges faced by developing countries' participants as the videos take either a long time or fails to download. In these conditions, it is difficult to expect learners to take part in a Google+ Hangout even though they may wish to. In order to serve students from developing countries with limited bandwidth and access times, MOOCs that aspire to engage learners from these environments need to consider offering suitable engagement tools such as: lower resolution versions of videos, facilitating offline "burst connectivity" tools which download the minimum text-only information during connection, allow offline reading and composition of replies and then upload interaction in a second "burst". Such patterns of online interaction were commonplace in the late 90s when dial-up Internet access was the norm at home.

4.3. Language and Culture

Most developing countries have local languages and only a small proportion of the population is competent in an international language, generally the language of the colonial occupiers. The majority of the MOOCs today are run in English and this limits the access to people from the developing countries because not many are competent in a second language to the level to take up an online course. Furthermore, courses are offered to a global audience of culturally diverse people, thus the issues encountered with Open Educational Resources (Adams, Liyanagunawardena, Rassool, & Williams, 2013) are similar to the ones encountered with MOOCs. However, MOOCs have other challenges to overcome; for example, making dynamic discussions inclusive for all participants. Humour in one context can be interpreted differently in another. Thus one can take offence at a forum post even though it was not intended. Participants from various locations may not understand the colloquial language and idioms used in forums. Unacceptable behaviour (for example, forceful intellectual debates, feelings of participation being demanded, and rude behaviour) from some MOOC participants was reported by Mak, Williams & Mackness (2010), which led other participants to cease posting on forums. Given that people from different cultures are engaging in the dialogue, the likelihood of conflict and misinterpretations can be greater than that of offering a course in a class. Thus MOOC facilitators have a greater challenge in facilitating discussions in MOOCs as their participants are a culturally heterogeneous group. On the other hand, MOOC online discussions can form the basis for collaboration and networking that can persist (even after the MOOC has ended) possibly providing valuable opportunities for sharing knowledge for learners from developing countries.

MOOCs have the potential to be an invaluable tool in offering education to marginalized groups in some cultures (if the other necessary conditions for participation are met). This could be females in countries such as Afghanistan where the Taliban, an Islamic fundamentalist group, ban females receiving education after the age of eight (Physicians for Human Rights, 1998); or the Dalit community (people belonging to Scheduled Cast) in Nepal where the majority of people do not have access to education or health services (Bhatta, 2012). Just as free political expression has found outlets on the Internet that are suppressed in the physical world in some countries, so could MOOCs provide an educational channel for those denied it in-person.

4.4. Re-use

In contrast to the earlier development of Open Educational Resources such as OpenCourseWare (OCW) by MIT, in which many of the visual materials (primarily course notes and lecture slides but also including some audio or audio/video of lectures and similar) were made available for re-use[4], MOOCs are generally made available under strict copyright terms: registration in the course is (money)

4 Under a non-commercial creative commons license – a heavily criticised move especially since there is considerable doubt about a common understanding of the meaning on "non-commercial" for such materials – does it mean that only non-profit education institutes can use it or does it only mean that the content cannot be packaged and sold as content, but may be used by a commercial education provider as part of their educational provision (Lowe, 2010).

cost-free and open (though charges are often made for additional services ranging from marking of coursework or taking exams to formal academic credit recognition) but the material is only available to be used by learners as learners on the course and not allowed to be copied, and re-used (in the original form or as revised derivative work) (Adams, 2013). For higher education policymakers, administrators and educators in the developing world while (used judiciously) OERs might offer them a basis for more cheaply developing their own fit-for-purpose (socially, culturally, and targetted to the needs and abilities of their learners) higher education systems, MOOCs may offer their learners a take-it-or-leave-it (Adams, 2013) colonial educational experience dependent on technologies only available to the already-privileged in those countries.

Building on the over forty years of experience of the UK's Open University in providing distance education (copied and adapted to local situations more or less successfully in many countries) using gradually evolving technologies for teacher/student information transmission and interaction, and for student/student interaction, might be a more successful way for the HE sector in many developing countries to proceed, rather than assuming that the MOOCs offered by the likes of Harvard and MIT in the US or the University of Edinburgh in the UK, will provide a good return on the time (and possibly money) invested by their students. As suggested by Johansen & Wiley (2011) there may be significant financial benefits in reusing OERs from elsewhere in developing locally-suited distance-learning materials. No developing world university has yet joined any of the big MOOC platforms (the closest being one Mexican partner in Coursera: Mexico is a transition nation) and besides, being a member of the platform does not provide any rights to reuse the materials on the platform from other members. Leber (2013) reports on an initiative to start an entirely MOOC-based university in Rwanda, which would be an interesting development in the MOOC spread to developing countries.

4.5. Conclusion

'Access' to digital technologies in parts of developing countries (for example, other than the capital and metropolitan areas) are still insufficient to support online learning (Liyanagunawardena, 2012). Together with the lack of international language and computer literacy, online learning even in its simplest form becomes a challenge to a large proportion of developing countries' population (Liyanagunawardena, 2012). The use of multiple learning spaces, overload of information and cultural sensitivity are some other aspects of MOOCs that poses great challenges to learners from developing countries. Even though there is a rhetoric that MOOCs will offer opportunity to and be embraced by learners from developing countries' who currently lack direct access to learning opportunities, especially at higher levels, in reality it may well be serving only the 'privileged' in developing countries who already have 'access' to digital technologies and international language learning (Liyanagunawardena, Adams, Rassool, & Williams, 2011). There is insufficient data on MOOC participants' demographics to tease out the level of participation from rural areas of developing countries. Future data collections from MOOC participants could support further investigations of developing countries participation in MOOCs to understand the uptake of MOOCs in developing countries illuminating our understanding.

So, while some, even a significant number, of individuals in developing countries may benefit substantially from the appearance and success of MOOCs, there is significant doubt that in their current form they will provide a significant platform for expanding the higher education needs of developing countries to match the expansion of opportunities in the developed world over the last few decades.

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In-depth

Cultural Translation in Massive Open Online Courses (MOOCs) [▲]

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Summary

This paper discusses how courses are made relevant to students in their respective cultural settings. Practices that enable such contextualisation, or cultural translation, are investigated in five Coursera Massive Open Online Courses (MOOCs). I collected data from lecture videos, quizzes, assignments, course projects and discussion forums, using a cultural translation observation protocol I developed for this study. I found that cultural translation was enabled in the course design of two courses and in the forum discussions of all five courses. The course design that enabled cultural translation included activities, tasks, assignments and/or projects that are applicable to students' own settings and gave students freedom to choose the setting of their projects and people with whom they worked. As for forum discussions, students in the five courses created informal study groups based on geographical locations, languages and professional disciplines. Findings in this study can inform best practices in designing and learning courses addressed to a culturally diverse group. The study is particularly important to MOOC designers and students.

Tags

massive open online courses, cultural translation, learning setting, student-oriented design, study groups

Languages

de es fr it pl

Introduction

MOOCs have recently dominated the debate in higher education, and educational technology in particular. These courses addressed to the global masses have triggered polarized discussion in academia, the media and the blogosphere. On the one hand, there is optimism that these courses are transformative for higher education (Thrun, 2012; Koller, 2012; Anderson, 2013; Horton, 2013). MOOCs are also perceived as a possible way to open access to education (Koller, 2012; Anderson, 2013), especially to learners from developing countries (Koller, 2012; Thrun, 2012). The potential contribution of these courses to educational development in developing countries seems to be perceived by important stakeholders. In October 2013, the World Bank signed an agreement with Coursera to provide massive courses addressed to learners in developing countries (World Bank, 2013). On the other hand, it has been argued that MOOCs, in their original format, are not ready to be used for improving quality and access to higher education at the global scale (Daniel, 2012; Bates, 2012). MOOCs that are currently taught to students from almost any corner of the world need to be flexible enough to enable cross-cultural relevance. Without cross-cultural relevance, meaningful learning is significantly reduced, especially for students that take courses developed in foreign settings.

Practically, a perfect cross-cultural relevance is quite difficult to achieve in MOOCs since the courses are open to anyone who has access to the Internet. This openness enables students from different cultural backgrounds to enrol and take the courses. The Hofstede Centre suggests six cultural dimensions on which various countries can be compared (http://geert-hofstede.com/dimensions.html). These dimensions are power distance, individualism versus collectivism, masculinity versus femininity, uncertainty avoidance, long-term versus short-term orientation and indulgence versus restraint. Taking the example of the individualism versus collectivism dimension and comparing the United States of America (USA), Sweden, the Philippines and Tanzania, the dissimilarity between countries, especially the developed countries and the developing ones, stands out. While the individualism versus collectivism indices for the USA and Sweden are high (91 and 71 respectively) those for the Philippines and Tanzania are low (31 and 25 respectively). Hence, some business ideas from an individualist society might not be compatible in a collectivist society.

MOOCs can, however, be designed with some flexibility to allow students from diverse cultures to adjust the courses to their specific settings. Such a recontextualisation of courses is not a brand new idea. D'Antoni (2007) advocates cultural translation as an important feature of Open Educational Resources (OER) to enable the adoption of these resources in foreign educational settings. Various institutions in Europe, namely University of Jyväskylä (Finland), Josef Stefan Institute (Slovenia) and The Universidad Nacional de Educación a Distancia (Spain), have already been engaged in cultural adaptation of OER produced abroad (Holtkamp et al., 2011). Mikroyannidis et al. (2011) argue that a collaborative adaptation of OER in the OpenScout project was enabled by social networking. Equally, Wolfenden et al. (2012), Lane & Van-Dorp (2011) and Kanuka & Gauthier (2012) recognize the critical importance of the possibility of adjusting OER to other settings. However, while OER allow no-cost access, use, repurposing, reuse and redistribution (Commonwealth of Learning & UNESCO, 2011) to increase the cross-cultural relevance of the resources, most MOOC materials are copyrighted under licences that prohibit such practices. These licences restrict making the original versions of the courses relevant and easily understandable to audiences from other cultural, geographical and professional settings. Tailoring MOOCs for a diversity of worldwide audiences has, indeed, been pinpointed among the challenges facing these courses providers (Leber, 2013). The more students' culture is distant from the course original culture, the more likely they are to find the courses difficult to understand. According to Jhunjhunwala (cited in Bartholet, 2013), language and cultural issues are challenges to many Indian students' comprehension of American MOOCs. Therefore, flexibility that allows students to adjust their learning to their everyday life and learning setting would make their learning more meaningful.

A low level of cultural translation or recontextualisation of MOOCs affects course management. Liyanagunawarderna et al. (2013) argue that cultural misunderstandings are likely to occur, especially in MOOC forum discussion. According to these authors, students can unintentionally make use of culturally embedded humour or expression and exclude learners that do not share their culture. Equally, students who are not highly competent in the course language, especially those that have learned that language informally, might unknowingly use slang expressions. This might hinder the understanding of other participants who are not from their regions. They might even innocently use inappropriate language. Distinguishing slang and formal language might be one of the difficulties encountered by foreign language learners, especially when informal learning has been a significant component of their language learning. It has also been noted that although cultural diversity is an invaluable resource in MOOCs, it might easily trigger the feeling of being offended for some students (Liyanagunawarderna et al., 2013), even a clash of cultures (Severance & Bonk, 2013). That is why multicultural literacy and tolerance of different perspectives are critical ingredients for an effective discussion in such a diverse environment. Besides difficulties that might occur in MOOC learning, the disparity between these courses and local context and culture has also emerged as one of the potential hindrances to their uptake in foreign settings (Young, 2013; Sharma, 2013). Suspicion of foreign MOOCs, especially those imported to developing countries, is often triggered by the lack of empathic orientation in seeing the local problem. Claims that MOOCs open access to education in developing countries seem to be not supported by convincing evidence that pioneers understand the local situation. The lack of such evidence leads to criticism of neo-colonial attitudes (Sharma, 2013; Liyanagunawarderna et al., 2013). Hence, cultural translation enablers need to be an integral component of MOOCs if these courses have to accommodate learners who enrol from a broad diversity of cultural backgrounds.

While no one size can fit the entire global body of MOOC students, best practices help students to adjust to the course in ways that make sense to them. One of many such practices has been the translation of courses into foreign languages. According to Thrun (2012), Artificial Intelligence, which is the first MOOC he taught at Stanford University in 2011, was translated into 44 languages. According to the author, this translation was made by 2000 volunteers who were enrolled in this class. Another good practice toward cultural translation in MOOCs consists of starting local study groups or geographical clusters for collaborative learning (Blom, et al., 2013). According to these authors, collaborative learning in such groups was required from students enrolled at École Polytechnique Fédérale de Lausanne who took MOOCs offered by this institution. Such groups are also initiated in various Coursera courses. Alternatively, students might create study groups based on disciplines or fields of interest if the courses they are taking can be applied to various disciplines. For instance, knowledge and skills learnt from a course on entrepreneurship and innovation can be applied in the fields of education, computer science, business and others. For this reason, MOOC students who are employed as educators might want to study together and those who are employed in business likewise. Unlike translation into a foreign language which requires the intervention of a translator, who can be seen as a third person, the development of study groups based on geographical location or field of study requires engagement of students. The final practice discussed in this paper consists of including projects in a MOOC (McAndrew, 2013). Such projects can be designed in a way that requires students to find a solution to a real life problem. Cultural translation is enabled when students are given freedom to choose the problem in their

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respective societies. Implementing this practice is mainly the responsibility of the course designer.

The current study discusses MOOCs students' and instructors/designers' best practices that enable recontextualization/cultural translation of the courses. It investigates how activities oriented to solving problems in students' respective societies are incorporated in MOOCs. It also probes how students make their learning relevant by learning through the language they are comfortable with and formulating study groups and/or geographical clusters for collaborative learning. Two research questions underpin the study:

- How were activities oriented to solving problems in students' respective societies included in MOOCs?
- How did students make their learning relevant to their context?

Research methods

I conducted this research as a multiple case study that involves a cross-case analysis (Thomas, 2011). The study is based on qualitative data collected from five Coursera courses. Table 1 lists the courses that I investigated.

To be able to collect relevant and detailed data from these courses, I enrolled in the courses and took them with full engagement, like other students that

Course	University	The run time
Artificial Intelligence Planning (AIP)	University of Edinburgh	28 January-3 March 2013
Internet History, Technology and Security (IHTS)	University of Michigan	1 March-28 May 2013
Leading Strategic Innovation in Organisations (LSIO)	Vanderbilt University	5 March-6 May 2013
Inspiring Leadership through Emotional Intelligence (ILTEI)	Case Western Reserve University	1 May-12 June 2013
Competitive Strategy (CS)	Ludwig-Maximilians-Universität München	1 July-11 August 2013

Table 1: MOOCs investigated in this study

MOOC/ Aspect	Design			Study groups			
	Lecture videos and in-lecture quizzes	Weekly quizzes	Assignments/ project	Discipline	Language	Geographical location	Others
AIP							
IHTS							
LSIO							
ILTEI							
CS							

Table 2: MOOC cultural translation observation protocol

were committed to studying them. Prior to the data collection phase, I sought ethical approval for the study from the University of Leicester. After securing approval, I collected data using an observation protocol (Table 2) I had developed for this purpose. The data were gathered from MOOC lecture videos, weekly quizzes, exams and assignments as well as discussion forums. Focusing on lecture videos, weekly quizzes, exams and assignments enabled me to identify activities that provide students with opportunities to apply what they learned to finding solutions to problems in their respective settings. As for discussion forums, this is where I identified study groups for collaborative learning that had been created and the rationale behind their creation.

I aimed to maintain construct validity and reliability in my study. To this end, I applied Yin's (2009) principles: using multiple sources of evidence, creating case study databases and maintaining a chain of evidence. Multiple sources consisted of the five courses as well as various course components discussed earlier: quizzes, final exams, assignments and discussion forums. I saved all the materials relevant to this study on two external hard drives for later reference. The folders that contain these materials on the two hard drives constitute the case study database. As for maintaining a chain of evidence, I used a cross-sectional reference to link the research problem, questions, research methods and evidence, from my introduction to my conclusion.

The courses I analysed in this study were delivered by various universities. To be able to engage in MOOCs, I selected the courses in which I was interested. This engagement with courses of interest to me reflects most students' engagement with their courses. Since I wanted to approach cultural translation from a student's perspective, I tried to simulate how students engage with courses, from the course selection to the course completion level. The more courses respond to students' interest, the more students tend to engage with their learning. Had I not taken courses I was interested in, I might have dropped out before I had finished the courses, and my feeling about the courses would be unlikely to reflect that of other students who seriously engage in their learning. As an engaged student, I was a participant observer. Yin (2009) defines participant-observation as a mode in which the observer assumes various roles and actively participates in the phenomenon that is being studied (p. 111). He notes the researchers' ability to see the reality from the point of view of someone who is inside the case study rather than external to it as one of the major advantages of participant-observation (p. 112). In my case, I could see cultural translation from the students' point of view rather than from the perspective of an external commentator. Hence, interest-based engagement with the courses enabled me to sympathise with other course takers.

Findings

At least one study group was created based on geographical locations, languages and fields of study. There were two attempts to create study groups based on students' age in IHTS. However, these initiatives were not successful. Some of the language-based study groups functioned in foreign languages I was not familiar with. To identify these languages, I used Open Xerox (http://open.xerox.com/Services/LanguageIdentifier), which is an online tool for language identification. The findings in this study are presented in the order the research questions were asked.

Research Question 1: How were activities oriented to solving problems in students' respective societies included in MOOCs?

The five courses share various aspects, mainly similar video lectures, and in-lecture quizzes for formative assessment, weekly quizzes and forum discussions. However, there are disparities concerning how students are placed at the centre of some of these activities. In-lecture and weekly quizzes in all these courses were content-oriented. Similarly, the final exams for AIP, IHTS, ILTEI and CS focused on the content. However, LSIO and ILTEI incorporated reflective activities and projects that required students to apply the MOOC concepts and theories in their own settings and workplaces. How these two MOOCs included activities that are applicable in a diversity of students' settings is detailed below.

The LSIO MOOC included innovation constraint diagnosis surveys in its activities. In these surveys, the student had to evaluate her/himself, the organization or school s/he works for or s/he got service from vis-à-vis innovation constraints at the individual, group, organizational, industry/market, society and technological levels. These evaluations were done using constraint diagnosis surveys developed by the instructor. Then, the student had to keep a copy of the completed survey to use it as a reference for reflective writing, which was submitted to peers for feedback. At least three peers provided feedback to this writing and other peer-graded assignments. To receive feedback from their peers, students had also to provide feedback to at least three classmates.

Moreover, the course had two tracks: a standard track in which students were not required to work on an innovative project, and a studio mastery track in which students had to complete an innovative team project. The studio mastery track project deliverables were submitted for peer feedback across six stages. The project had to start in a team of three to six people. In the first stage, each team member suggested an innovation project to the team. Then, the team discussed and agreed on one project to work on and created a project design brief, which was the output at this stage. Considering the high rate of drop out in MOOCs, the instructor tolerated drafts of the projects done by only two people in subsequent stages. In the second stage, each individual student generated and shared 101 ideas on the group project. In the third stage, the teammates shared one another's 101 ideas and distilled all this collection of ideas to formulate four solution concepts. Then, they defined each concept, presented the four concepts graphically and identified challenges and opportunities. In the fourth stage, each team member reviewed the feedback on their Stage 3 deliverable, chose the solution concept s/he personally thought was the best and completed a concept assessment worksheet that enabled her/him to evaluate the concept relative to the six categories of innovation constraint highlighted earlier. Then, s/he had to identify two most compelling constraints and devise strategies to mitigate them. In the fifth stage, the team came back together to determine the most promising of the four solution concepts they had formulated in Stage 3 and evaluated in Stage 4. Using a project prototype template developed by the instructor, the teams defined the information-generation experiments they would use in addressing remaining questions as they moved toward the execution of their project. The final stage had a video presentation of the entire project as a deliverable.

Similar to LSIO, ILTEI had reflective activities that the instructor referred to as personal learning assignments. These activities were student-centred in that they required students to reflect on how various course concepts apply to their lives. For instance, one of the personal learning assignments required students to think of a leader they worked with who was so inspiring that if s/he moved to another company the employee (the student) would want to seek a transfer and move with them or volunteer there. Then the students had to write specific things the leader did or said and reflect on how that leader made the employees feel. Finally, students shared their reflection notes and their feelings during the reflection experience.

ILTEI also had a practicum track that is comparable to LSIO's studio mastery track. Each student that followed the practicum track was required to conduct three practical tasks in his/her setting or workplace and write a report on each of them. The first task required the student to identify two volunteers to participate in coaching sessions. The student assumed the responsibility of a coach with compassion and the volunteers were coachees. The student/coach had to ask coachees questions about their future dreams or ideal self (vision or hope), their current value and virtue (mindfulness), the person that helped them most become who they are (compassion) and their desired legacy, experience or achievement (playfulness). The coach would use such questions to maintain coachees in a positive emotional attractor state characterized by happiness, smile, energy or similar tipping points. Then the coach (the student) had to write an essay that reported how the coachees moved between Positive Emotional Attractor and Negative Emotional Attractor states, strategies used to bring the coachees back to the Positive Emotional Attractor state and the result of the conversation. The second task asked the student to interview ten to twenty people who were close in her/his life or workplace about the time s/he was at her/his best. Then, s/he had to look at the interviewees' responses and identify recurring patterns as well as emotional and social intelligence patterns. Finally, s/he had to submit a report of at least 500 words on this activity. As for the third task, which was similar to the second one, it required the student to ask her/his colleagues at work to pinpoint the time in which they were proud of the organization or team as well as when they were at their best. Then, s/he had to identify recurring patterns or themes from the colleagues' responses, which would constitute the elements of the shared vision for the organization or team. Based on these elements, the students had to draft a vision statement of at least 500 words for their organization or team.

Research Question 2: How do students make their learning relevant to their context?

In LSIO, students could take advantage of the freedom they were offered and choose projects that were relevant to their cultural settings. For this to happen, students would choose teammates from the same setting or ones who were familiar with that setting. Alternatively, students could work on a project that would be transferable to their jobs, or applicable to their fields of employment or study. This could be especially valuable for students interested in multicultural literacy development. Such students preferred to work in teams whose members were from various cultural backgrounds. It was possible to form project teams based on one of the two criteria or both. Similarly, students in ILTEI could choose coachees and interviewees from their workplace or families. They could also choose volunteers among people who shared their professional interest. The freedom offered to students to choose their projects was a great enabler of cultural translation.

Students also made their learning relevant to their respective contexts through the way they engaged in the five MOOCs' forum discussions. In

MOOC/Aspect	Study groups based on			
	Discipline	Language	Geographical location	Age
AIP	5	4	5	0
IHTS	0	7	16	2
LSIO	14	6	40	0
ILTEI	3	7	41	0
CS	0	5	26	0

Table 3: Rationale behind the creation of study groups in MOOCs

this respect, they created informal study groups based on geographical locations, fields of study/work and languages. Table 3 summarises study groups in the five courses.

As indicated in Table 3, study groups based on geographical location generally dominated in IHTS, LSIO, ILTEI and CS, but they were only five in AIP. ILTEI and LSIO had a higher number of study groups based on geographical location than other courses: 41 and 40 groups respectively. This was probably because contributions in the forum discussions counted toward the overall grades in both courses. In addition to study groups based on geographical location, each of the five courses had study groups based on language. Study groups based on disciplines of work or study were created only in LSIO, AIP and ILTEI. The number of such study groups was far higher in LSOI than in the other two MOOCs: 14, 5 and 3 respectively.

As for study groups based on students' age, this was attempted only in IHTS. Two students started threads in attempt to discuss the content with peers of their age group: under 21 and under 16 respectively. However, these age-based threads could not attract other students: they received only three and five responses respectively.

Discussion

The way assignments and projects in LSIO and ILTEI were flexibly designed demonstrates that it is possible to tailor MOOCs to individual learners' needs, in their own cultural settings. Project-based activities (McAndrew, 2013) constituted a significant component for students in the studio mastery track in the LSIO MOOC. In both LSIO and ILTEI, students could relate their learning to their everyday/professional life. The inclusion of tasks, activities and assessments that are relevant to various cultural and professional settings in courses is what can be termed diversely student-oriented design. Unlike teacher-oriented design in which students work on tasks conceived from the teacher's perspective and setting, tasks in diversely student-oriented design are conceived from the learners' perspective and can apply to various cultural settings. Student-oriented design can be considered narrow if only students from the teachers' settings or other similar contexts can see a direct application of the course to their professional settings or everyday lives. However, in both LSIO and ILTEI, students from any cultural background could apply their learning in their specific settings. In other words, the student-oriented design was culturally diverse in the two MOOCs. In this way, the two courses were designed to allow a cultural translation (D'Antoni, 2007). In other words, students from various cultural backgrounds can adjust their learning to their own setting since they are given freedom to choose the project and beneficiaries of their work. The two MOOCs constitute good examples of how contextualisation (Wolfenden et al., 2012; Lane & Van-Dorp, 2011; Kanuka & Gauthier, 2012) can be achieved. As for AIP, IHTS and CS, opportunities for students to adjust their learning within their setting were limited. It should be noted, however, that the nature of some courses does not allow easy contextualisation for all settings. For instance, AIP and IHTS require students to be in a setting with high technological access and be familiar with at least basic computer and Internet technology to have a grasp of the application of the course concepts. Briefly, activities that enable students to solve real life problems in their respective settings can be included in MOOCs by designing for tasks, assignments and projects that can be made relevant to various settings and by offering freedom to students to choose the setting of their projects and people they work with. This answers the first research question.

Students created study groups or teams for their project based on geographical locations, languages or professional disciplines. Unlike MOOC students enrolled at École Polytechnique Fédérale de Lausanne who were required to participate in collaborative learning groups limited to this institution (Blom, et al., 2013), study groups were not required in the five courses I investigated (except the LSIO project teams). LSIO had far more discipline-based study groups than other courses. This may have been catalyzed by the requirement to work in teams on the project for students in the studio mastery track. Many of these students might have preferred to team up with peers who shared their professional interests. With regard to study groups based on geographical locations, AIP had far less groups than other MOOCs. In AIP, only five geographical location-based groups were identified in the forum discussion. It should, however, be noted that collaborative learning in this course took place in many spaces including the discussion forum, the course wiki, twitter and the Second Life virtual world. These alternative discussion environments competed with the course discussion forum in attracting students' interest. As for the language-based study groups, they were present in each of the five courses. Therefore, students made their learning relevant to their context by choosing and working on projects that were applicable in their own settings and by discussing the course materials with peers who understood their cultural context. This answers the second research question: "How do students make their learning relevant to their context?"

Concerns that MOOCs developed in Western societies might not suit other settings (Young, 2013) are partially true, but this is mainly an issue in the course design and students' engagement. As discussed above, some MOOCs are designed to enable cultural translation at a high level, others are not. Equally, students create study groups to discuss MOOCs from their own perspectives. Some MOOCs might not be relevant to students in some settings. However, this tends to be an issue also for students who take other online and face-to-face courses developed elsewhere. This is especially the case when a course was not designed to accommodate students from a diversity of cultural backgrounds. In an earlier paper (Nkuyubwatsi, 2013), I highlighted that international face-to-face students may find their learning not relevant to their own setting, especially when their classes are not internationally diverse in terms of participants. In a class with only one international student, class discussions easily slip into local cultural realities and, therefore, unintentionally exclude the stranger student. Equally, instructors can easily design culturally embedded activities that do not accommodate the minority foreign student. Home students in classes dominated by their colleagues from a single foreign cultural background can have a similar experience. However, if the class cultural diversity is kept in mind in the design process, the course can appeal to all students, regardless of their backgrounds as demonstrated in LSIO and ILTEI.

As noted earlier, the embedding of cultural translation enablers might be quite difficult in some courses, depending on their nature and focus. However, designers of courses addressed to a multicultural audience who try their best to incorporate cultural translation enablers are more likely to provide a cross-cultural satisfaction towards their courses. AIP, IHTS, and CS could have embedded cultural translation enablers by giving students the opportunity to reflect, discuss and write on how the concepts in these courses apply to their respective settings rather than having all assignments structured from the instructors' perspective. The application of artificial intelligence, the history, technology and security related to the Internet and competition in business can be explored in various settings. Giving students the opportunity to discuss these issues in their respective settings could have enabled them to reflect on problems that are of most concern to them. Therefore, keeping diversity in mind during the course design and stimulating students' engagement in study groups, virtual and face-to-face, can make MOOCs and other courses addressed to international students relevant across cultural backgrounds. The closing statement of the LSIO professor reflects a diversity of mindset in course design:

> *So it surely is important to know that [sic] your constraints, in your context, using the language that matters to you. And so I've broken up the world in a way that makes sense in terms of teaching this stuff, but you need to break up the world in a way that makes sense in terms of implementing, in terms of getting the projects done that are important to you.*
>
> (Owens, 2013) [Quoted with permission]

The discussion of cultural translation needs to be viewed through a medium-strength lens, rather than a week or powerful one. As discussed earlier, courses developed in foreign settings tend to be rejected because there is the feeling of hegemony of Western education (Young, 2013; Sharma, 2013; Liyanagunawarderna et al., 2013). Those who want to use MOOCs to transform lives of people in developing countries probably need to empathise with local stakeholders and demonstrate an understanding of local problems from local people's perspective. Equally, openly licensing course materials to enable local practitioners to make them relevant and use them in the way that responds to their contexts will increase trust in MOOC providers who want to impact positively on lives of people in developing countries. At the other extreme, a radical rejection of MOOCs, simply because they are not home-made, limits educational exchange that could be beneficial to learners and educators worldwide. Diversity and multicultural learning experience tends to be richer in MOOCs and these two learning ingredients can be beneficial to students and teachers regardless of their location or cultural backgrounds. The good news for MOOCs and educational stakeholders across cultures is that embedding cultural translation enablers in a course makes it more relevant to students from a diversity of cultural backgrounds. This is a niche that educators and other stakeholders need to exploit to facilitate a cross-cultural and multi-directional exchange of knowledge, skills and expertise.

Conclusion

In this paper, I discussed cultural translation, the process of making courses relevant to students in their respective cultural settings, across five Coursera courses. In two of these courses, cultural translation was enabled by the inclusion of activities that required students to work on projects or tasks that were practical in their cultural settings. Students were given freedom to choose the setting and participants in their projects/assignments. Cultural translation was also assisted by student-created study groups based on geographical locations, languages and professional disciplines. These best practices indicate that MOOCs can be tailored to each individual learner regardless of her/his cultural setting, and require course designers to keep diversity in mind. They also call on students to learn collaboratively via informal study groups created for this purpose. While students in the five courses participated in such groups, only two of the five courses were designed to enable cultural translation. The lack of cultural translation was found to be an issue of course design rather than being a typical feature of MOOCs. Designers of courses addressed to internationally diverse groups can learn from the LSIO and ILTEI designs in order to accommodate all students. If enabling cultural translation is deliberately kept in mind in the design process and students engage in collaborative learning with their peers, the course can be relevant to students regardless of their cultural background.

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In-depth

MOOCs and disruptive innovation: Implications for higher education [▲]

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Summary

The opportunity that Massive Online Open Courses (MOOCs) offer for cost effective massification of learning has generated significant interest from governments, higher education institutions (HEI) and commercial organisations. A growing number of HEI have been involved in experimenting with MOOCs for the purposes of expanding access, marketing and branding, as well as the potential of developing new revenue streams. The motivation for some MOOC providers is a philanthropic one and for others a business proposition. However, in both cases, there is the challenge of finding a viable business model that allows for sustainability of MOOC provision.

This paper will use the theory of disruptive innovation (Bower and Christensen, 1995) to examine MOOCs development and how their approach could be used to help institutions explore innovative approaches for teaching and learning and to develop new business models in order to gain competitive advantages in the education market. MOOCs provide institutions with a vehicle to think creatively and innovatively to explore new business models and flexible learning paths in HE provision. However, there is a need to rethink current higher education structures and policies and working practices that obstruct innovation. This includes funding arrangements and the ability to disaggregate teaching from assessment and accreditation for differential pricing and pursuit of marketing activities.

Tags

MOOCs, Disruptive Innovation, Sustaining Innovation, Open Courses, Business Model

Languages

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1. Introduction

Massive Open Online Courses (MOOCs) have recently received a great deal of attention from the media, entrepreneurial vendors, education professionals and technologically literate sections of the public. The promise of MOOCs is that they will provide free to access, cutting edge courses that could drive down the cost of university-level education and potentially disrupt the existing models of higher education (HE). This has encouraged elite universities to put their courses online by setting up open learning platforms, such as edX. New commercial start-ups such as Coursera and Udacity have also been launched in collaboration with prestigious universities, offering online courses for free or charging a small fee for certification that is not part of credit for awards. Larger corporations such as Pearson and Google are also planning to move into the HE sector as global players and are likely to adopt a MOOC-based approach as a part of their plans.

A new company, Futurelearn, has been launched by the Open University in the UK, to bring together a range of free, open, online courses from leading UK universities for learners around the world (Futurelearn, 2013).

The rapid expansion of MOOCs has sparked commercial interest from venture capitalists and major corporations who want to enter the HE market using a MOOC approach. Most significantly, it has opened up strategic discussions about the disruptive potential of MOOCs in HE and forced established providers to re-visit online learning and open education as strategic choices for the future. In this case, there is a significant question for higher education

institutions to address; are online teaching innovations, such as MOOCs, heralding a change in the business landscape that poses a threat to their existing models of provision of degree courses? As Lawton & Katsomitros point out, the major innovations with MOOCs are not about access to academic staff, peer interaction, wiki-style forums, and automated assessment; those can be found in many online courses offered by traditional universities over the last few years. The disruptive innovation of MOOCs is in shifting costs from students to institutions and future employers, by offering services such as matching students to jobs using the evidence of their performance in MOOC courses.. Many MOOCs are not sustainable in their current form, as they rely on venture capital and foundation funding which will either demand a return on investment of a sustainability model that does not require ongoing capital support. It is likely that different business models will emerge for MOOCs in the future, and the opportunities and threads posed to established institutions are as yet unknown but potentially significant.

The theory of disruptive innovation (Bower and Christensen, 1995) offers an explanation as to why some innovations disrupt existing markets at the expense of incumbent players through a combination of technological innovations that make it possible to develop alternative products and services resulting in a new business model. In the context of online distance learning including MOOCs, this possibility is brought about through the combination of wider societal adoption of communication and, particularly, Internet technologies, changing funding models and the development of new ways of teaching and learning that leverage this opportunity. If this is the case, then the theory of disruptive innovation suggests that there is a strong argument for establishing an autonomous business unit in order to make an appropriate response to these potentially disruptive innovations.

2. The current development of MOOCs and other forms of open courses

The development of MOOCs is rooted within the ideals of openness in education, that knowledge should be shared freely, and the desire to learn should be met without demographic, economic, and geographical constraints. As figure 1 shows, since 2000 the concept of openness in education has been evolving rapidly, although it has its origins in the early 20th century (Peters, 2008). Massachusetts Institute of Technology (MIT) established OpenCourseWare in 2002 and the Open University set up OpenLearn in 2006, representing an ongoing development of the open education movement. Influenced by the early development of MOOCs, various open learning platforms have been set up by elite institutions; examples from 2012 include MIT edX and OU's Futurelearn. A key message that emerges is that the evolution of MOOCs is leading to more players in the market as HEI and private organisations seek to take advantage of these innovations in online learning.

A number of bespoke MOOC platforms have been developed and offer courses independent of or in collaboration with universities. For example,

• edX (https://www.edX.org/) is a non-profit MOOCs platform founded by Massachusetts Institute of Technology and Harvard University with $60 million of resources contributed by the two institutions to support the project.

• Coursera (https://www.coursera.org/) is a for-profit company, which started with $22 million total investment from venture capitalists, including New Enterprise Associates and Kleiner, Perkins, Caufield & Byers Education.

• UDACITY (https://www.udacity.com/) is another for-profit start-up founded by Sebastian Thrun, David Stavens and Mike Sokolsky with $21.1 million investment from venture capitalist firms, including Charles River Ventures and Andreessen Horowitz.

Whereas edX offer only Harvard and MIT's courses, Coursera focuses on providing a platform that any university can use and Udacity only offers its own curriculum with specialised areas. Other open education initiatives, such as Udemy, P2PU and Khan Academy have been around for a while and provide opportunities for anyone

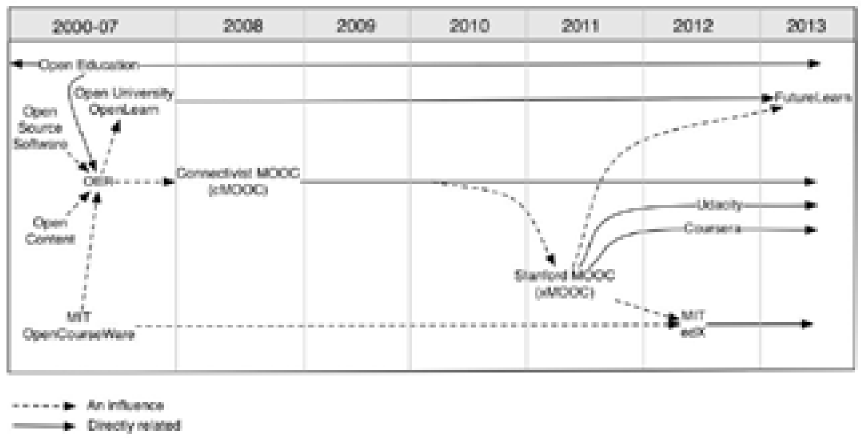

Figure 1: MOOCs and Open Education Timeline (Yuan and Powell, 2013)

to learn with experts, peers and others outside traditional universities. Table 1 indicates the major differences between the initiatives described above in terms of financial motivation, access, fees and credits.

Initiatives	For profit	Free to access	Certification fee	Institutional credits
eDx	x	√	√	x
Coursera	√	√	√	x √
Udacity	√	√	√	x √
Uduemy	√	x √	√	x √
P2PU	x	√	x	x

Key

x Not a feature

√ Feature present

x √ Feature partially present

Table 1: Comparison of key aspects of MOOCs or Open Education initiatives (Yuan and Powell, 2013)

The most common revenue stream for the major new MOOC providers is to charge fees for certificates. Whilst edX is a not- for-profit MOOC platform with the goal of helping universities achieve shared educational missions, in the longer term it will also need to be self-sustaining. Coursera and UDACITY are examples of for-profit organisations, they are working on developing a variety of business models, and according to their published commercial strategies, these include: selling student information to potential employers or advertisers; fee-based assignment grading; access to the social networks and discussions; advertising for sponsored courses; and tuition fees for credited courses (Educause, 2012). Table 2 provides an overview of potential business models proposed by current MOOC providers.

edX	Coursera	Udacity
Certification	• Certification • SecureAssessments • Employee recruitment • Applicant screening • Human tuloring or assignment marking • Enterprises pay to run their own training courses • Sponsorships • Tuition fees	• Certification • Employers pay for recruit talent student • Students résumés and job match services • Sponsored high-tech skills courses

Table 2: Overview of potential business models by platform (Yuan and Powell, 2013)

As table 2 shows that common approaches to generate revenue are considered by Coursera and other start-ups working in partnership with HEI, including: charging students a fee for certificates of participation, completion or even transcripts; providing premium services such as recruiting tools that link employers with students who have shown ability in a given area; and philanthropic donations from individuals and companies. However, it is a significant challenge for partner universities to generate income in these ways. In established business models, universities have control of the customer value proposition in that they provide any recognition of learning and set tuition fees. For MOOCs, most participating institutions have decided that they will not offer credits as part of traditional awards for these courses, probably as a result of concerns about the quality of the courses and the downside risks posed to their branding. It would be also against the initial ideals of MOOCs if universities started to charge tuition fees for their courses. Therefore, many institutions participating in MOOCs consider the courses they offer to be a branding and marketing activity at present.

MOOCs promise to offer flexibility, affordable access and fast-track completion at a low cost for whoever is interested in learning, which have been seen as disruptive innovation to disrupt the existing higher education provisions. Disruptive innovations have reshaped markets and shifted the power from the established players to new start-ups and alternative providers in the global technology, social media and music industries. A key question for HEIs is: will MOOCs replicate the pattern of disruption seen in other market places?

3. Disruptive innovation theory

In the context of technology and business literature, the term “disruptive innovations” denotes innovations that deliver a physical product or a service to consumers in such a way as to go against market expectations. Christensen (2003) identified two types of innovations that affect organisations and businesses; sustaining and disruptive. According to Christensen, a sustaining innovation is about improving the existing system while a disruptive innovation creates an entirely new market, typically by lowering price or designing for a different set of consumers or different needs of existing customers. Typically disruptive innovations combine a new technology that has the potential to evolve rapidly, with an innovative business model.

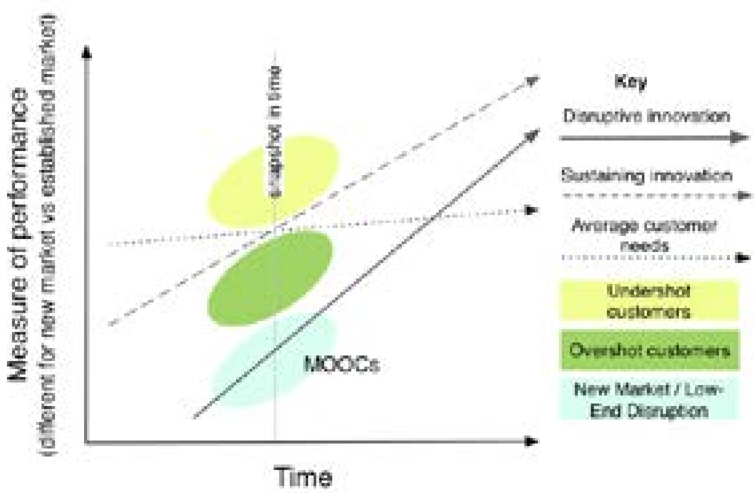

Figure 2 presents a model of disruptive innovation that illustrates the current development of MOOCs.

In general, sustaining innovations target high-end customers who demand better performance of an existing product or service and they are prepared to pay more for it – 'undershot customers'. Disruptive innovations, by contrast, do not attempt to bring better products to established customers. They are innovations that develop a new-market disruption or take root at the low-end of an existing market offering a low-end disruption with a performance that is less than currently available products, but at a cheaper price to customers who find this attractive –'overshot' and 'non-consuming' customers. Over time, their performance improves and they move up-market, eventually competing with established market leaders.

Christensen (2003) pointed out that established market leaders are often extremely good at exploiting sustaining innovations in order to achieve the short-term company growth but it is new companies that emerge to exploit disruptive innovations. Therefore, different organisations need different strategies to overcome the challenges of disruptive innovations posed over time. For those established organisations, it is important to understand the process of disruptive innovation because it offers established organisations access to significant new markets, longer-term survival or new ways to sustain the existing businesses. However, to avoid being disrupted, established companies often set up a small spinoff companies that function as start-ups. These companies make the new low-end product with different resources, processes and business models; and are independent enough to ignore the established performance metrics of the parent organisation. For these new start-ups, it is necessary to navigate the process of disruptive innovation and explore new business models that allow them to extend a low-cost value proposition up market in order to generate the significant returns on investment required to take on and beat the status quo. If they can't do this, the start-up companies will be overtaken by experienced and well resourced, existing companies in the new market.

4.MOOCs disruption and innovation in higher education

As figure 2 shows, a disruptive innovation analysis of MOOCs identifies the initial market segment as being non-consuming costumers of HE for whom a new product is created by converting complicated, expensive HE provision into simpler, more affordable offerings. Typically, this is achieved by offering free courses to a different set of learners or meeting different needs of existing students in HE institutions. The analysis shows that MOOCs contain key characteristics of disruptive innovation; this is a combination of new business models with an enabling technology. However, at this early stage of MOOCs adoption, it is difficult to predict the impact of the new start-ups on conventional HE providers. It is also worth noting that education is a complex system which involves multiple players, complicated processes, and in some cases highly regulated markets with significant state subsidy and incentive to study with established institutions. Therefore, using disruptive innovation to explain the phenomenon of MOOCs in HE should be applied with caution to avoid superficial conclusions. Christensen & Eyring (2011, p10) concluded that:

> *"universities are anomaly that the original framing of disruptive innovation could not explain. For example, most entrants have indeed entered the "low end" or "new market" of higher education, e.g. community colleges and private providers. They have almost uniformly Driven up-market to offer bachelor's and advanced degrees in more and more fields – just as the theory would predict. But the demise of the incumbents that characterises most industries in the late stages of disruption has rarely occurred among colleges and private universities."*

Zhu (2012) compared MOOCs with how digital format, the Internet and later iTunes disrupted the music industry. He pointed out that the new alternatives replaced traditional CD-based music distribution by promising lower cost and more convenience. However, the HE marketplace is not directly comparable to media. There is less overlap between universities' existing markets, which primarily serve young students qualified to enter higher education, and the new start-ups' MOOC market, which focuses on professionals or people who cannot afford or gain places to traditional universities. Therefore, MOOCs cannot replace existing universities in the same way as iTunes replaced CDs in the music industry. However, the combination of technology enablers and new business models opens up the possibility that MOOCs can extend a low-cost new-market disruption to students demanding better performance.

As Clayton Christensen pointed out, all technologies can be applied to sustain or disrupt any industry's incumbents (Christensen, 2003). New start-ups, such as Coursera and Udacity have adopted MOOCs as disruptive innovations with a focus on developing new business models, new markets and new ways to serve different needs of learners. In contrast, most HE institutions see MOOC development as a sustaining innovation to improve their performance through experiments with new forms of online learning. For example, edX institutions such as MIT and Harvard are using MOOCs as an experimental space to learn how to educate their on-campus students more effectively (Bates, 2013). San Jose State University are trying out MOOCs in traditional classes, "flipping" the experience so students take the MOOCs as homework and engage in deep problem solving in the classroom (Jarrett. 2012).

The theory of disruptive innovation suggests that it is necessary to set up an autonomous unit in order to escape the host organisation's current culture, processes, systems and decision making from blocking an appropriate response to a potentially disruptive innovation, until it is too late. For HEIs, the key question is how to identify and respond to disruptive innovations, in this particular case, MOOCs. If MOOCs can be developed to the point whereby learners can complete full degrees and gain qualifications it may impact on enrolment at traditional institutions and contribute to a reshaping of the HE market in the future.

5. Implications for educational policy

Higher education is already experiencing a period of unprecedented change worldwide. The cost of funding HE has become a focus of national policy with most governments looking for new funding mechanisms, reduced costs and improvements in the quality of teaching and learning. There is significant momentum behind the concept of free and open access to high quality university learning, and it is likely that content and courses will continue to be promoted resulting in more MOOCs and other types of open education approaches emerging. However, there is also a need to rethink current higher education structures and policies that obstruct innovation. Currently, new ways to fund universities and the role of private providers in higher education have become hot debates and major policy concerns all around the world, especially when finances are tight and competitiveness is key. The existing HE funding model has been considered to be a major barrier to exploring new business models and innovative approaches in institutions. According to Christensen et al (2008, p42), action needs to be taken at a higher level:

> *"Policymakers must first address higher-education budget constraints by helping low-cost disruptive universities - public and private - gain market share by eliminating barriers and partnering with them to grow enrolments and capability. These partnerships should foster new models of higher education in autonomous business units separate from the existing institutions."*

The increasingly competitive climate will put significant pressure on traditional universities to find new ways of teaching students to reduce costs to give flexibility with fees. Existing universities might, for example, set up commercial subsidiaries to provide more open and flexible provision; the Open University's Futurelearn is one example of a new, more flexible organisation.

Degree awarding power has become a bottleneck for private providers to fully participate in the HE market. There is a great debate on whether degree provision should or could be disaggregated from teaching. What does this mean for traditional universities? How can make degrees be made more relevant to learners' need and a changing society? And how the quality of degrees be guaranteed between diverse providers? Wiley and Hilton (2009) pointed out that:

> *"the threat to the monopoly traditional higher education has held on degrees comes from other areas as well. In the computer science domain, for example, technical certifications from Cisco, RedHat, Microsoft, and others can prove more valuable to prospective employees than a bachelor's degree in computer science. The university's monopoly on certifying prospective employees has expired."*

Often private providers offer degree programmes that are closely aligned to the world of work, created in conjunction with employers and professional bodies and taught by professionals who have had direct experience of their subject matter in practice. These degrees may be more attractive to potential students than traditional university degrees. It has been reported (Soulsby, 2013) that there is a decline of adult learning in UK, mainly caused by the economic downturn since 2008 which has affected individuals' willingness to spend money on learning. More university level of courses offered by various MOOCs providers may encourage take-up of flexible and life long learning through an open approach. However, there are concerns that allowing for more diverse degree provision amongst providers will threaten the quality assurance guarantee that existing UK institutions offer through established quality assurance mechanisms enshrined in law and managed by the Quality Assurance Agency.

6. Implications for higher education

The emergence of MOOC style innovations shows a convergence of interests in social, economic and technology developments in education in a global context. According to Global Industry Analysts (2010), the global e-learning market will reach $107 billion by 2015. However, it is not entirely clear how the MOOC approach to online education will make money. Most MOOC start-ups do not appear to have clear business models and are following the common approach of Silicon Valley start-ups by building fast and worrying about revenue streams later.

The emergence of new educational delivery models including the rapid development of MOOCs is another source pressure on conventional HE institutions, but also offers opportunities for those institutions able to change and develop new provision. Foremost this requires institutions to address strategic questions about online learning and where the different innovations such as MOOCs fit within their activities. It is a mistake to see MOOCs as an isolated issue on which policy and strategic decisions need to be taken, as they are part of a broader landscape of changes in HE that includes the development of open education. It can be argued that MOOCs have the potential to impact on higher education in two ways: improving teaching; and encouraging institutions to develop distinctive missions that will include considerations about openness and access for different groups of students. MOOCs also provide institutions with a vehicle to think creatively and innovatively and to explore new pedagogical practices, business models and flexible learning paths in their provision.

New business strategies and models will be needed in response to the challenges posed by new funding structures and tuition fees and the new contexts that HEI operate in. The potential of MOOCs to open up higher education to the masses has challenged the traditional way of thinking about delivering higher education. Many HEI will be forced to explore new business models that will deliver online education at lower costs and expand the range of their provision both for strategic reasons and in response to demand from learners. Disruptive innovation and associated theories may offer HE institutions some possible business solutions and strategies to respond to the evolution of MOOCs, for example, setting up new units with different resources, processes, and priorities to explore new educational approaches and services. Institutions can launch new market disruptions to target those who are not able to go to universities, or they may launch up-market sustaining innovations by reducing the cost and providing better learning experiences without extra cost or low end market disruptions to target those who look for simple and straight forward courses rather than complicated university degrees. Institutions will need to assess their strengths and develop a strategic plan that enables them to make the most of campus and online education by providing MOOCs or other open education initiatives.

The popularity of MOOCs is forcing universities and colleges to rethink how to make their curriculum delivery models and courses truly flexible and accessible. There is a long tradition of HEI seeking to make learning more flexible with course modular design and bankable credits to encourage learners to study at a time and peace that suits their own needs. For example, developing approaches to negotiated, practice-oriented curricula in the workplace through initiatives such as the ASSET programme (Dann 1990, 53; Winter and Maisch 1996). Powell, Millwood and Tindal (2008) report the development of the work-focussed model of learning for undergraduates that is delivered entirely online and offers a personalised curriculum that enables students to continue to work and study full time, fitting study around their work and family life (Powell, Millwood and Tindal 2008). Open courses based on new structures, ways or working and use of technology can make higher education more cost effective and accessible and may also contribute to balancing work, family and social life. Learners have access to a variety of non-traditional learning models including access to courses and materials to self-direct their own learning beyond their classes and institutions. More flexible models and open approaches will encourage more mature students to participate in higher education and gain qualifications to further their careers.

7. Conclusions

MOOCs promise to open up higher education by providing accessible, flexible, affordable, high quality resources for free or at a low cost for learners who are interested in learning. The popularity of MOOCs has attracted a great deal of attention from HE institutions and private investors around the world either seeking to build their existing brands or to enter the education market. Established institutions will need to look more closely at and learn from the different initiatives that are developing new business, financial and revenue models. These initiatives are designed to meet the different needs of new groups of learners in an open HE marketplace. Open education brings new opportunities for innovation in higher education that will allow institutions and academics to explore new online learning models and innovative practices in teaching and learning. At a national and international level, new frameworks for HE funding structures, quality insurance and accreditation to support different approaches and models for delivering higher education will be required. Policy makers will need to address openness and make education more affordable and accessible for all and at the same time be profitable for the institutions in an open higher education ecosystem. For policy makers and institutions, the theory of disruptive innovation provides a useful lens through which to consider these changes and a starting point for developing and implementing their own strategic responses.

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In-depth

Towards Teacher-led Design Inquiry of Learning [▲]

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Summary

This paper proposes "teacher-led design inquiry of learning" as a new model of educational practice and professional development. This model combines four existing models. It integrates teacher inquiry into student learning, learning design, and Learning Analytics, and aims to capture the essence of the synergy of these three fields. Furthermore, we identify how Learning Analytics and the integrated model inform each other and could help integrating Learning Analytics into teachers' practice. The last claim is demonstrated through an illustrative scenario. We envision that the integration of the four models could help teachers align both the improvement of their practices and the orchestration of their classrooms. Future empirical investigation is envisaged using a design based research framework and participatory design approach to engage teachers with the integrated model in a professional development process. We envisage that the integrated model will promote quality enhancement in education at a personal and collective level, and will be used to design better Learning Analytics, learning design and learning enactment tools. The main limitation of the integrated model is that it requires organizational changes, and allocation of resources, in order to allow it to significantly impact practice.

Tags

Teacher Inquiry into Student Learning, Learning Design, Learning Analytics, Orchestration, Formative assessment.

1. Introduction

This paper introduces the first version of an integrated model of teacher inquiry into student learning, learning design, and Learning Analytics. As an outcome of an Alpine Rendez-Vous workshop held in January 2013, the integrated model aims to capture the essence of the synergy of the three fields, leading us towards a new strand of inquiry, which we are calling teacher-led design inquiry of learning. The paper seeks to investigate how Learning Analytics can give teachers an understanding of students learning processes in order to improve their experiences. We envisage that the integrated model will be used to design better Learning Analytics tools, specifically tailored to the learning scenarios which can now be viewed from a multitude of perspectives. We provide the context for understanding how these different fields can complement one another and build on each other's strengths. Beginning with a brief introduction

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of the fields, we go on to review four existing models. These form the foundations for the integrated model, which we propose as the central contribution of this paper. We proceed to identify the relationship of Learning Analytics to the steps of the integrated model and conclude by highlighting directions for future research.

Teacher Inquiry into Student Learning

Teacher Inquiry into Student Learning (TISL) is a focus of the European Integrated Project NEXT-TELL (http://www.next-tell.eu). It addresses the professional development of teacher practice by investigating student learning through action-oriented, evidence-based teacher-led research, with a particular focus on e-assessment. TISL (Clark, Luckin, & Jewitt, 2011), a systemic approach to teacher inquiry, has its roots in "insider view" approaches such as critical inquiry, action research, and teacher research, where teachers conduct their own research, in real classrooms and school settings, focusing on local practices. There has been a gradual shift from researcher-centered approaches to a more teacher-centered and design-centered approach that uses inquiry methods to support and guide teachers when participating in evidence-centered and evidence-based decision-making (Clark et al., 2011). It is this move towards evidence-centered design, together with a focus on technology support for teacher inquiry that TISL aims to support. TISL emphasizes teacher-led research in the development of effective e-assessment models, teacher assessment literacy and certification and the alignment of the preceding elements to schools' strategic planning as a sustainable form of teacher professional development. The ability to find research questions driven by teachers' own interests gives them ownership of the questions and of the findings and may encourage them to implement change derived from their own inquiries (Clark et al., 2011). Data from student activities gives teachers an opportunity to develop themselves as professionals through their own practice, for better learning. TISL is therefore one key issue in formative assessment.

Learning Design

Learning Design (LD) is the act of devising new practices, plans of activity, resources and tools aimed at achieving particular educational aims in a given situation. It is informed by subject knowledge, pedagogical theory, technological know-how, and practical experience. At the same time, it can also engender innovation in all these areas and support learners in their efforts and aims (Mor & Craft, 2012). Research and practice of learning design have evolved along two paths: one concerned with the automation of workflows from conceptualization to enactment, the other with sharing design knowledge among practitioners. The first strand focuses on machine-readable representations of learning design, such as IMS-LD (Koper, 2006). The second focuses on design practices, tools and human-readable representations, such as design patterns, scenarios and swim lanes (Conole, 2010).

A LD process typically begins by describing the learning context, the aims of learners, teachers and institutions, the resources at their disposal and the constraints under which they operate. The designer generates and tests conceptual models of learning activities intended to achieve those aims and the resources that would support them. The chosen models are elaborated at growing levels of detail until they are implemented in the enactment environment. Ideally, at every step along the way, the designer should be able to share the designs with peers for feedback, and review the designs of others to consider what could be adopted and adapted to the situation at hand. Each step in this cycle – capturing context, conceptualization, elaboration and deployment – requires appropriate representations and tools to manipulate these.

Learning Analytics

Although Learning Analytics (LA) can simply be seen as “the measurement, collection, analysis and reporting of data about learners and their contexts” (LAK 2011), it aims to extend beyond proposing tools responsible for analyzing learning outcomes, providing a holistic, dynamic and formative view of learning processes. A multitude of LA techniques have been identified, pertaining to different research communities and ranging from simple statistics, to data-mining tools, intelligent tutoring systems, discourse analytics, social network analysis, all with emphasis on information visualization (Cooper, 2012). Yet there is a clear need for further research on how to integrate these tools effectively within TISL or LD models. A computational perspective considers the identification of inputs, analysis methods (which can be external to the tutor performing the educational experiment) and formats for output. By contrast, an integrative approach strives for continuous refinement of the learning scenario, integrating outcomes from Learning Analytics throughout the entire process. Ultimately, a meta-level feedback loop should be established, where results from LA act as promoters or incentives for conducting new teacher inquiries and the design of new educational scenarios. Therefore, the visibility, the impact and interconnection of LA with TISL and LD expands beyond providing the tools and means to evaluate learning outcomes.

2. Foundational Models

This section introduces each of the four models that lay the foundation for the integrated model. The models are the TISL Heart, the Design Inquiry Model, the Scenario Design process model, and the Model for Integrating Design and Analytics in Scripting (MIDAS). Each one of these proposals have been co-designed and tested with teachers, obtaining positive results.

The target audiences of these models, methods and tools are mostly practitioners – teachers, trainers, instructional designers: teachers who wants to inquire into the learning of their students for the TISL Heart Model, teachers/practitioners as designers of pedagogical scenarios for the Scenario Design process model, teachers who want to monitor students’ activity for the MIDAS model.

The TISL Heart

The first TISL model developed by the London Knowledge Lab (Clark et al., 2011) was based on the teacher inquiry and knowledge-building cycle that promotes valued student outcome developed by Timperley, Wilson, Barrar, and Fung (2007), forming the basis of the model and method described here. The TISL Heart model and its corresponding method (Hansen & Wasson, 2013; Hansen & Wasson, submitted), developed at Uni Health, is rooted in teacher practice as captured in a focus group study of teachers at a Norwegian high school. During the focus group sessions, the teachers discussed how they collect, analyze, document, use and share data on student learning, to further develop teaching. The focus group concluded with the teachers drawing their own model of how to conduct student research. An analysis of the drawings and the discussions showed that the teachers were engaged in aspects of teacher inquiry into student learning, though not in a systematic way (Cierniak et al., 2012; Avramides et al., 2013).

The analysis resulted in the TISL Heart model (Hansen & Wasson, 2013; Hansen & Wasson, submitted), a conceptual model that combines an understanding of teacher practice and the theoretical aspects of evidence-based-change. The TISL Heart method supports professional development by leading teachers to use student data to improve practice, and thus student learning. Furthermore, in order to have a visual presentation that can be used to explain TISL to teachers, the theoretical TISL Heart model and the TISL Heart method have been combined into the TISL Heart (see Figure 1).

The top of the TISL Heart is the Kick-off, when a teacher first identifies the issues in which s/he is interested. Related to these issues are Assumptions and beliefs that flavor the teacher's understanding of the issues. Once aware of the issues and assumptions, a manageable Research question (?) would need to be formed. The "?" feeds into the heart of the TISL Heart, the Method, which expounds how to collect student data to answer the "?". Student data is collected during teaching and assessment, which results in a Learning outcome, the analysis of which feeds into Feedback (for students), is shared (with other teachers), and is used for reflection, which leads to new assumptions, new practice (teaching and assessment), and thus, further change. Table describes the steps in the TISL Heart method.

Design Inquiry Model

The Design Inquiry model (see Figure 2.) combines the iterative structure of educational design research (Mor & Winters, 2007) with the principles of inquiry learning (Edelson, Gordin, & Pea, 1999; Anastopoulou et al., 2012). Educational practitioners follow a cycle of **1** defining their project, **2** investigating the context in which it is situated and identifying appropriate techno-pedagogical theories, **3** reviewing relevant cases, **4** conceptualizing a solution, **5** implementing a prototype of that solution, **6** evaluating it and **7** reflecting on the process. Although this cycle is presented as a neat linear progression,

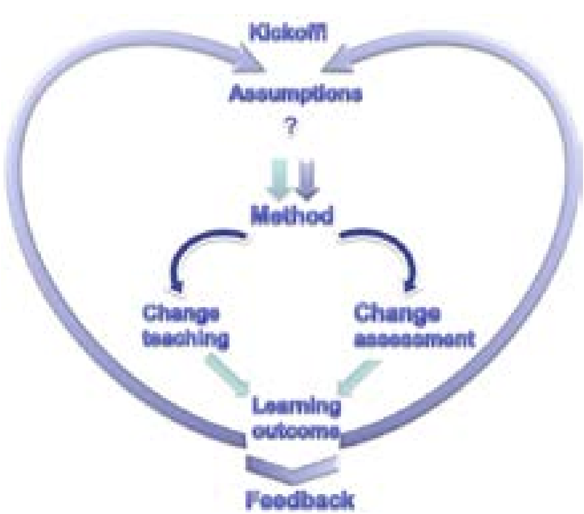


Figure 1. The TISL Heart

Steps	Description
Kick-off	Is there something you would like to know? What are the students' learning needs? Your learning need?
Assumptions	State your assumptions! Formulate and explain your first thoughts from the Kick-Off!
Research question	Develop a research question! Formulate& reformulate!
Method	Find a method! How will you find/collect the answers?
Changing teaching and assessment	Change! Collect data from teaching and assessment!
Learning outcome	Analyze! What is the result of changed practice?
Feedback and sharing	Change based on evidence! Report!W

Table 1. The TISL Heart method

in reality project work is messy and iterative. Practitioners revisit various points as their understanding evolves.

Laurillard (2012) argues that teaching should be repositioned as a design science, in line with paradigmatic distinction of Simon (1996) between natural science which describes how the world is, and design science which is concerned with how it should be. Ideally, we would want teachers to adopt a design science stance towards their practice. However, as the TISL work above demonstrates, it would be unrealistic to expect practitioners to allocate the resources required for rigorous and systematic scientific investigation. Instead, we propose a model of design inquiry – a projection of the ideal of design science into realistic settings.

Mor and Craft (2012) define learning design as "the act of devising new practices, plans of activity, resources and tools aimed at achieving particular educational aims in a given situation". In that sense, every learning design is a hypothesis about learning: when we design a learning activity, resource or tool we are implicitly claiming that within a given context, learners engaging with the designed artefact will achieve particular educational aims. Such a claim can be the seed hypothesis for a process of inquiry. Recent studies demonstrate how training teachers as learning designers enhances not only their practical skills, but also their theoretical understanding (Laurillard, 2008; Ronen Fuhrmann, Kali, & Hoadley, 2008; Voogt et al., 2011). Positioning their design initiatives in an inquiry cycle can further enhance their development, by adding an extra layer of rigor, and connecting educational theory to concrete experiences.

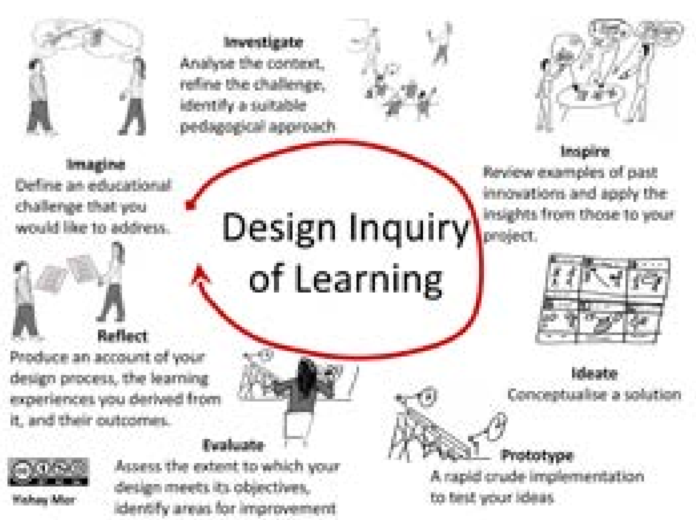


Figure 2. The Design Inquiry model

The design inquiry of learning approach is at the core of the Learning Design Studio model (Mor & Mogilevsky, 2012), which has been used in several MA courses and in the recently conducted Open Learning Design Studio MOOC.

Scenario Design Process Model

The model of "Scenario Design process" (see Figure 3) has been co-designed with groups of *teacher-designers* in the French secondary educational system (pupils from 11 to 18) during the research project on learning scenarios design and uses (CAUSA) at French Institute of Education (2005-2009). The considered *teacher-designer* has a good grasp of the knowledge domain to be taught and can be considered, to some extent, as a domain-specialist. S/he is supposed to master a certain range of basic technological competencies defined by national certification and, in general, s/he is not assisted by technical specialists in charge of implementation of his/her design.

Our goal is to model the steps followed by a teacher-designer while designing and using a learning scenario. This scenario would digitally represent the organization of the system and of the learning situations to set up. We focus on the life cycle of the scenario, following three main steps: design, enactment and evaluation, with a view to capitalizing or using it again. This life cycle, shown by Figure 3, was based on teachers' everyday practices, it relies on an empirical study based on two steps: firstly, the elicitation of the design process from two expert teachers and, secondly, the validation of this process by several groups of teachers (Emin, Pernin, & Guéraud, 2009).

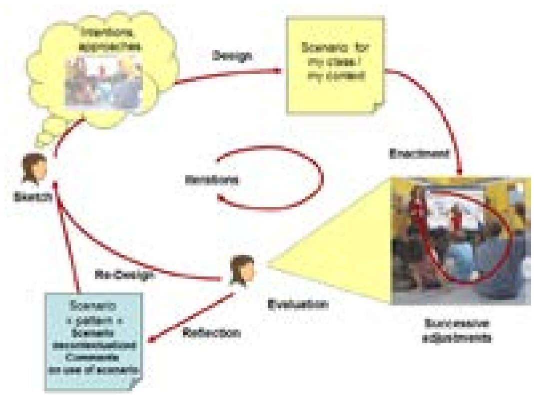


Figure 3. The Scenario Design process model

The Scenario Design process model describes a process as follows. The first step in the design of a pedagogical scenario by a teacher-designer is to define the intentions (in terms of learning outcomes, competencies and knowledge) and the pedagogical approach (e.g., the way of teaching, the role of the teacher). The result is a general *sketch/idea* of the learning scenario.

From this starting point, the *design* of the scenario for the class, tightly linked with the specific context, can begin. The teacher integrates iteratively and progressively the different constraints of his specific context. We defined four types of constraints: domain constraints (e.g., didactical constraints, availability and/or adaptability of existing resources), pedagogical constraints (e.g., class size, audience characteristics, roles, type of grouping), situational constraints (e.g., location, schedule, duration, tools and services available, face-to-face or hybrid), and economical or administrative constraints (e.g., financial, organizational, political) (Emin, Pernin, Prieur, & Sanchez, 2007).

The next step assumes the implementation of the "a priori" scenario; this is the step of enactment, where the teacher adjusts/adapts the scenario and achieves a different, "on the fly", orchestration than the one s/he initially envisioned and designed.

After the actual implementation, the teacher *evaluates* the scenario and its successive adjustments; this enable *redesign*, comments on the scenario for further use and a step of -, the definition of a "scenario pattern" in order to share it with other teachers or to reuse in another context. These patterns or de-contextualized scenarios can be used as an input in the first step of "scenario sketching". According to our empirical study, the design of a scenario relies also on know-how, reuse of strategies (Schank & Abelson, 1977) and imitation of recognized good practices, associated with personal representations of the profession of the teacher and of the expert within the domain.

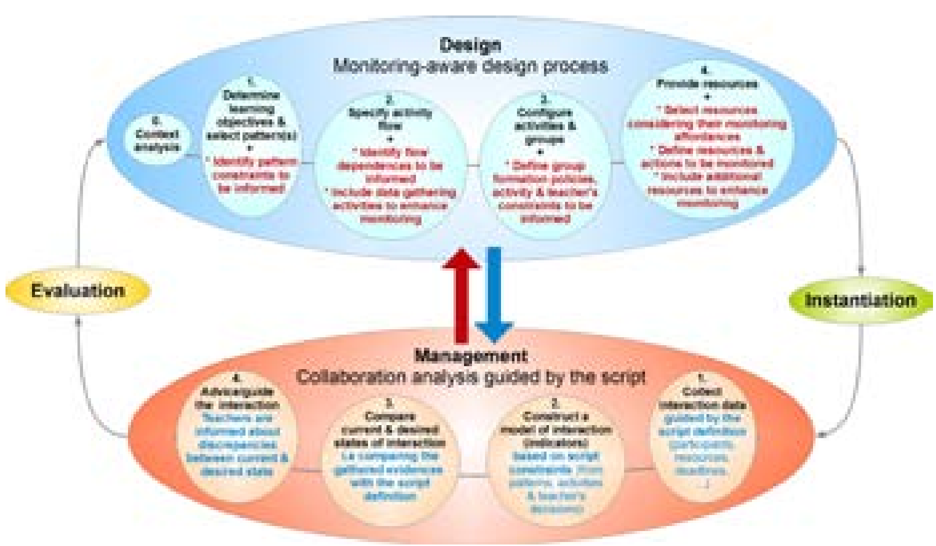
We have pointed out previously that this is an iterative process of design and enactment and changes can be made at each step of the loop. The process model we propose is based on principles, valid for both conventional training and digitally enhanced training methods.

MIDAS4CSCL: Model for Integrating Design and Analytics in Scripting for CSCL

Scripting and monitoring are two long-discussed techniques to foster effective collaboration in Computer-Supported Collaborative Learning (CSCL) (Jermann, Soller, & Lesgold, 2004). These two techniques are respectively related to Learning Design and Learning Analytics. On the one hand, scripting structures the learning scenario and provides students with a set of instructions that guide potentially fruitful collaboration. On the other hand, monitoring facilitates the intervention of the teacher in order to redirect the group work in a more productive direction.

Though scripting and monitoring have demonstrated to be effective supporting teachers in the orchestration of CSCL scenarios, the alignment of both techniques could provide additional benefits. Following this approach, we developed a model for integrating scripting and monitoring throughout the life-cycle of CSCL scenarios (MIDAS4CSCL - Model for Integrating Design and Analytics in Scripting for CSCL) (Rodríguez-Triana, Martínez-Monés, Asensio-Pérez, Jorrín-Abellán, & Dimitriadis, 2011; Rodríguez-Triana, Martínez-Monés, Asensio-Pérez, & Dimitriadis, 2012). The purpose of this model is to provide teachers with design and management support capable of linking their pedagogical intentions and run-time information needs, by aligning scripting and monitoring techniques.

According to the literature, the lifecycle of CSCL scripts goes through several phases. Though there is no consensus, they could be summarized in the following ones (see Figure 4): the design of the learning scenario; the instantiation the designed activities to address the concrete tool instances, participants and groups that will participate in their execution; the execution of the activities themselves and run-time management and, eventually, the evaluation of those activities. Our model focuses on the design and management phases,



describing the connections between scripting and monitoring. To build this model, we used existing proposals related to the design and collaboration management of CSCL scripts (Soller, Martínez-Monés, Jermann, & Muehlenbrock, 2005; Villasclaras-Fernández et al., 2009).

For the design phase, we proposed a *monitoring-aware design process of CSCL scripts*, Figure 4 (top) (Rodríguez-Triana et al., 2012). This process guides teachers to reflect and make explicit the design decisions that could eventually affect monitoring: the pattern(s) that the script implements -if any-, the activity flow, the configuration of each activity and group, and the resources and tools to be used in the scenario. The process comprises two cycles: the first one guides teachers in identifying basic constraints to be monitored regarding activities, groups and resources; the second one extends the script with new data gathering and/or monitoring support activities.

For the management phase, we proposed a process of *collaboration analysis guided by the script*, Figure 4 (bottom) (Rodríguez-Triana et al., 2011). This process defines how the design-time pedagogical decisions captured in the script may guide the analysis of users' interactions to provide teachers with relevant monitoring information. The collection of interaction data is guided by the specification of each learning activity, focusing on the data sources and the user' interactions most relevant to inform about the script constraints. Afterwards, a model of interaction is built, using script constraints to define the "desired state". Then, the gathered evidences (current state) and the script definition (desired state) are compared in order to identify the accordance and discrepancies between them. Finally, teachers interpret this output and intervene in the learning situation if needed.

This model has been co-designed and tried out with different teachers in several authentic CSCL scenarios carried out in university settings (Rodríguez-Triana et al., 2011; Rodríguez-Triana et al., 2012). The participant teachers valued the proposal positively and stated that it was helpful for the orchestration of their scenarios.

Discussion

As Table 2 shows, the aforementioned models are based on the areas previously presented. The TISL heart is based on TISL and aims to improve teachers' practice through teacher research. Similarly, the design inquiry model combines teacher inquiry and learning design to enhance teacher's practice. The scenario design process model uses the design of the learning scenario to regulate the current situation and improve future designs. Finally, the MIDAS4CSCL combines learning design and analytics in order to support the orchestration tasks.

Table 2. Overview of the areas addressed in each model and their purposes

MODELS	AREAS			PURPOSES	
	TISL	LD	LA	Improve teachers' practice	Improve orchestration (adaptation/ assessment)
The TISL heart	X			X	
Design inquiry model	X	X		X	
Scenario design process model		X		X	X
MIDAS4CSLC		X	X		X

Despite the purposes and the strategies followed in these models are different, there are several commonalities in the phases that constitute them (as it is described in the following section). Thus, we envisioned that the integration of the four models could help teachers to align both the improvement of their practices and the orchestration of their classrooms. Besides, as we verified in the MIDAS4CSCL model, we hypothesize that Learning Analytics could provide the required resources to apply our integrated model in real scenarios.

3. Integrated Model

Starting from all the previous models, we propose an integrated model (see Figure 5) that provides an integrated view and traceability between the particularities of each existing approach. This integrated model is described in seven phases: 1 Initiation; 2 Context analysis or investigation; 3 Formulation of the design objective and the research question; 4 Design of the method to achieve the learning objective and to answer the research question(s); 5 Enactment; 6 Evaluation; 7 Reflection and Re-design.

A possible scenario for the integrated model follows Carla, a chemistry and mathematics teacher in an Upper secondary school. Her analysis of students' assessment last year suggested some common misconceptions in the understanding of converging series. This year she decided to inquire this problem more thoroughly. She consults the integrated model to plan her teacher research project. The *Initiation* was her realization of the students' misconceptions. She has some idea as to why the misconceptions are happening. To investigate (*Investigation*) this thoroughly, she forms a concise conjecture (*Research question*) based on what she knows and what she thinks is the solution to this issue. Next, she uses learning design tools to translate this conjecture into a plan of action she can implement in class (*Design*). In doing so, Carla projects her research question into a realistic setting. Designing the learning activity, the resources and the use of tools, makes Carla's teaching more reflexive, because she documents her changes, based on previous learner data and her assumptions in order to achieve a particular educational aim. Collecting new data, by aligning scripting and monitoring techniques, Carla is provided with design and management support in order to link her pedagogical intentions and run-time information needs. After the actual implementation (*Enactment*), Carla evaluates (*Evaluation*) and shares her findings with peers and experts and reflects on their feedback. This results in a new *Initiation*: new assumptions and the need to form a new research questions. In this sense the different parts of inquiry, learning design and Learning Analytics helps Carla to develops as a teacher, for professional development through own practice.

There is a synergy between the Integrated Model and Learning Analytics (LA) as they provide each other with data. For example, data from LA may trigger the teacher to investigate student learning, while the student data collected from teacher inquiry feeds LA.

Table 3 presents these relationships between the Integrated Model and Learning Analytics.

4. Discussion

Personal Inquiry vs. Generalization

TISL Heart	Design Inquiry Model	Scenario Design Model	MIDAS4CSCL	Integrated Model
Kick-off	Imagine	Idea of the learning scenario, intentions and pedagogical approaches		Initiation
Set assumptions	Investigate		Context Analysis. Definition of prerequisites	Context analysis or investigation
Define R&D Question		Design of the scenario for the class/ context, successive iterations	Define learning objectives	Formulation of the design objective and the research question
Design method to answer the question	Inspire and ideate		Select the pedagogical pattern. Configure the activity flow, groups and resources	Design method to achieve learning objectives and to answer research question(s)
Enact changed teaching and assessment	Prototype	Enactment and successive adjustments	Instantiate the design. Enact the design	Enactment
Evaluate learning outcomes. Provide summative feedback	Evaluate	Evaluation of the scenario enactment	Evaluate learning situation and design. Provide feedback	Evaluation
Refine overall model (formative feedback loop)	Reflect	Reflection on the design, comments and patterns. Re-design and decontextualization	Re-design	Reflection and re-design

Figure 5. Integrated Model

The primary concern of the TISL model is teachers' personal professional development through their inquiry. By contrast,

Learning Analytics provides	Integrated Model	Learning Analytics requires
· Insights that trigger teachers to change practice	· Initiation	· Data from previous analysis
· Partial image of context based on historical or related data	· Context analysis or investigation	· Historical data from the context or related data (comparing with similar situations or contexts)
Systematic way of organizing data		· Context model, normalizing the data to be analyzed
	· Formulation of the design objective and the research question	· Constrained formulation of the design and the research question. · Connections to be established between them
· Suggestions in the decision-making process (e.g., providing info about tools that may offer data for the analysis) · Support for comparing the research questions with the design: may the current design answer the question(s)? (if not, iterate)	· Design of the method to achieve the learning objectives and to answer the research question(s)	· Collection of information about available data sources/tools (capabilities/affordances regarding monitoring purposes) Identification of the assumptions /constraints to be verified · Comparison of information needs of assumptions/constraints/ probable outputs and the data sources · Input and output integration

Table 3. Relationships between the integrated model and Learning Analytics

Learning Analytics provides	Integrated Model	Learning Analytics requires
· Real-time monitoring of the learning situation · Detection of critical situations · Visual representations of the results · Suggestions about ways of regulating the situation (for the teacher or for the students – for SRL)	· Enactment	· Collection and integration of data from the different sources · Comparison with assumptions/ constraints · Generation of visualizations · Feedback to teacher based on previous regulation actions · Documentation of teacher regulation of actions and changes (e.g. to take them into account in future)
	·Evaluation	· Interpretation of the data gathered (questions, learning objectives, assumptions, constraints, indicators) · Extrapolation of trends · Correlation of results with external data sources
· Trend analysis · Results (the data monitored, the documentation collected and the evaluation) connected with the research questions	· Reflection and · Re-Design	

Table 3. Relationships between the integrated model and Learning Analytics

scientific method is oriented towards sharing, scrutiny and aggregation of knowledge. The Learning Design tradition tries to combine both: supporting the individual designer in their tasks, by sharing and reusing design knowledge. Yet this often lacks the rigor of scientific inquiry. An integrated model, as presented here, would strive to balance these forces: allowing practitioners to perform their work, while at the same time developing their professional abilities and sharing the knowledge they construct within a critical and supportive community.

Overscripting, Orchestration, Regulation and Re-design

One problem raised by several authors (Dillenbourg & Tchounikine, 2007) concerns the limits of a too prescriptive approach in learning design. This seemingly rigid facet of learning design is sometimes contrasted with an "orchestration" approach (Dillenbourg & Jermann, 2010). By making an analogy with theater or music, it is possible to distinguish two contrasting views. The first states that it is necessary to define very precisely all the tasks to be performed by each type of actor in the process, providing detailed deterministic scripts. At runtime, there is no room for improvisation; the text must be followed to the letter. The second, used for example in jazz or in improvisational theater, provides actors with a general frame within which each may play theirs own part. In this case at runtime, the quality of the result depends not only on the performance of each actor, but also on players' ability to listen to each other and on the ability of a team leader (a conductor) to "orchestrate" (before and during the play) the different parts by giving an "intention".

Many limitations of the first approach can be raised, most notably that it does not allow for unplanned developments, emergent phenomena and personal adaptations. It promotes a "process-centric" attitude, where learners and teachers focus on the tasks to be performed and lose sight of the original aims behind them. It matches with a behaviorist approach where an appropriate sequence of tasks is systemically supposed to reach a learning goal.

By contrast, a "design-orchestration" approach may offer a more robust alternative, where the designer concentrates efforts on the essence of the design; the learning intentions or objectives, by defining a "synopsis" based on "open interactional situations" selected for their capacity to sustain specific learning practices in specific contexts. For each "open interactional situation" the teacher-designer provides actors with a set of resources or tools that can be used or enriched by the learners themselves. The teacher-designer knows that this initial scenario could be "adjusted" or "refined" at runtime by the tutor or by another actor. The inevitable unforeseen problems can often be solved more easily by human intervention than by an automatic system; regulation is thus made easier.

Integrated Model and Learning Analytics

The integration of LA in the teacher's practice may play a crucial role in the enhancement of learning. Nowadays, teachers have to carry out overwhelming amount of tasks to manage their lessons, reducing the possibility of devoting time to inquire and reflect on students learning. To face such problem, the integrated model presented in this paper offers some clues about how LA may be integrated in teacher's practice, describing the required input and the potential affordances. Though we do not have empirical evidence of the acceptance of the integrated model, we have based our proposal on models that have been co-designed with teachers and that have obtained positive evaluations. Nevertheless, we expect to validate and refine our proposal involving teachers in a short-medium term.

The main limitation of the Teacher-led design inquiry of learning model, presented in this paper, is that it requires organizational changes, and allocation of resources, in order to allow it to significantly impact practice. Despite the growing acknowledgment of the potential of Learning Analytics, most institutions see its implementation as a centrally provided service, with teachers and learners as consumers of pre-packaged information. By contrast, the approach described here would ideally see teachers (and perhaps learners) as active partners in the design of Learning Analytics tools.

Likewise, the adoption of learning design and teacher inquiry, as professional practices, is lagging far behind the desired state. Examples such as the teacher development trust, which promoted teacher inquiry as a framework for professional development, are far from the norm. Learning design is acknowledged predominantly in the context of online learning (e.g. at the Open University, UK), and is often misinterpreted as limited to the visual design of learning resources. The model we propose demands not only the adoption of both teacher inquiry and learning design, but the integration of both elements into a coherent framework of practice.

Future work

The Teacher-led design inquiry of learning model draws on the synergy of several strands of empirical work supported by established theoretical frameworks. Nevertheless, its proposed form is still a conjecture and needs to be validated and elaborated empirically. Such empirical investigation will expose the strengths and weaknesses of this approach and ultimately demonstrate its impact of the quality of the learning experience. To carry out such a project would require (1) engagement of educational institutions and the practitioners within them, (2) participatory design of suitable practices that implement the model and the tools to support them (3) formative and summative evaluation of these practices and tools and (4) dissemination of the outcome of this process to the wider community.

Conclusions

This paper explored the potential synergy of three traditions of research in TEL: Teacher Inquiry into Student Learning (TISL), Learning Design (LD) and Learning Analytics (LA). Four existing models that partially connect TISL, LD and/or LA were reviewed, to propose an integrated model. Then the models' possible interactions with LA were considered. This can be a promising direction for future development of educational practice, as well as a rich field for research. LD and LA are currently gaining ground as potent approaches to technology-enhanced educational practice. Yet, to gain validity – LD needs to incorporate data, and to gain impact – LA needs to influence design. Thus, both LD and LA can only manifest their full potential if they are integrated in a coherent cycle of inquiry and teachers professional development through research from own practice and innovation scaffolded through a method that supports the teacher step-by-step. We see the model proposed here as a first step in this direction.

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In-depth

The Maker Movement Implications from modern fabrication, new digital gadgets, and hacking for creative learning and teaching

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Summary

The "Maker Movement" deals with innovative forms of production and do-it-yourself work. It is not only a way for new business models and developments, e.g. using 3D print or other new digital tools and gizmos, but also influencing education. This paper introduces several diverse terms (from FabLabs to Hackerspaces) and gives insights into background, practice and existing experiences from Maker Movement in educational settings amongst all age groups. As a conclusion, the authors present reasons why practitioners and researcher should consider its educational potential. Besides its creative and technological impacts, learning by making is an important component of problem-solving and relating educational content to the real world. Besides this, digital tools for making are not expensive, for example apps for mobile devices or rents for 3D printer (compared with desktops in 1:1 settings). The Maker Movement is seen as an inspiring and creative way to deal with our world, it is aware of ecological challenges and of course, and it is able to develop technological interest and competences casually. Finally, the authors give recommendation for reading for all who got interested in making.

Tags

3D print, maker movement, hackerspaces, innovation, creativity

1. Exploring new trends in education: The Maker Movement

As innovative educators and researchers, it is important to be up-to-date on current trends and developments and how they might impact education. In higher education, a popular resource for e-learning trends and future developments is the New Media Consortium's (NMC) Horizon report (e.g. Johnson et al., 2012) that is released yearly. Based on data collected from professionals in the field, the report focuses on the potential wide-range adoption of technologies currently used for learning within the next few years. Another popular resource, The Innovating Pedagogy report (Sharples et al., 2013) from the Open University in the UK views trends and future developments more broadly to include new trends and future (un-invented) technologies. Grounded in new educational terms, theories and practices, it proposes ten innovations that "have not yet had a profound influence on education," but "have the potential to provoke major shifts in educational practice, particularly in post-school education" (Sharples, et al., 2013, p. 3). One of the innovations listed in the 2013 Innovative Pedagogy report is "maker culture" with the subtitle "learning by making" that "encourages novel applications of technologies, and the exploration of intersections between traditionally separate domains and ways of work" (Sharples et al., 2013, p. 33). The Maker Movement was already named a top ed-tech (educational technology) trend in 2012 by hackeducation.com (posting from November; see Watters, 2012). Its potential for education has been avidly discussed on several websites and discussion forums, where some see it as the next revolution in education, using statements such as "The next revolution in education will be made, not televised."[1] This article attempts to answer the question: What is the "Maker Movement" and what are its influences and its (potential) impact on learning and education? Given the possible impact of this trend on education, the aim of this contribution is to provide a broad introduction to the issue and discuss its likely influence on education as a first step to initiate discussion of this (potential future) trend.

Within this article we will a) introduce the Maker Movement and its elements b) describe how it relates to other developments in the history of education c) provide examples of how it has been adapted and has influenced learning spaces or educational settings d) review existing literature on this new phenomenon, and e) discuss the implications for learning and teaching with respect to why educators, learning organisations as well as researchers should be aware of these new developments. A scientific in-depth analysis of the status quo is not possible in this article as we were not able to find any existing comprehensive work that brings together these related strands, stories and existing work within the new field. Due to the newness of this phenomenon, we also reviewed sources such as Wikipedia, other Web sources and reports on current developments, whose validity might be a point of contention. It is also possible that despite our efforts, we have missed some existing literature or part of the puzzle. Nevertheless, we hope this contribution is a helpful step forward to provide a robust overview of these new developments and their significance for educators.

2. The Maker Movement: Internet of Things, its adoption trough makers and their key ideas

The idea behind the Maker Movement is to create and develop new things (concrete or digital) using new tools such as 3D printer in open spaces, work shops or labs (Anderson, 2012). It combines innovative forms of productions and do-it-yourself work. Even if not everything and every action amongst makers is digitally driven, making deeply builds on the development of the "Internet of Things" (IoT). Small computers or digital devices and tools, which are connected via the Internet, are built and used to create or produce new products. Some examples for this are: to sew fancy interactive clothes, to develop new user interactions with the Internet using RFID chips (for example to send an e-mail if a key is hung up at home), or to construct a robot which is able to clean one's own flat. Making in this context does not just focus on IoT and uses a fusion of the digital and physical world as well as traditional tools.

In the "Maker Movement Manifesto", Mark Hatch (2013) identifies the following nine principles for the Maker Movement:

[1] http://www.techlearning.com/features/0039/meet-the-makers/54261#sthash.XT9Z5nj5.dpuf (2014-04-04)

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- "MAKE – Making is fundamental to what it means to be a human. We must make, create, and express ourselves to feel whole. […]
- SHARE – Sharing what you have made and what you know about making with others is the method by which a maker's feeling of wholeness is achieved. […]
- GIVE – There are a few things more selfless and satisfying than giving away something you have made.[…]
- LEARN – You must learn to make. You must always seek to learn about your making […]
- TOOL UP – You must have access to the right tools for the project at hand. Invest in and develop local access to the tools you need to do the making you want to do.[…]
- PLAY – Be playful with what you are making, and you will be surprised, excited, and proud of what you discover.
- PARTICIPATE – Join the Maker Movement and reach out to those around you who are discovering the joy of making. […]
- SUPPORT – This is a movement, and it requires emotional, intellectual, financial, political, and institutional support. The best hope for improving the world is us, and we are responsible for making a better future.
- CHANGE – Embrace the change that will naturally occur as you go through the maker journey. […]" (pp. 1 ff).

According to Hatch (2013), his manifesto is only an initial sketch. He writes, "In the spirit of making, I strongly suggest that you take this manifesto, make changes to it, and make it your own. That is the point of making" (p. 2).

Social movements do not normally originate from one point or one man's idea, but take place as multiple sub-developments in different ways. This is also true of the Maker Movement that has evolved in multiple forms such as public studios and laboratories where people are able to make something (sometimes for a small fee) and these forms have received different names. Specific terms and hubs for the Maker Movement such as the FabLab initiative in MIT, hackerspaces and makerspaces are explained later in this section. On the one hand, these terms are

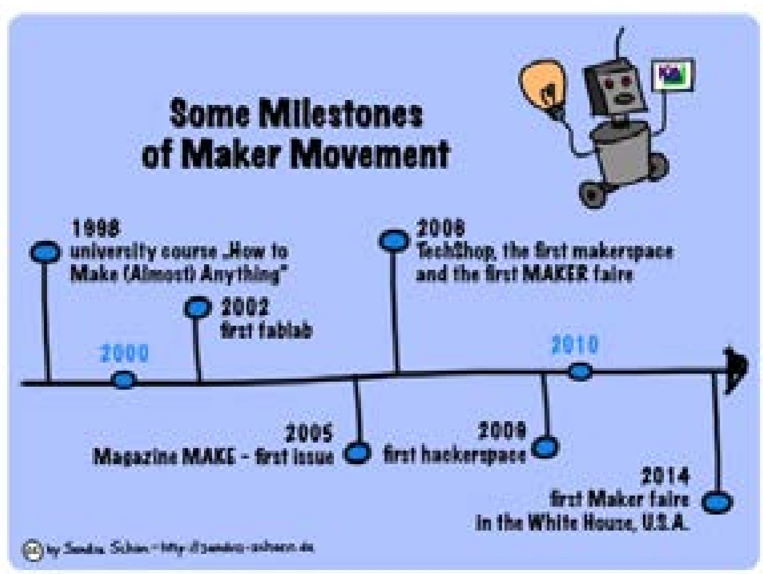

Figure 1: Some Milestones of Maker Movement

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sometimes used synonymously with each other, and on the other, fundamental differences between their concepts (concerning business model; non-profit vs. commercial) and main activities (fabrication, programming, and the role of digital tools) have been highlighted. Some readers may hesitate to accept the term "Maker Movement" because they might consider it an exaggeration for a recent development to be equated to a social movement. Using existing definitions and theories, Walter-Herrmann (2013) confirmed that the FabLab movement is a social movement, and we consider the FabLab as a part of the Maker Movement. Although all the different terms and definitions that fall under the Maker Movement do not have a "corporate identity" and are not always viewed as belonging together, and some might not regard the Maker Movement as a social movement, it is used as a heuristic term in this paper. The following paragraphs describe some of the different terms, movements and hubs that make up the Maker Movement (Figure 1).

The Fablab

The motto of the MIT Fab Lab (short for "fabrication laboratory") project is "Give ordinary people the right tools, and they will design and build the most extraordinary things."[2]. The project originated in 2001 at the Center for Bits and Atoms at the Media Center of the Massachusetts Institute of Technology under Neil Gershenfeld, the author of the book "Fab, The Coming Revolution on Your Desktop - From Personal Computers to Personal Fabrication" (Gershenfeld, 2005). Fablabs "provide access to prototype tools for personal fabrication" such as a 3D printer or laser cutter[3]. Following the opening of the first FabLab in MIT in 2002[4], Fablabs have spread across the world from Boston to Africa and Europe. They have found application in areas such as agriculture, health or housing, and are (normally) supported by non-profit organisations or funded by communal sponsors. Examples from Europe are the OTELO initiative ("Offenes Technologielabor", in English open technology lab, Austria non-profit organisation, http://www.otelo.or.at/otelo/idee/), the HappyLab (Vienna, Austria, co-financed by the Ministry and others, http://happylab.at) or the FabLab Munich (Germany, non-profit organisation, http://www.fablab-muenchen.de/). The Fab Lab foundation describes four essential features of registered FabLabs: Public access (free, at least for some time), a common set of tools, participation in the FabLab network, and they have to sign the FabLab Charta[5][6]. Currently about 280 FabLabs can be found at the foundation's Website[7].

Maker faires

In 2005, the same year of the publication of Gershenfeld's book, a new magazine called "MAKE" was published in the U.S. MAKE is issued every two weeks and focuses on do-it-yourself projects involving computers, robotics, electronics, and other product areas. The magazine established the first Maker faire in 2006, a public and now annual event, in San Mateo Fairgrounds with over 100 exhibiting makers. "Maker faire" is a trademark, thus all events are registered and supervised by the Maker magazine. The special nature of these events has been emphasized by Watters (2012), who states, "There were plenty of other science fairs this year — including ones at the White House and at Google — but Maker Faire is fairly unique, I'd argue, in its culture, creativity, and community." By now, several Maker faires have also been hosted in Europe, for example the "European Maker Faire 2013" in Rome[8]

[2] http://www.fablabdc.org/about/history/ (2014-04-07)

[3] http://www.fablabdc.org/about/history/ (2014-04-07)

[4] As mentioned by Walter-Herrmann & Büching (2013, p. 12), there are several other sources and also similar development elsewhere.

[5] http://www.fabfoundation.org/fab-labs/ (2014-04-07)

[6] http://fab.cba.mit.edu/about/charter/ (2014-04-08)

[7] http://www.fabfoundation.org/fab-labs/ (2014-04-07)

[8] http://www.makerfairerome.eu/check-out-the-program/ (2014-04-04)

or the Maker Faire 2013 in Hannover (Germany)[9]. Last, but not least, the White House in the U.S. plans a "maker faire" in 2014[10].

Do-it-yourself (DIY)

The new technological possibilities, grassroot-driven activities and FabLabs comes include the do-it-yourself (DIY) as a new business model. In a book titled "Makers," Anderson (2012) termed the "Maker Movement" a business development that can be likened to a new industrial revolution. The possibility of fabrication using new tools such as 3D printers by nearly everyone is a foundational part of this development. It allows inventors not only to develop a smart idea, but also to produce it. Invention, design and business go hand-in-hand, providing a lot of options for enterprising people, such as the possibility of very small businesses and low risks. According to Anderson, makers are combining do-it-yourself and manufacturing with new digital tools that he terms "digital DIY". Additionally the sharing of ideas and plans amongst the community is a unique cultural dimension of the movement that, along with fabrication, is supported by the usage of uniform standards.

[9] http://makerfairehannover.com/ (2014-04-04)

[10] http://www.youtube.com/watch?v=e53UPiFDH0k (2014-04-04)

Makerspaces

Another part of the Maker Movement is the development of "makerspaces". Makerspaces are (commercial) studios equipped with digital fabrications tools such as 3D printers or laser cutters, vinyl plotter and AutoCAD software that anyone can use for a relatively small fee. The mindset of people organising and visiting such makerspaces and its workshops is described as open, friendly, supporting and creative. The CEO of the first commercial makerspace, the "TechShop" founded in 2006 in Silicon Valley, Mark Hatch describes makerspaces as "a center or workspace where like-minded people get together to make things" (2013, p. 13). Success stories from the makerspace TechShop are contained in the Maker Manifesto (2013). Making is therefore an inspiring and creative way to use modern technologies and communication tools to support the potential development of innovation with a business impact (Anderson, 2012).

Hackerspaces

Besides "FabLabs" and "makerspaces", there are also "hackerspaces" (or "hacklab", "hackspace"). Whereas the first two terms are tend to be used synonymously and are used for public areas with digital production tools, hackerspaces have a slightly different focus. The idea of "hackerspaces" originated in Germany as an idea of the Chaos Computer Club in 2009[11]: Physical public meeting rooms for hackers (software developers and experts) are seen as inspiring places for open software development – and other technical applications. The first "hackerspace" was at the "c-base space station" in Berlin, Germany "a culture carbonite and a hackerspace [that] is the focal point of Berlin's thriving tech scene"[12]. Other popular hackerspaces are the "NYC Resistor" in New York City, USA).

In summary, the term "Maker Movement" has probably been coined based on all the above terms such as "MAKE", the MAKER faires, Anderson's (2012) book "Makers", Hatch's "Maker Movement Manifesto" and several others. It is used in several references in the educational literature. However, the term "Maker Movement" is not widely used or used by all those who describe these activities and who might prefer to still use other terms with slight differences and meanings for the activities we heuristically describe as part of the "Maker Movement" in this article. Perhaps the current phase of

[11] See Wikipedia, http://de.wikipedia.org/wiki/Hackerspace#cite_note-1 (2014-04-04)

[12] http://bergie.iki.fi/blog/ingress-table/ (2014-04-14)

the Maker Movement and its bunch of terms (and definitions) is comparable with the early years of the OER (Open Educational Resource) movement, where several terms such as free open educational content, open learning resources, were used to describe the similar resources. Before people in the field came together, shared terms and resources, and the phenomenon was more widely acknowledged, several terms were used by people in different parts of the world or the field. This also means that a term other than "Maker Movement" could get more popular in the future, but understandably, we are unable to foresee it. Before we describe how the Maker Movement and its tools are influencing educational and learning environments, we would like to explore the history of this movement in education.

3. Roots and references of the development in education: Constructionism

The construction of knowledge using physical artefacts and the usage of technologies to invent or engineer is not new in education. In this section we trace the roots of the Maker Movement to other developments in the history of education (see figure 2). Reformist and progressive educators from the first half of the 20th century such as Maria Montessori, Friedrich Fröbel, Johann Heinrich Pestalozzi, Célestin Freinet and John Dewey promoted the usage of physical artefacts and tools in education. All of them viewed "the prospect of child development in the fact that he/she constructs knowledge by him/herself through physically manipulating his/her environment" (Schelhowe, 2013, p. 95). Montessori emphasized the use of all the senses in learning, while John Dewey was a strong proponent of learning by doing, who emphasized two-way learning interactions between learners and their environments, stating that learning should entail "participation in something inherently worthwhile" and a perception of the "relation of means to consequences" (1926, in Archambault, 1964, p. 150).

Building on Jean Piaget's view of learners constructing knowledge by interacting with their environment, Seymour Papert proposed constructionism or "learning-by-making" (Papert & Harel, 1991, p. 1) where learners would use tools to make things in order to construct knowledge. Providing the example of

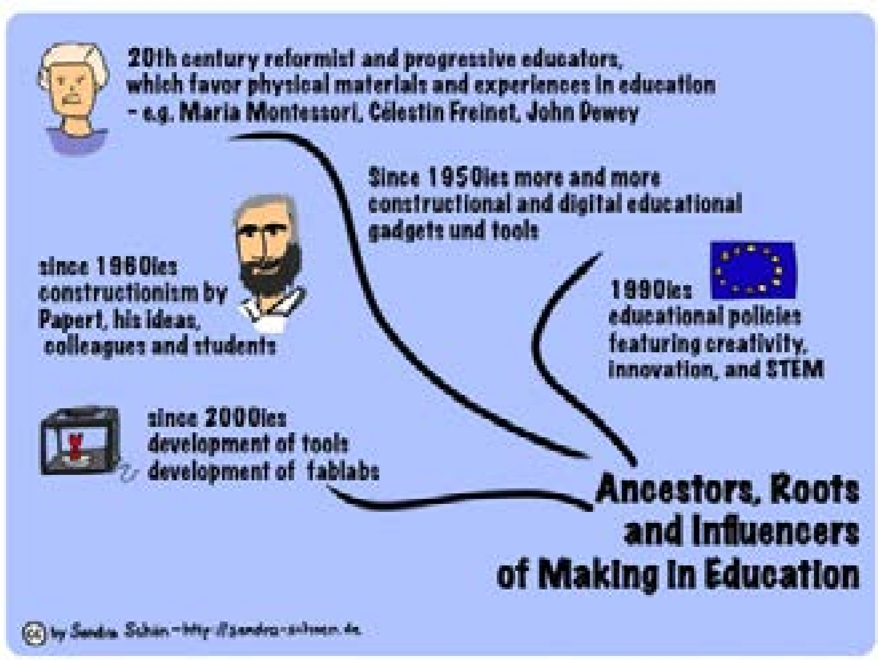

Figure 2: Ancestors, roots and influences of making in education

children creating soap sculptures in art class, that "allowed time to think, to dream, to gaze, to get a new idea and try it and drop it or persist, time to talk, to see other people's work and their reaction," (Papert & Harel, 1991, p. 1) Papert describes constructionism as a means to learn "in a context where the learner is consciously engaged in constructing a public entity, whether it's a sand castle on the beach or a theory of the universe" (Papert & Harel, 1991, p. 1). According to Papert, Logo, a language he developed in 1960 enabled students to use "this high-tech and actively computational material as an expressive medium; the content came from their imaginations as freely as what the others expressed in soap" (Papert & Harel, p.2). Papert's seminal work "Mindstorms" that describes a microcosmos for children as a computer based learning environment (Papert, 1980) and innovative projects at MIT such as the Constructionist Learning Lab (Stager, 2006) have greatly influenced present learning environments for makers. Papert describes eight main ideas of his Constructionist Learning Lab as: "learning by doing", "technology as building material", "big idea is hard fun", "learning to learn", "taking time – the proper time for the job", "you can't get it right without getting it wrong", "do not unto ourselves what we do unto our students", and "we are entering a digital world where knowing about technologies is as important as reading and writing" (Martinez & Stager, 2013, p. 73f).

Interestingly, the idea of "engineering for children" was often focussed on boys in the 1940ies to 60ies, whereas the education focus of "making" for girls was on cooking, tinkering and household. Small wooden blocks are probably the first developed materials for children to build, construct and engineer a small new world. The development of small plastic blocks by the Swedish enterprise LEGO (1949/1958) are the modern popular plastic variant of such educational engineering materials. Probably the first construction kit for radio technology was offered in 1950 by KOSMOS. Other examples of development toys for children are the construction toy "Fischertechnik" available since 1965 that enables the building of small machines in children's rooms or classrooms. Digital technologies have also played a role in educational toys for engineering since the introduction of the LEGO Mindstorms series at the end of the 1990ies. This construction kit allows children to built robots and machines with a programmable brick computer, sensors and motors. It is available since 1998 and builds on prototypes developed by the MIT Media Lab.

While several of educational tools were developed in conjunction with the educational theories discussed above, not all educational tools and learning spaces related to the Maker Movement might be directly derived from them. Besides the Maker Movement and constructionist traditions, technologies have been used as digital tools for creating or learning in several other settings that are influenced by other reasons, aims and theoretical backgrounds, which are too diverse to review in this article that is focused on the Maker Movement. For example, science fares are similar to maker faires, but focus on fostering interest in science and sciences activities. Another example are science museums or universities that have labs or workshops for children to arouse interest and provide interactions in science. Other activities, such as programming sessions for kids, aim to foster well-defined competences, for example software developing skills. Further reasons to use technologies and digital tools in learning are the development of media skills, communication skills, creativity and civic participation.

4. Exemplars of Educational Application from the Maker Movement

Within our paper we use the term “making” as related to new forms of relative simple ways to fabricate real or digital things with digital tools, including fabrication, physical computing and programming (see Martinez & Stager, 2013). Building on how “making” is a result of several developments and theories in the history of education, in this section we review some exemplary educational tools, learning spaces and educational settings that we consider representative of the Maker Movement. We start with short introductions to tools that are explicitly built to initiate and foster creative engineering and application in children and adults (see figure 3).

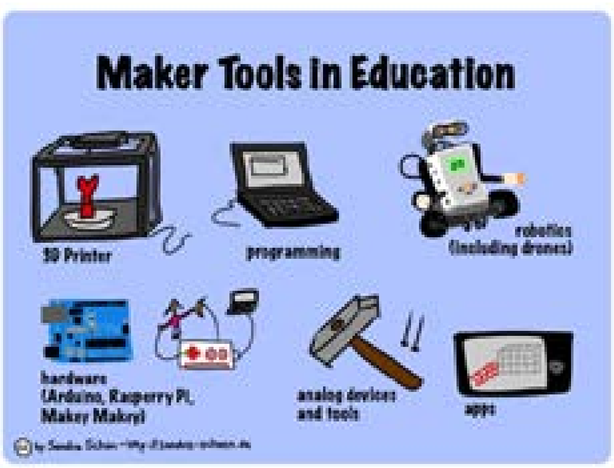

Figure 3: Digital Tools for Making in Education

Physical Computing

Physical computing[13] encompasses several digital tools such as sensors or micro controllers that are used to control systems, regulate motors and other hardware or to make analog signals available for computer software. In recent years, the “MakeyMakey kit”[14] developed by students of the Media Lab at the MIT has gained a lot of attention. The kit was developed to create and invent new forms of inputs for a computer. The very simple usage makes it possible to use bananas as input keys of a laptop or putty as a joystick (at least as input device for the arrows). Additionally, Arduino[15] and Rasperry[16] Pi hardware kits are comparatively simple hardware devices that are programmable with relatively simple developer knowledge. “Lillypads” is a special hardware kit used for clothes, for example, it is now possible to design a dress that blinks according to the bass within a dance hall. Robotics kits such as Lego Mindstorms[17] that enable the creation of robots, which can perform different activities, also belong in this category.

Programming Tools

Several educational programming tools are available that have been specially developed for children. Etoys, directly influenced by constructionism and Logo, enables the programming of virtual entities and their behaviours. It was followed by the development of programming language Scratch[18], a multimedia authoring tool popular in educational settings for both children and adults, by the MIT Media Lab’s

[13] See http://de.wikipedia.org/wiki/Physical_Computing (2014-04-04)

[14] http://www.makeymakey.com/ (2014-04-04)

[15] http://scratch.mit.edu/ (2014-04-04)

[16] http://www.raspberrypi.org/ (2014-04-04)

[17] http://www.lego.com/en-us/mindstorms/?domainredir=mindstorms.lego.com (2014-04-04)

[18] http://www.lego.com/en-us/mindstorms/?domainredir=mindstorms.lego.com (2014-04-04)

Lifelong Kindergarten group. Over 400,000 Scratch projects have been created in the last decade and are shared in a Web-based community platform using a Creative Commons license that allows users to re-mix parts of projects to new products. A further example of an educational Java-based programming tool that enables community sharing is GreenFoot, which older students can use to build interactive games and simulations. As hackerspaces focus on software development and open source software, an open movement for coding by children has emerged, called „Coder Dojo“ and driven by the idea „We want every child to have the opportunity to learn how to code which is why the movement is Open Source“[19].

Fabrication Tools

Although fabrication tools are used and adapted for educational settings, it appears that that special educational adaptations of these tools are not yet available. Special 3D printers for children as toys are currently a future vision that might be a possibility according to reports about a partnership of Hasbro and 3D systems[20]. Although it seems to be possible to construct a 3D printer with Lego Mindstorms[21], a special 3D printer for educational purposes is not yet available.

North American experiences with making with kids

Martinez and Stager offer four possibilities of using materials for making in educational settings: “1. Specific concept. Use the materials to teach a specific concept, such as gears, friction, or multiplication of fractions. 2. Thematic project. Visit a local factory, amusement park, airport, construction site, etc. and construct a model of it. Design a set for our medieval carnival. 3. Curricular theme. Identify a problem in Sub-Saharan Africa and build a machine to solve this problem. 4. Freestyle. The materials become part of your toolbox and may be used when you see it. This choice of media or medium requires student to develop technological fluency (p. 65).”

In the USA, makerspaces for kids exist in various learning environments, namely, in-school, after school, home-based, homeschooling and museum-based (Young Makers, 2012). An example of a makerspace within schools is the MENTOR program in 2012 that piloted ten low-cost makerspaces in California high schools. By 2016, MENTOR aims to have more than thousand makerspaces installed in high schools (Watters, 2012). A special makerspace for kids located in Toronto (CA) that is described by Jennifer Turliuk, Co-executive and “Chief Happiness Officer” as follows:

“The first element is a dedicated space where kids know that they can be safe, be creative, and have autonomy, and we’ve seen that they really take ownership and do things like tell other kids to clean up after themselves or to act more safely with tools, which I haven’t seen elsewhere. Secondly, we have real tools — we give kids the ability to use soldering irons, saws, glue guns, things that are quite dangerous. If kids ask us if we can do something for them because they’re too scared or they’re not sure how, we generally say no and help them learn to do it safely and become more comfortable with it, or find another way to achieve their goals. Thirdly, process over product — we emphasize that it’s okay to fail, and we value experiential learning (learning by doing), so instead of telling them step-by-step instructions, we advise them to try and figure out how to do it themselves, ask other kids, or research it online.“[22]

Developments specific to Europe

[19] from http://coderdojo.com/#zoom=3&lat=48.9225&lon=-35.15625&layers=00B0T (2014-04-04)

[20] http://www.theguardian.com/technology/2014/feb/17/hasbro-3d-printing-children-kids (2014-04-04)

[21] A tutorial: http://www.instructables.com/id/LEGO-bot-3d-printer/ (2014-04-0

[22] http://makezine.com/magazine/how-to-remake-the-world-by-making-with-kids/ (2014-04-04)

Two main forms of maker-like learning spaces and the usage of such tools in learning settings in Europe are workshops in and outside of schools. These workshops are driven by the need to foster STEM knowledge and skills at an early age. For several years now, workshops focusing on robotics, electronics or similar areas use technologies to increase interest and skills in technologies, development, and engineering. Typically, such workshops are offered as "research centers for pupils". For example, such workshops for children were held in Bremen in 2008[23]: "Sports and technologies" (for children between 9 and 13 years), "mobile robots" (for children from 11 to 15 years) and "humanoid robots" (for children between 13 and 17 years). Workshops for children (and adults) within the FabLabs and makerspaces in different parts of Europe, mentioned earlier in this paper, also serve as excellent learning spaces that focus on showcasing certain techniques and encouraging the creation of creative and innovative products. For example the Austrian FabLab "happylab" in Vienna offers special programs, workshops and times for children[24].

5. The Maker Movement and education – considering its educational potential

As a conclusion of our introduction of Maker Movement and its educational adaptations, we want to summarize reasons for its educational potential. While we acknowledge that there are other forms of learning activities and educational strategies that also include relevance to the environment, creativity, and problem-solving, such as problem-based learning or project-based learning, there are several reasons why we consider the Maker Movement to be a trend relevant to educators. There are potentially diverse approaches to structure reasons for making in education. We choose the traditional didactic triangle of teacher, student and content, which is in our case a set of tools for our following description (see figure 4).

Maker students

We start our collection of reasons for making in education with a look at the student. Children today grow up with

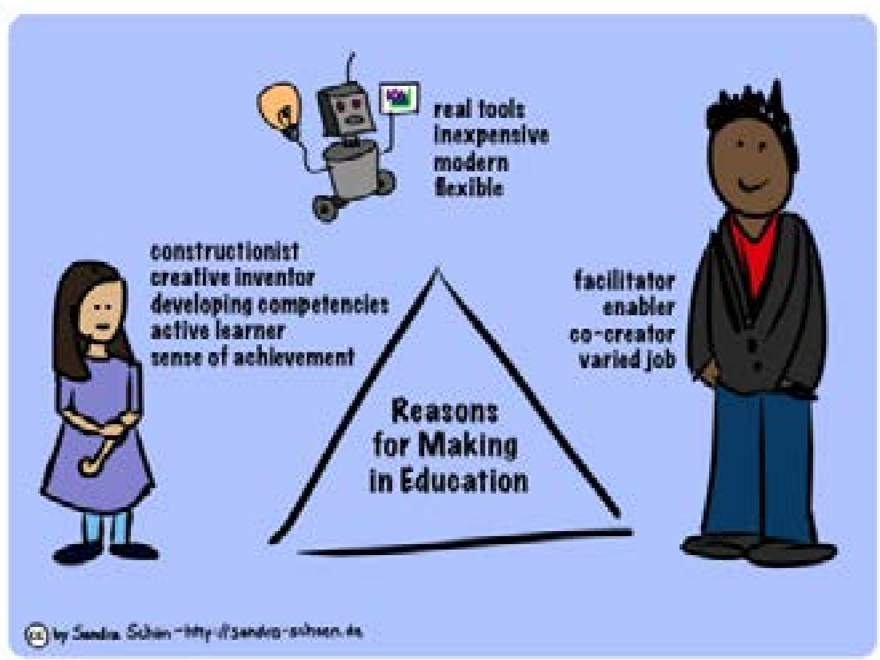

Figure 4: Reasons for Making in Education

[23] http://www.innovationscamp.de/workshops.php (2014-04-05)

[24] http://happylab.at (2014-04-05)

digital technologies (Ebner et al., 2013). Using modern digital tools is in general a way to meet their expectations and prior knowledge. Educators can exploit this familiarity with technology, students' tendency to play with technology, and the easily availability of technology to help students create or construct products that relate to their environment. Especially maker tools and maker movement will challenge and develop their ability to construct something, and potentially to construct something new, creative and innovative. Making in education may address specific learning content, for example electronic circuits. Nevertheless, it can address a wide range of teaching goals for students. Besides STEM and technology interest, knowledge and competencies, this includes creative, innovation development, and problem solving. Maker students are active learners, with a high need to explore, to discuss and to share experiences and ideas. Also social and personal competences are to be included in our potential learning goals. In general, the skills of creating and innovating can have a broad impact on students' lifelong learning and ultimately for education and society.

Besides this, making as constructionist activity of students is a theoretically and historically funded principle for successful learning, coined as "learning by making (doing)" (see above; Papert & Harel, 1991). With respect to learning, it helps young and old experiment with innovation, develop an open mind, be creative, compute, and problem-solve, while considering the impact of their creations on society, ecology, and the environment.

The construction within making leads to several products and concrete results: Students fabricate "real things" (such as a machine) or products (such as a stop motion animation). Compared with typical learning results for students in form of ranked test results and marks, this can be seen as valuable source for senses of achievement. This can be important, but is not restricted to, school underachievers. And sense of achievement might be the best, when making comes up to solve problems of the real world, and/or when teachers and parents are surprised by students' ideas, solutions and constructions. Last, but not least, the openness of the maker movement and its Internet affinity additionally have the potential of idea sharing and co-operation in excess of classroom boarders.

Maker teachers

Looking at the teacher in a maker setting, it is obvious that traditional teacher-centred teaching does not fit. Typically, teachers in maker settings change their role to facilitators and enablers. Making means that students themselves are active. This automatically shift teachers' role from leading to support and tutoring. In contrast to problem solving and project tasks, where teachers are experts or at least the most experienced in the classroom, maker settings may also dangle such clear competence gaps. On the one side, students may be better or more experienced in one of diverse tools, for example the sewing machine or the mobile phone. But even more important, the openness of the setting and the creative results within this approach may lead to a situations, where the students may be better as the teachers. Co-creation, and also learning by teaching, than will not only be a (wished) mind-set, but teaching reality. This can be challenging as well as motivating and surprising for teachers. For students, it is the chance to see teachers as inspirational partners as well as models for their own learning, while watching their (better) learning and problem solving abilities.

Maker tools and content

As a third strand we want to discuss the role of maker tools and "maker content" for education. As described, these are digital tools and facilities to fabricate and produce new products and also art work. Inherent, the do-it-yourself approach includes up-cycling and other environment friendly materials. What maker tools and materials make special from the perspective of learning and instruction is that they are real content, compared with typical learning materials as textbooks, virtual learning environments, blackboard and so on. Maker tools are not only "theoretical" content as concrete, real action is needed to deal with them. Making deals also with theories and concepts, but more important is practice and transfer. As we mentioned in our paragraph about educational roots and ancestors, the character of maker tools and content and the related work with it has be seen as important for learning at least for several centuries of educational theorists and practice, if not for all human times. Making own experiences, making something concrete, dealing with concrete (but also "digital") products can be seen as an elementary learning with the potential of deep learning adventures.

Although learning and education is seen as important in current times, financing issues plays a big role. Of course it might sound expensive to equip a maker space in a school for example with 3D printer, laser cutter or vinyl plotter, and several other tools and materials. Nevertheless, the making approach is neither a 1:1 setting for high-end tools, nor is it focusing only at very special disciplines and ages. Compared with other approaches for learning with technologies, especially the 1:1 desktop setting in computer classes or personal textbooks in every discipline, maker tools are inexpensive. Maker tools are of great flexibility, as they can be used for a diverse set of disciplines, learning settings, focus and learners' ages. While making might involve the use of physical materials, it is increasingly also possible to produce virtual artefacts while "making", as mentioned above (e.g. with Greenfoot). Digital software for making is also not very expensive, is increasingly available as open source, and can often be used on mobile devices that are becoming more usable and more popular lately. Similar to other maker tools, such maker apps on mobile devices enable children of any age to create and make and are not specialised for special ages, settings and disciplines.

Not necessarily, but an important driver to use and deal with maker tools is simple that they are modern and up-to-date. There are so many tools and application scenarios that it is simple to realise ideas that were not thinkable some years ago. This is attractive for students and makes it magic for educators: Maker tools bring the possibilities to use up-to-date technologies and innovative learning settings in classrooms. Compared with the effort to offer up-to-date learning software and hardware for computer and Internet based learning for a whole school, the usage of latest tools and developments know gets realistic.

From our perspective, these are several reasons why educators and policy makers should consider the Maker Movement and its potential in education. Of course, making in education has not only potentials, but also challenges. Inherently, several challenges might influences our sketched potentials negatively. Papert and Harel (1991) for example see a challenge in the prevalence of "instructionism" in mainstream education: The need of teachers to feel to be in control of learning environments and to lecture students, is opposed to students being able to experiment and create to learn. Besides such challenges, our list of reasons to consider making as a new form of learning and teaching for education hopefully inspires to take a deeper look into the field.

In-depth

6. Learning from Experience: Further Resources about the Maker Movement

We would like to end this article with further resources for readers who might want to read more about the present the state of the art of literature, research and further education with respect to the Maker Movement.

There are a lot of collections for maker educators that concentrate on new tools and gizmos as well as potential products or exemplary developments. Wilkinson and Petrich (2014)'s book "The Art of Tinkering" presents the products and projects of more than 150 makers "working at the intersection of art, science and technology" These include example recipes for conductive dough or how to fuse plastic for up-cycling. The book's cover itself is printed with a special ink that conducts electricity ("open up this book and discover how to hack it").

The amount of research on selected maker issues, for example tinkering with computers, robotics in schools or programming with pupils is enormous. Selected books that make an initial contribution to the role played by "making" in education are:

- An open access book, "The Maker Club Playbook" is offered by Young Makers (2012). It is for everybody who wants to open a makerspace and includes several examples for education settings and approaches. Also for practitioners and free available is the "Makerspace Playbook" by Makerspace / Maker Media (2013). The PDF includes helpful lists from tools to funding ideas. A good help to design maker programs as activities for children, including also for example maker faires for kids, is offered with open access by New York Hall of Science (2013).
- Martinez and Stager (2013) 's "Invent to Learn" about "making, tinkering and engineering in the classroom" is meant for educators and gives insights into learning concepts, examples and the practice of making in schools. They describe the development of makerspaces in schools and also a didactical framework for its usage in the classroom.
- Honey and Kanter (2013)'s "Design. Make. Play. Growing the next generation of STEM innovators". is meant for practitioners, policymakers, researchers and program developers and is a collection of several chapters on making, but only on games, which potentially influence and foster the STEM competences of children.
- Diverse digital tools for education are also topic of a chapter within the German speaking L3T textbook that is available as open educational resource (Zorn et al., 2013).

European educators had already started to adopt, to adapt and to share their experiences. From our point of view, especially community building and research above the diverse strands of maker activities – for example of FabLabs, hackerspaces, or coder dojos – should brought together. As our research, especially in German speaking countries pointed out, terms and ideas of several shops and communities may potential (and actual) maker activities for children. We would love to inspire you, besides reading and discussing, and to initiate you to be an active part of the maker movement for educational purposes. Just make it!

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From the field

Experiences with technologies in learning environments

- ➔ **Gamification and working life cooperation in an e-learning environment**
- ➔ **Investigating teachers' perception about the educational benefits of Web 2.0 personal learning environments**
- ➔ **Conceptual Quilting: A Medium for Reflection in Online Courses**
- ➔ **The e-Learning Café project of the University of Porto: innovative learning spaces, improving students' engagement in active and collaborative learning**
- ➔ **A New Direction for the Learner Experience. Engaging Students in Participatory Design of a 21st Century Classroom Chair-Desk**

From the field

Gamification and working life cooperation in an e-learning environment [▲]

SUMMARY

Despite the importance of cooperation between education and the working life, there are substantial difficulties on the road. Gamification refers to introducing game elements into another domain. While there is evidence on the usefulness gamification in education, its potential in bridging education and working life is still untapped. Our contribution is in investigating the possibility of facilitating knowledge sharing through a gamified platform. The case study describes the development and execution of a game-based platform for working-life cooperation, acting as a knowledge-sharing platform between schools, students, and participating entrepreneurs. In the case study, the hurdles identified in previous research were successfully overcome. Entrepreneurs evaluated the results of the game positively, expressed high motivation, and felt the produced knowledge was useful. Results suggest the potential of a gamified learning environment in increasing engagement, motivation and participation in a problem solving community of students and entrepreneurs. The nature of a game supports a shift towards learning in working life, the interviewees argue.

Tags
gamification, working life cooperation, knowledge community, cooperative education, entrepreneurship educationg

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Languages
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1. Introduction

There is a high demand for partnerships between education and the working life. In Europe, the Council of the European Union calls for enhancing partnerships between vocational and higher education, employers and other parties. One purpose of better cooperation is to ensure that the competencies students learn match those needed in the labor market. Employers have an important role in identifying these competences and contributing to them. This is particularly important in terms of the competitiveness of Europe in a difficult global economic climate. There is also the perspective of knowledge sharing and knowledge dissemination. Educational institutions possess vast bodies of knowledge, which should be put into use in fostering innovation and ensuring its transfer into practice (The Council of the European Union 2009).

Working life cooperation is particularly necessary in entrepreneurial education. Entrepreneurial education has a positive connection to the propensity of becoming an entrepreneur (Kolvereid and Moen 1997), but it is necessary to employ learning by doing. Entrepreneurship is difficult to teach only based on theory – a link to actual practice is necessary (Fiet 2000). One way of ensuring authentic education is through cooperation with real-life entrepreneurs. However, the hurdles of cooperation may compound in the entrepreneurial context, where time is scarce and scarce resources considered critical (Mariotti & Glackin 2014, p. 14).

In this article, we approach cooperation between education and the working life from a new angle: through gamification. Deeper cooperation between education and the working life is essential and strategically important from the point of view of student competences as well as innovation transfer. However, research suggests that even though the importance of cooperation is accepted, it is difficult to achieve. Some of the hurdles in cooperation relate to motivational dispositions, while others relate to the lack of common working cultures between the parties. Gamification is a new development that addresses the issues. There is evidence that gamification can impact motivation as well as changing the working cultures – whether in education or in business use. We describe an example of a community of multiple educational institutions, businesses, and students working together through a gamified environment.

2. Cooperation between education and the working life

Educational systems are facing challenges. Today, the production of knowledge requires deeper cooperation with the working life, which raises multiple questions of interaction between the school, the workplace, and society. As Tynjälä et al. (2003) discuss, new demands change the way knowledge is produced and disseminated in education.

The new way of thinking about education ties closely together the topics of learning, innovation, and solving working life problems (Tynjälä et al. 2003, Van den Bergh et al. 2006). This type of thinking is based on a socio-constructivist view of learning, where issues such as learner activity, authenticity and problem solving become important (Blumenfeld et al. 1991). The idea of learning through experience is not new, dating back to Dewey's conceptions of learning by doing and having been extensively developed by Kolb in his experiential learning theory (1984).

Integrating all of these aspects is no simple feat. As Gibbons et al. (1994) have noted, the entire production of knowledge is shifting from a research focus towards more practical application. The shift takes place through what Gibbons et al. term "Mode 2" interaction. Similarly, Engeström (2001) has discussed the application of expansive knowledge creation in bridging learning and workplace development.

Rogers and Horrocks (2010, p. 142) discuss this shift in terms of two dimensions: the processes of learning and the settings where learning takes place. The structured, formalized processes often associated with schools are a separate dimension, they argue. Of course, these are often related: we expect school learning (formal setting) to be structured (formal process), and workplace learning (informal setting) to be unstructured (informal process).

Historically, a gap has existed between the two worlds of formal and informal learning, theory and practice, and school and work. As Resnick (1987) has famously noted, traditional learning in schools has been formal, structured, intentionally planned, whereas learning at work has been and still is mostly informal at nature. The challenge is to break the barriers between these silos.

As Wenger (2011) argues, schools are in a transformation related to the management of knowledge. While education-working-life cooperation can take multiple forms (Ylikoski & Kortelainen 2012), there is a need for bringing together students, academics, teachers, and practitioners in new practice-oriented communities. These "knowledge communities", as defined by Earl (2001), "exchange and share knowledge interactively, often in nonroutine, personal, and unstructured ways, as an interdependent network". Such networks are often seen in businesses striving to create learning organizations, by connecting various bits of knowledge with the knowledge-enable actors (Earl 2001).

According to Wenger (2011), the new type of cooperation borders on issues such as organizing educational experiences that ground learning in practice; connecting students' experiences to actual practice; and serving the lifelong learning needs of students by organizing communities of practice.

These knowledge-creating communities serve multiple purposes. They support developing the organization through improving skills, assisting learning by sharing best practices, help develop professional skills, help in recruiting talent, and even driving company strategy and identifying new business opportunities (Wenger & Snyder 2000). Moreover, as Wenger (2004) has noted, communities of practice are "social structures that focus on knowledge and explicitly enable the management of knowledge to be placed in the hands of practitioners." The idea here is that the people who use knowledge in day-to-day activities, are in fact in the best position to manage this knowledge. The difference from the conventional expertise-related emphasis is dramatic.

Even though the need for closer cooperation between schools and the working life is becoming accepted, it still appears difficult to achieve (e.g. Lee & Hung 2012). Studies (Henricksen 2012, Katajavuori et al. 2006) point that much more needs to be done before true collaboration is achieved. Gupta and Govindarajan (2000) have outlined the major difficulties in sharing knowledge in knowledge communities. Some of the main hurdles in knowledge flows relate to motivational dispositions of the parties. Other issues have an impact as well, such as the value of the information, the existence and richness of information channels, and the absorptive capacity of the receiving party.

The gap between schools and the working life stems at least partially from different cultures. Aside from different cultural backgrounds, Gomes et al. (2005) have found a gap in the nature of knowledge. According to their results, business people find that the knowledge produced by an educational institute is of little practical value to the company. Hence, the benefits of knowledge sharing may not always be perceived as worth the cost (Gupta & Govindarajan 2000). The phenomenon may be emphasized in small business contexts and entrepreneurial businesses, where time becomes crucial (Mariotti & Glackin 2014, p. 14). This links back to Resnick's (1987) address on what is perceived important in a learning setting.

All of the problems as listed by Gupta and Govindarajan (2000) can have an effect in the knowledge sharing community of a school and its surrounding working life. Both parties can be affected by motivational issues. Proper information channels may be absent as well. There may not be appropriate processes of collaboratively creating the knowledge, hence making new cooperation platforms necessary.

3. Gamification and overcoming hurdles in cooperation

Gamification, the introduction of game-like elements and logic into other domains, is one of the hottest topics today. While there appear to be numerous accounts of gamification's positive effects on learning and business (e.g. Corcoran 2010, Daniels 2010, Lee and Hammer 2011), there is very little evidence on its effect on bridging these fields. Interestingly, the effects of gamification parallel the problems related to education-working life cooperation. We argue gamification could be used as a tool to overcome the hurdles in a knowledge community.

Gamification can boost student motivation, focus and activity in the matter, particularly when combined with a student-centric, active learning view (Thomas & Brown 2011, Shelton & Scoresby 2011). A game logic and game elements of a learning environment can increase engagement and sense of ownership. Muntean (2011) argues that these are essentially based on improved feedback. In a game, instant feedback is essential to create a sense of urgency and immediacy. Similarly, in a gamified environment, the user gains a feeling of being in control of the results (e.g. Pavlus 2010).

A relevant feature in a gamified environment is the sensation of total involvement, often termed "flow" (Csikszentmihalyi 1990). Sheldon (2012) argues that an immersive feeling of being in the flow is one of the most important benefits that gamification can offer. Feeling of being in the flow causes people to lose track of time, bordering the feeling of happiness (Csikszentmihalyi 1990).

The sensations of being in the flow, feeling engaged and immersed, assist learning by increasing participation and consequently, expended effort and focus. Typically a gamified context contains elements designed to improve felt immersion and flow (see e.g. Deterding et al. 2011). However, it is important to differentiate between different focuses of these elements. Extrinsic rewards (or motivators) refer to outcomes separate from the activity while intrinsic motivators relate to the inherent enjoyment of the activity (Bonus 2011, Shelton & Scoresby 2011). The traditional way of motivating students is related to extrinsic rewards, such as credits or grades, which is prone to causing difficulty as the learning and rewards become separate. In gamification, it is important to avoid choices increasing separation from the content.

It is important to keep in mind that gamification as such does not imply turning everything into a video game. For example, Bonus (2011) argues that a successful instructional game represents a simplified, simulated picture of reality. The authentic nature of a learning task and gamification are not opposing goals. According to Bonus (2011), gamified learning needs to offer constant feedback on activity with little concern for failure; needs to align game mechanics with instructional goals; needs to align the game narrative with instructional goals; and finally, needs to allow players to choose and customize their characters.

Based on the problems in education-working life cooperation and the potential benefits of gamification, we propose the following. As previous research has found, motivational issues can cause a major obstacle in creating a practice-oriented knowledge community (Gupta & Govindarajan 2000). We propose that the motivational effects of gamification can be expanded from students to working life participants as well.

One reason for the shortfalls in knowledge community creation is related to how the created knowledge is perceived (Gupta & Govindarajan 2000). There is ample evidence of students having created world-class innovations and started successful corporations (e.g. Google and Yahoo! originated as student projects), suggesting students can have tremendous potential. The difference may be related to how students approach knowledge creation. Is it only a compulsory chore, or is it about really putting your mind to it? We propose gamification can have a positive effect on the outcomes.

Lack of common culture and platforms are problems, which might benefit from gamification. The flow and immersion of a game lowers the threshold to participate, while potentially increasing the propensity for risk taking. In knowledge communities, we propose that a gamified approach may facilitate entrepreneur as well as student participation. It may be easier to formulate the goals of the cooperation in a game, taking a different angle than in "real life", with less to lose if the project fails.

4. Methodology

The case study brings together entrepreneurs, students, and teachers in a knowledge-producing game. Our analysis focuses on participating entrepreneurs' perspective on work-based and game-based learning as well as co-operation with schools. As discussed by Gomes et al. (2005), business people are particularly critical in finding practical value in educational cooperation. The participating entrepreneurs represent small businesses, where the entrepreneur is actively involved in daily business operations, strengthening the research argument. All participating entrepreneurs had had some cooperation with an educational institution, although none had participated in a game. Hence, the entrepreneurs may have had a lower threshold for participation. Importantly, they also had experience of traditional educational cooperation.

We interviewed all six participating entrepreneurs on their experiences. We also sought input to our assumptions of game-based learning in education–working life cooperation. The theme interviews focused mostly on experiences with the game, while also covering other possible experiences in educational cooperation. Additionally, we collected student input to support the key criteria. While the focus of the research is on the entrepreneurs' perspective, students brought valuable information about the cooperation. Students participated in a group discussion in class, which was videotaped and transcribed. Also, students' reflective thoughts in written reports were used. Interviews were conducted during the spring of 2013.

We adopted an emotionalist view on interviewees as experiencing subjects who actively construct their social worlds. We treated the data as means to an authentic insight into people's experiences, and tried to achieve this through semi-structured, in-depth and open-ended interviews (Silverman, 2001, p. 87). Following Holstein and Gubrium, 1997 (p. 116), our aim was to formulate questions and provide an atmosphere conducive to open and undistorted communication. This way, respondents were allowed to use their own ways of defining and describing the phenomenon of interest, and also to raise important, fresh issues not contained in a more structured interview schedule or data collection procedure (Denzin, 1970, p. 125; in Silverman 2001, 93).

Following the chosen approach, our concern was not with obtaining objective facts but with eliciting authentic accounts of subjective experience (Silverman, 2001, p. 90). The interviews were first videotaped, and then transcribed into written form. Following that, the textual data was analyzed through different categorization devices. We categorized the data firstly on the basis of the described forms of cooperation, and then focused on the descriptions of the drivers and modes of various actions. On the one hand, our aim was to find similarities between the narratives; on the other hand, we identified contradicting and absent experiences.

Additionally, we applied frame analysis to explore the relationships between interviewees' interpretations of the cooperation and the cultural context of the cooperation (see e.g. Alasuutari, 1995, p.111-115). In this case, the frame refers to sets of rules that constitute activities so that they are defined as activities of a certain type (Goffman 1974). When interviewees created a picture of "what is going on" within the cooperation, our aim was to locate a frame that makes the situation understandable.

In the project, a business perspective, an entrepreneurial perspective, a pedagogical perspective and social media perspective were present in a knowledge community. Because of the gamified nature, however, the community appeared as a game to the participants. As argued before, we introduced gamification into the community to lower the thresholds in cooperation.

The "LOL[1]" game was an online community of entrepreneurs, students and teachers. It featured an online game board, designed to support learning on three educational levels. The purpose was to enable students to work on authentic business problems in teams. Entrepreneurs, on the other hand, offered their skills and knowledge for the community's use.

[1] LOL is a dual meaning acronym, representing both the well-known Internet meme and the words "Slightly Odd Business" in Finnish. The name was chosen to represent something easily approachable and non-intimidating. While it would be accurate, we will nevertheless refrain from calling the game S.O.B.

The project was funded by the Uusimaa Regional Council (Finland), as part of the European Regional Development Fund Program. The coordinating party was InnoOmnia, the development unit of the Omnia Vocational School of Espoo, Finland. The Kasavuori Secondary School of Kauniainen (Finland) and Laurea University of Applied Sciences of Lohja (Finland) participated in designing the game and piloting the game in fall 2012. The game was played in three physically separate schools by piloting student groups.

The game took place on a virtual game board, running on a web server and accessed with a browser. The game board was designed for keeping track of all the sections within the game. The game board was programmed by a game designer agency, using the Google Education platform. A visual designer created the board's visuals, aiming for "fun and accessibility" in the layout.

Using Google Apps for Education, the teams were given virtual workspaces for developing and sharing ideas. The game also featured a Facebook page, which was used for communication and collaboration. Game board updates, new tasks, and task feedback appeared as notifications in Facebook. Finally, a YouTube channel was used for distributing related videos such as interviews and video reports. The main game application was connected to the applications in the workspaces as well as the game's Facebook page. Virtual trophies appeared both on the game board and on Facebook.

The game tasks focused on entrepreneurial day-to-day issues. The educational purpose was to support students' business studies by giving them the opportunity to solve real entrepreneurs' authentic problems. For the entrepreneurs, the community offered new insights and solutions into their business problems. In practice, all of the problems were related to marketing issues such as product design, marketing communications, and distribution. This was the result of the entrepreneurs' decisions and not a limitation of the game itself.

In the game, students formed teams and tackled the tasks as presented by the entrepreneurs in YouTube interviews. They sought to find creative solutions to the problems, while keeping in mind typical business constraints.

Two rounds were played in the game, with different entrepreneurs participating in each round. The rounds consisted of several sections to break up the workflow into meaningful segments. As an individual game round consisted of multiple tasks requiring planning, research and presentations, taking several weeks, only two rounds of the game were played within the semester. First, students formed teams and devised a strategy. The next phase consisted of a pitching contest, where teams made presentations on the tasks that they preferred. An educator served as game leader, giving feedback and assigning the tasks to teams based on these pitches. The game's Facebook group was the main platform for discussion, feedback and commentary during the game rounds.

Next, students got to plan their final solution. They made a rough outline of the creative idea and implementation, on which the game leader gave feedback. Finally, students designed the final solution for the task and videoed it for YouTube.

Having reviewed the final propositions, entrepreneurs gave feedback, while teachers gave education-related feedback on the video reports. A jury of participating entrepreneurs chose the winners based on best match with business objectives. Virtual trophies and awards were distributed to the winner teams.

5. Findings

In the interviews, a recurring theme relates to the flow of information and knowledge sharing. Importantly, the knowledge flows exceeded the borders of the schools and businesses. We could observe knowledge sharing between student teams and entrepreneurs, as well as between different entrepreneurs. In this sense, the knowledge community created in the game represents Earl's (2001) description.

Moreover, the interviews suggest that the community met Wenger's and Snyder's (2000) call for multiple purposes. We could observe knowledge flows from the students to the entrepreneurs, helping in identifying new business opportunities. Students reported gaining new insight into their studies, reflecting Wenger's & Snyder's skill improvement. Finally, with entrepreneur collaboration, sharing of best practices could also be observed.

Transferring knowledge and ideas in multiple directions was perceived as the most substantial result. The ideas that students created brought "new approaches" and "useful input"; in the interviewees' own words. Many entrepreneurs commented that the ideas surpassed their expectations. Some of the students managed to go outside the box in their thinking, which was commended in the interviews. This was particularly apparent in the cooperation across educational levels.

The entrepreneurs brought their skills and experience into the table, offering this knowledge to the students. At its best, this resulted in cooperation, shared learning and transfer of knowledge to the end of creating new business opportunities (see Wenger & Snyder 2000). New business opportunity development is apparent in the following quote:

> *"For me, the biggest thing is that we got to think about issues together. The kids brought up new ideas – like suggesting new youth target groups for my products – and I have expanded my marketing scope based on those ideas."* (Interviewee)

The entrepreneurs felt the students' ideas as particularly useful when the students brought in a youth perspective, whether in terms of marketing, service use or technological literacy, as this quote demonstrates:

> *"Students have a lot to give for marketing and sales based on their own experiences in life, such as 'how I do this thing'. You can go to a corporate seminar to hear media gurus talk about technology and social media, but they do not really live in that world. These young people do."* (Interviewee)

Entrepreneurs participated in jury sessions, where the winners for each round were decided. In terms of knowledge transfer, these sessions offered a lot particularly in terms of sharing best practices. As this quote suggests, the game succeeded in creating a network of knowledge where every participant had the opportunity to learn and share knowledge for others:

> *"I was totally blown away by the closing session, where other entrepreneurs were present. I got a lot of ideas, like what you could do with this or that, and even commented another entrepreneur's business problem. The diversity was a very good thing."* (Interviewee)

Based on previous research, we expected difficulties in cooperation and knowledge sharing to focus on motivational dispositions, perceived value of information, and suitable platforms. Overall, we managed to overcome these hurdles. In general, entrepreneurs perceived the game highly positively. Cooperation across multiple educational levels, a fun approach to serious content, a creative implementation and fostering creation of new ideas were all perceived as worthwhile and valuable goals.

In the interviews, there are multiple mentions of the value of the information produced in the game, supporting our proposition of the usefulness of gamification. Entrepreneurs were surprised how well the game succeeded. Many felt they received something concrete from the ideas that students produced – perhaps for the first time ever. Another sign of success is that several entrepreneurs would have liked to see the ideas taken into practice: they felt the students' ideas had so much potential that they could have been developed further to a more detailed level. Within the schedule, this was not possible, however.

A recurring theme in the interviews concerns the level of involvement and motivation resulting from the game. Motivation was one of the potential problems identified in the literature review. Based on the results, all entrepreneurs experienced increased motivation to participate, and most students reported the same.

Genuine problems taken from an entrepreneur's life make for a more authentic learning experience. For the students, this had several benefits. The students reported a higher level of motivation because of the authenticity. Similarly, entrepreneurs felt the novel approach increased their interest in cooperation. It was easier to participate

Photo: Teemu Ylikoski

in cooperation with a limited scope and a fun aspect. Educators and entrepreneurs observed a sense of ownership taking place within the students. It was as if the students started feeling the tasks and ideas more as their own. This would imply a shift towards intrinsic motivation. This is an important observation from a learning standpoint.

Because of the nature of the game, the tasks could be constructed so as to resemble reality. This is at the core of the motivational aspect of the game. In the interviews, entrepreneurs praised the knowledge creation tasks on multiple occasions. Students were presented with genuine real world problems with no single solution. The entrepreneurs felt these open-ended tasks were a unique opportunity to learn the challenges of business life as well as cooperation skills. Students had an opportunity to learn in practice what it is like to solve business problems. There was no single predetermined correct outcome – just like in real life. This forced students to look for solutions creatively, not relying only on textbooks in their search for knowledge. This approach emphasized the practical nature of the required ideas, as the following quote demonstrates:

> *"I feel it is important to be able to give the students the tools and a place to work, but not limit them with ready-made solutions. We should let them think it out and come up with a solution. During the game, I think it was important to note that for every group who had made their own decisions, each and every one of them stood behind those decisions in the end."* (Interviewee)

The game appeared to facilitate cooperation and thus overcome the hurdles of missing common platforms (discussed by Gupta and Govindarajan 2000). Entrepreneurs were highly in favor of development of games such as this. Students taking on the role of the entrepreneur, solving daily problems and cooperating through gamification were perceived as important future directions. Knowledge creation becomes more concrete through these directions. The game succeeded in transferring real knowledge and ideas, through which cooperation gained a genuine, concrete meaning, as discussed in this quote:

> *"This is a good way of linking the school with businesses. Rather than the usual 'pretending to cooperate' way, here we have really done something concrete with real outcomes."* (Interviewee)

Entrepreneurs were unanimous on the need for more informal, "real life" learning opportunities. In order to learn skills required in today's workplace, students need an authentic, genuine learning environment. On-the-job learning came up in multiple instances as an example of a non-institutional learning setting. Entrepreneurs also felt that interviews, discussions and meetings were necessary in order to create better learning and interaction, as opposed to classroom learning. These observations suggest that potential differences in cultures and perceptions of knowledge between the participants could be overcome.

Finally, one purpose of the game was to advance entrepreneurial education. Students had the opportunity to assume the role of the entrepreneur and try a small-scale version of the entrepreneur's daily life. Students described this as having been useful, e.g. in a potential future situation, where one would have the opportunity to create an innovation, as this quote suggests:

> *"…we worked on this innovative product, and talked to the entrepreneur. I'm thinking entrepreneurship is not so far away anymore. If I had a good idea, I might think about commercializing it and becoming an entrepreneur."* (Student)

Entrepreneurs felt similarly about entrepreneurial attitudes and education being transmitted. This final quote summarizes the benefits of the game:

> *"In best cases, students get to see all aspects of an entrepreneur's life. The students get to play in the entrepreneur's role, coming out of the everyday school settings. For some, it can be exciting to work with a live entrepreneur, doing real things, seeing what the entrepreneur does for a living and what it takes to survive."* (Interviewee)

6. Summary and conclusions

Education today requires a cooperative relationship with the working life. This cooperation can evolve into an authentic partnership, where knowledge is created and transferred interactively, in mutual collaboration. There is an increasing need for practice-oriented communities to support learning. However, it seems that the parties are often worlds apart. Differences in cultures, perceived benefits of the cooperation, and lack of appropriate platforms render true collaboration between education and the working life difficult. Deep collaboration requires letting go of the preconceptions of who is the learner and who is the information provider. In the new type of cooperation, all participants must be able to contribute equally.

We have experimented with an online gamified platform with the purpose of bringing the parties together, towards closer cooperation and knowledge sharing. The platform can be seen as a way of creating a more informal, realistic and authentic learning setting, where real-life problems can be tackled. In addition to bridging the education-working life gap, we experimented with bringing together schools in three educational levels.

The LOL game is an example of a practice-oriented community that is built on knowledge sharing. Gamification was used as a tool for improving collaboration, motivation, and perceived authenticity. Numerous statements from entrepreneurs as well as students emphasize the sensation of authenticity arising from the game. The ability to work on a "real" problem and produce "real" results recurs in the findings.

Previous research suggests that gamified environments can support active participation. In the LOL game, the learners became active participants on the hunt for new information. This was achieved by designing the game so that success relies on active studying, information search, problem solving, and risk taking. The fun, concrete approach resonated with the entrepreneurs as well.

An intensive learning game requires substantial effort from the learner, supporting active seeking, trial and participation (Thomas & Brown 2011, Cohen 2011). On the other hand, gamification also makes collaboration and peer support possible and even more rewarding. Several observations suggest that gamification facilitated in communicating the target problem. This seems to have impacted on pedagogical aspects as well as collaboration with the working life. We found multiple examples of the entrepreneurs being highly motivated in the project. Could gamification support in making educational outcomes more concrete and valuable in the eyes of the practitioner? It would appear so. The entrepreneurs seemed delighted with the results obtained.

Overall, the results are highly promising. At its best, cooperation approached a true knowledge creating community, where all parties were involved in creating and transferring knowledge. The game acted as a bridge between the world of education and the working life. It seemed to motivate the participants in both ends, by creating a fun way of thinking about the curriculum and the day-to-day business problems. It also helped in creating a platform through which new ideas could be transferred in one direction and entrepreneurial skills in another direction. Finally, the ideas developed through the game were perceived as highly practical, addressing the third obstacle in cooperation.

Based on the results, a gamified approach shows potential in the light of entrepreneurial education. The game lowered the threshold of participation for students and entrepreneurs. Making entrepreneurship something that is fun and involving does not necessarily take away the seriousness of the message. On the contrary, student quotes suggest entrepreneurship may be closer than before the game. Nevertheless, more research is needed to measure gamification's effects on students' entrepreneurial attitudes.

A practice-oriented approach is in many ways the future of education. However, research suggests that often the cooperation remains rather superficial and lacking in depth. The entrepreneurs in this case study felt very strongly about the concrete results produced in the game. Also, by participating in the game, entrepreneurs were forced to take a new angle to their business problems. Many expressed that the new way of thinking opened up new horizons altogether.

In the future, we would welcome research into the effects of gamification in knowledge sharing. This project has touched some of the issues, but several topics are still uncovered. The small scale of the study imposes limitations; while the observations support our conclusions, more research in larger quantities is needed. Also, the role of the educators should be investigated. This project was in the fortunate situation of having a number of involved and motivated educators, but sometimes more effort may be needed to convince all participants.

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Investigating teachers' perception about the educational benefits of Web 2.0 personal learning environments [▲]

SUMMARY

Implementing personal learning environments (PLEs) in educational settings is a challenging and complex process. Teachers as the main agents of change in their classroom settings need support in designing and implementing these new learning environments and integrating them into the educational process. In this paper, we propose a model to implement Web 2.0 PLEs in educational settings based on the conceived objectives of PLEs, namely (i) enhancing the students' control in educational process and (ii) supporting and empowering students to build and deploy their PLEs. In addition, we develop a technological prototype based on the model, and report and analyze the perceptions of a group of teachers regarding the potential of the prototype to improve the educational process. The results suggest that the implementation of the model can contribute to the development of a student-centric learning environment and improvement in the teachers' technological, pedagogical, and content knowledge (TPACK).

Tags
PLE, Web 2.0, design-based research, student's control, eLearning 2.0, TPACK

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1. Introduction

In recent years, the concept of personal learning environments (PLEs) has attracted the attention of researchers and practitioners in the educational technology domain. Attwell (2007b) says:

> *Important concepts in PLEs include the integration of both formal and informal learning episodes into a single experience, the use of social networks that can cross institutional boundaries and the use of networking protocols (Peer-to-Peer, web services, syndication) to connect a range of resources and systems within a personally-managed space.*

The main feature of PLEs that distinguishes them from other sorts of technology-based learning initiatives lies in their emphasis on the role of students as the manager and developer of their learning environments. In this regard, Attwell (2007a) defines Web 2.0 PLEs as activity spaces, consisting of loosely coupled Web 2.0 tools and learning resources collected by students to interact and communicate with each other and experts in order to address their heterogeneous learning requirements, the ultimate result of which is the development of collective learning. Along similar lines, Drexler (2010) and Väljataga & Laanpere (2010) define the development of PLEs as a student-driven learning process and an important learning outcome constructed by students.

Implementing the PLE concept in educational settings is a complex process that consists of several challenges. Firstly, it requires redefining the commonly accepted roles of teachers and students in the educational settings. The traditional procedures of teaching assume students as not sufficiently knowledgeable individuals to take full control over their learning. This assumption strengthens the role of teacher as the main controller of the educational practices with the main goal of transferring predefined content to the students (Dron, 2006) resulting in too much teacher control in the educational process and leading to poorly tailored learning experiences, student boredom and demotivation (Garrison & Baynton, 1987). Residing too much control with the teacher can diminish mutual communication as well as opportunities for students to construct meaning and knowledge. It is in stark contrast to the conceived objective of PLEs, which is to transfer control of learning from teacher to students (Attwell, 2007a; Buchem, 2012). Secondly, generally speaking, teachers, as the main agents of change in their classrooms, are resistant to adopt technological and pedagogical innovations (Ertmer & Ottenbreit-Leftwich, 2010). Hope (1997) wrote, teachers basically have to contend with two factors with technology adoption: (i) the psychological effect of change and (ii) learning to use technology. Nonetheless, the PLE concept has introduced the third challenging factor to teachers: rethinking their pedagogical approach to facilitate more student control in the educational process using Web 2.0 tools and technologies. Thirdly, beyond some technologically oriented approaches, there are not clear references and well-established pedagogical models of PLE-based teaching and learning, and practical advice to support it available. In this regard, as asserted by Fiedler & Valjataga (2011), while there is an intense focus on issues of re-instrumentation of teaching and learning practices in the PLE literature, enhancing students' control as the main objective of PLE remains largely untouched and ignored. Therefore, teachers do not have a clear perception of the PLE concept, and its technological and pedagogical implications and benefits, which makes them hesitant to accept and adopt the concept.

Research has shown that new technology or pedagogy adoption decisions are mainly influenced by teachers' individual attitudes towards the technology or pedagogy, which in turn are formed from specific underlying personal beliefs about the consequences of the adoption (Sugar et al., 2004; Ma & Harmon, 2009). Therefore, they must be personally convinced of the feasibility and benefits of the new technology or pedagogy before adoption and integration occur (Lam, 2000). Research has suggested that one of the best ways to convince and motivate teachers to adopt a new technology or pedagogy is by providing opportunities for them to witness and perceive the benefits of these changes. In this regard, Ertmer & Ottenbreit-Leftwich (2010) asserted that observing examples and models of a technology integration or a pedagogical approach by teachers can increase their knowledge, change their belief system, and convince them to adopt the new technology or pedagogy by helping them to understand what the approach or tool looks like in practice and to make a judgment about whether that approach or tool (i) is relevant to their goals, (ii) enables them to meet student needs, and (iii) addresses important learning outcomes.

In this paper, we seek to develop a model to support building and deploying PLEs and to investigate teachers' perceptions regarding the impact of PLEs on improving educational practices. In this regard, first we develop a pedagogically oriented model for PLE-based teaching and learning. Then we build a technological prototype based on this model to be used as an example for introducing and presenting the PLE concept. Afterwards, in order to examine how the prototype can contribute to improving the educational practices, we report the results of the conducted interviews with a group of teachers in the context of a secondary school. Finally, we propose design principles and guidelines to improve the next version of the prototype.

2. Research Methodology

In order to develop a model to support building and deploying PLEs, an approach using design-based research for one iteration was used, comprising four broad phases, as illustrated in Figure 1 (Ma & Harmon, 2009). Design-based research focuses simultaneously on practice and theory through finding and solving practical problems and providing design principles. To do so, it starts with (i) identifying and analyzing a complex real world educational problem in the research context and (ii) generating a solution based on reviewing existing theories and consulting with practitioners, (iii) evaluating the solution by gathering empirical data, and (iv) reflecting on the design experience to refine the solution and construct theoretical knowledge (Reeves et al., 2005).

3. Analysis of a practical problem

The context of this research is a secondary school. Seeking ways to take advantage of the PLE concept, Web 2.0 tools and social software to enrich teaching and learning processes, and to improve pedagogical and technological competencies of teachers and students are the main drivers for this school. Following design-based research, we started our research by identifying a problem within this context.

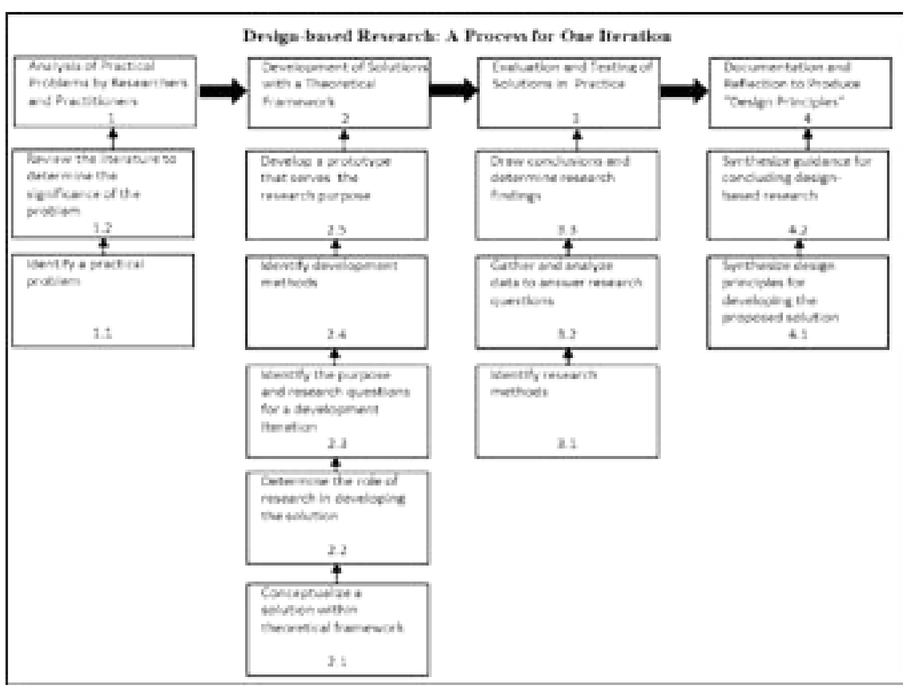


Figure1. Design-based research: A process for one iteration (Ma & Harmon, 2009)

3.1 Identify a problem

Although the school's teachers have been trying to adopt a PLE-based pedagogical approach, there was not a model available to support teachers and students to develop and deploy their PLEs. As a result, the teachers did not have a clear conception and understanding of the PLE concept and its benefits and implications for their educational practices, which affected their willingness to adopt and apply this concept in their classrooms.

3.2 Determine the significance of the problem

In the e-learning domain, PLEs are increasingly attracting the attention of educational researchers and practitioners as an effective pedagogical approach to addressing issues of personalization and student's control. A problem with supporting the conceived objectives of PLEs has been that, while there are a large and increasing number of suitable Web 2.0 tools and learning resources, a comprehensive pedagogical and technological framework as well as practical advice on how to construct Web 2.0 PLEs is unavailable. Affected by this gap, educators at different educational levels are forced to adapt and rethink their teaching approaches in conjunction with the advent of new Web 2.0 PLEs without having a clear perception of PLEs and a roadmap for attending to students' various needs (Kop, 2008; Fiedler & Valjataga, 2011).

4. Development of a solution with a theoretical framework

To address the identified problem we decided to develop a pedagogical model and technological prototype based on this model. There are two main conceived objectives of PLEs that can be used to outline a model for developing and deploying PLEs in educational settings, being (i) enhancing the students' control in the educational process, and (ii) supporting and empowering students to design and develop their PLEs (Attwell, 2007a; Johnson & Liber, 2008; Drexler, 2010; Valtonen et al. 2012). To support these objectives, several learning theories and principles should be involved in order to define the main components of the model and their interactions.

Student control in the educational process is concerned with the degree to which the student can influence and direct their learning experiences and it relates to several aspects of the educational process (Garrison & Baynton, 1987). Firstly, the theory of transactional control (Dron, 2007) suggests that control is concerned with choices. Based on this theory, an indicator for a "mature learner" is her ability for making relevant and effective choices in her learning journey. Hence, providing students with proper technological, pedagogical, and social choices to define their learning aims and methods is a prerequisite step for them to achieve control over their learning by moving from a "state of dependence to one of independence", and has the potential to enhance the student's feeling of ownership and control. According to Buchem et al. (2011), there are different sorts of choices for students in PLEs including technological choices (i.e. learning tools), pedagogical choices (i.e. learning objectives, learning content, learning rules and, learning tasks), and social choices (i.e. learning community).

Secondly, developing and applying PLEs requires flexible pedagogical approaches and technological activity spaces to allow students to construct and manipulate their learning environments by defining their learning goals, choosing tools, joining or starting communities, and assembling resources (Attwell, 2007a). Providing flexibility in pedagogical approaches or technological aspects has the potential to improve students' control over their learning process. As asserted by Buchem (2012) there is a strong relationship between students' control and their feeling of ownership over learning with (perceived) possibilities to manipulate their learning environments.

Thirdly, according to Johnson & Liber (2008), any attempt for developing PLEs should focus on the personal development of students as an inherent aspect of PLEs. Reflection has been asserted as the core source of personal development (Schon, 1983) by enhancing the effectiveness of learning and promoting metacognition, learning to learn and self-regulation (Verpoorten et al., 2012). Accordingly, any model that aims to support the development of PLEs should provide opportunities and triggers for students to reflect on their learning practices. Contextual information on the learning process has been proven to support the students' reflection by stimulating the students' engagement in a collaborative process, raising their awareness about the learning environment and triggering their reflection about acquired competences (Glahn et al., 2007). In a PLE-based learning scenario, an important part of contextual information encompasses past or current activities or events occurred in the learning environment through deploying web tools by the students. Collecting and presenting these information can provide possibilities for students to observe each other's learning behavior, reflect on their learning process and progress by comparing aspects of their learning experience with other students, and collaborate with peers by sharing and receiving material and providing feedback (Verpoorten et al., 2012; Valtonen et al., 2012).

Fourthly, according to Johnson & Sherlock (2012), there is a bidirectional and feedback relationship between the learning environment and the student's personal agency in such a way that the things that students do are transformative of the environment within which they operate, and vice versa. According to Rahimi et al. (2013a), in PLE-based learning both teachers and students should be assumed as learners. Indeed, the teachers in order to improve their teaching practices have an unceasing need to learn how to teach with technology, while the students need to learn how to learn by managing technology. From this perspective, the teacher and students are partners in the educational process (Clayson & Haley, 2005) and as noted by Ho (2003, p. 51), " teaching is not the art of filling the student with knowledge in the way one would fill and empty receptacle. Teaching is a two-way learning process in which the student and teacher help each other to learn by sharing their insights and difficulties with each other." From the PLE perspective, it can be argued that any attempt for enhancing student's control should recognize and corroborate the role of students in this feedback mechanism.

Figure 2 depicts the proposed implementation of the model, built upon the mentioned learning theories and principles. The model consists of two main parts, namely parts A and B, to address the two above-mentioned objectives of PLEs, respectively. Part A aims to enhance students' control in the educational process. Derived from the mentioned learning principles, this part has four main components, being (i) choices, (ii) personal activity spaces, (iii) aggregated information, and (iv)feedback system. The teacher seeds the learning environment by providing appropriate technological, pedagogical, and social choices. The students can access and use these choices in their personal activity spaces to perform learning activities and support their learning requirements. Appropriate information pertaining to these learning activities then can be aggregated to be used to support reflection and collaboration among

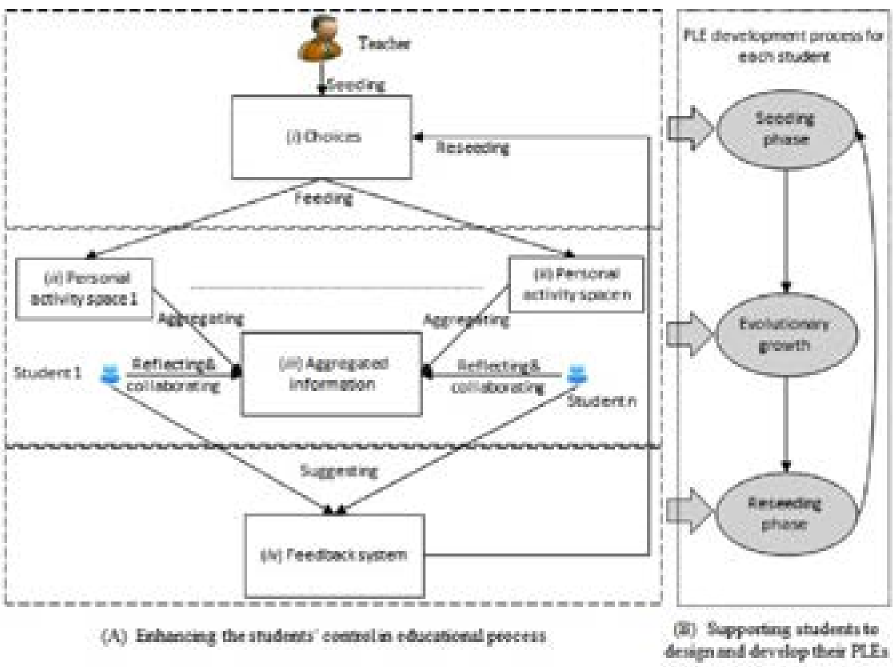


Figure 2. The proposed model consists of two parts to support the main objectives of PLEs

the students. The feedback system aims to encourage the students to discover and introduce the learning affordances of the provided choices and other sorts of learning resources based on the ways that they perceive and operationalise them in their learning process. The teacher can use this insight for reseeding and reshaping the learning environment.

Part B illustrates how the model supports students to design and develop their PLEs. The model follows an iterative end-user development (EUD) approach (Fischer & Scharff, 1998) for designing and building PLEs. The EUD concept was originally developed in the field of computer science and human-computer interaction aiming at allowing and empowering end users of software applications as “owners of problems” to act as designers to engage actively in the continuous development of their environments. Fischer & Scharff (1998) introduced the *seeding, evolutionary growth*, and *reseeding* (SER) process model to operationalize this concept by encouraging designers to conceptualize their activity as meta-design, thereby supporting end users as the developers of their environment rather than restricting them the role of to passive consumers. From this perspective, a PLE can be envisioned as a learning environment seeded by the teacher, *as designer*, with an initial set of relevant technological, pedagogical, and social choices (*seeding phase*). Then it is flourished and evolved by adding new learning resources through active participation of the teacher and students as a community of learners (*evolutionary growth*). The PLE will be reseeded through the feedback mechanism in order to add new choices or remove the current choices (*reseeding phase*).

4.1 Determine the role of research in developing the solution

The role of this research is to develop a first-iteration design of a model for constructing PLEs.

4.2 Identify the purpose and research questions for a development iteration

The purpose of this research is to implement a technological prototype based on the model and then to examine the perceptions of teachers about the potential of the prototype to improve the educational process. The following research question guides the research:

> *How do teachers perceive the PLE prototype as a means to improve the educational process?*

4.3 Identify development methods

Several issues pertaining to the implementation of the prototype need to be addressed, including (i) choosing an appropriate technological platform, (ii) identifying the tools to develop the prototype, (iii) providing technological choices to seed the prototype, (iv) determining the specifications of the PLE interface and, (v) supporting the reseeding phase.

Recent advances in computing, multimedia, communication, and web technologies have provided unprecedented opportunities for the educational institutions and learners to pursue and enrich their teaching and learning activities. Taking advantage of these advances, cloud computing is becoming a main paradigm in addressing the requirements of the web-based teaching and learning initiatives. Cloud computing supports SaaS architecture (i.e. the capabilities of software applications are exposed as services) and provides reliable, assured, and flexible service delivery while keeping the users isolated from the underlying infrastructure. As a result, "cloud computing makes it possible for almost anyone to deploy tools that can scale on demand to serve as many users as desired" without bickering about technical expertise and maintenance issues (Al-Zoube, 2009).

Google apps for education[1] is an appropriate cloud-based platform providing numerous technological possibilities for developing the prototype. It allows students to access thousands of available gadgets or build their own to fulfill their heterogeneous learning needs and provides several possibilities to support online collaboration and social learning. For instance, Google Docs and Spreadsheets allow the creation of documents and spreadsheets with more collaborative capacity and enable students to communicate around content. Also, Google Calendar lets students and teachers to set their personal or class-wide learning goals, plan the educational events, and monitor their learning process. Moreover, Google sites allows student to create their own private or public websites to publish and present their thoughts and findings.

The interface of the PLE prototype for each student can be divided into two parts: a personal part and a social hub. The personal part provides the student's access to a gadget container comprising of thousands gadgets. The student has full control over her personal part and can use it as an activity space to support her learning purposes by accessing, using, adding, customizing, sharing or removing gadgets. The social hub is a shared place between all PLEs where the information pertaining to students' activities and experiences in different tools is aggregated using aggregation software and presented to be used as a source of reflection and collaboration. It also contains a set of common tools seeded by the teachers to support the main educational processes of the school, namely orientation, execution and evaluation processes.

Google sites supports developing a specific type of start page consisting of two parts including public and private parts, accessible via a unique URL. The public part is manageable by the admin of the page and is visible for all of the allowed users, while the private part is visible and manageable only by the users. These functionalities define the start page as an appropriate option to build the PLE interface by using the public part of the start page to develop the social hub of the PLE interface and

[1] http://www.google.com/enterprise/apps/education/

the private part for the personal part of the PLE interface.

To support the reseeding phase, the functionalities of Google spreadsheets and Google sites, along with HTML, can be used to implement a feedback mechanism. This mechanism allows the students to introduce and share their preferred web tools and learning resources based on a defined structure, explain the learning benefits and affordances of tools, and rate them based on some defined criteria such as perceived ease of use or learning usefulness.

4.4 Develop a prototype that serves the research purpose

After having identified and chosen the development methods, the next step was to implement the prototype. Figure 3 shows the PLE interface for each student consisting of a social hub and a personal part.

The social hub provides the following functionalities:

- Seeding the PLE with appropriate choices in terms of web tools, useful links and relevant people
- Providing links to the students and teachers' websites and blogs
- Presenting teacher's announcements
- Aggregating the information pertains to learning activities and experiences of students accomplished in different tools by using a feed aggregation software (i.e. FriendFeed[2])
- Managing class-wide activities by using a calendar widget

The personal part provides students a flexible activity space to manage their learning activities and develop their PLEs by exploring and exploiting the learning affordances of the provided choices and a rich set of the available gadgets.

For each web tool seeding the PLE, an introduction page illustrates the tool and its educational usages, as shown in Figure 4. Also, the students are asked to evaluate the tool and explain its learning affordances based on their personal experiences with the tool. This information then can be used by teachers to reseed and retool the learning environment and design appropriate learning tasks.

As a part of the reseeding phase, as shown in Figure 5, the students are encouraged to introduce new learning resources they have found useful to be used to reseed the PLE.

[2] http://www.friendfeed.com

Figure 3. The interface of PLE for each student

Figure 4. A page for introducing each web tool and receiving students feedback about the tool

Figure 5. A page for introducing new learning resources by students and teachers

5. Evaluation and testing of the solution in practice

5.1 Identify research methods

Due to the exploratory nature of this research, we chose qualitative research methods to support data gathering and analysis processes (Yin, 2008). Yin identified six possible sources of evidence including: documentation, physical artifacts, interviews, direct observations, participant-observation, and archival records. For the purpose of this study, we selected the interview as the main method to collect data. We adopted a purposeful sampling technique (Patton, 2002) to select teachers with a variety of background and disciplines, and with a different amount of experience related to using web tools to support their teaching process.

5.2 Gather and analyze data to answer research question

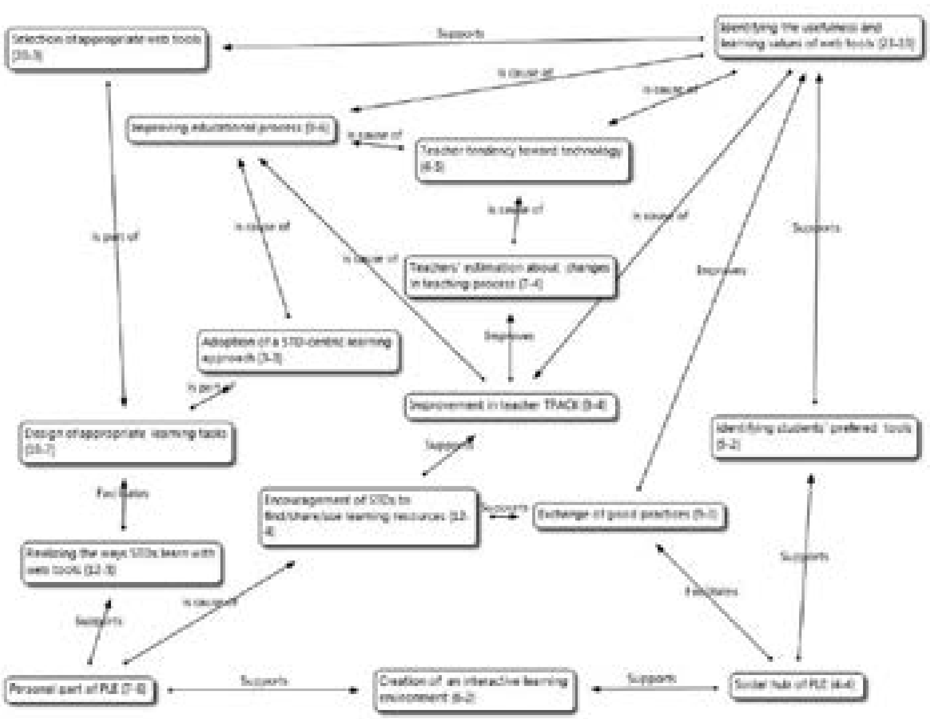
After having identified the research methods, we started to collect and analyze data. For data collection, six interviews with ten teachers were conducted. We used the following procedure to conduct each interview: A few days before each interview an account to access to the prototype was created and sent to the interviewees along with a brief description of the PLEs concept. Due to the unfamiliarity of the most of the interviewees with this concept, we asked the interviewees to explore the prototype before the interview meetings to gain an initial perception of the PLEs concept and prototype. Each interview lasted between one to two hours. During each meeting we first started by introducing and explaining the PLEs concept and then receiving their reactions and feedback about the concept and prototype based on their previous experiences of using web tools in their classrooms. As stated by Ma & Harmon (2009), linking the topic of discussion to the past experience of interviewees can mentally prepare them to use their experiences to evaluate conceptual models and prototypes. In the second part of interview, we described the different functionalities of the prototype. We presented different scenarios to explain how these functionalities can support their teaching practices as well the learning process of students. After this part, we asked the interviewees about their final thoughts, perceptions, expectations and reactions to the prototype.

The collected data then were analyzed by using Atlas.ti software. The analysis procedure included transcribing audio data, entering data into Atlas.ti, coding data, reading the transcripts organized by codes, writing memos, recoding and merging similar codes as necessary, grouping codes into categories, creating network diagrams by establishing relationships or links between codes, and writing up conclusions.

5.3 Draw conclusions and determine research findings

Figure 6 presents the results of the analysis phase describing the teachers' perceptions about the ways that the prototype can contribute to improving the educational process. In this figure, the first number between parentheses indicates groundedness (that is, the number of times mentioned in the interviews), the second number indicates density (that is, the number of codes to which it has a relationship).

Participants remarked that the *personal part of PLE* (7 mentions, see Fig.6) can help teachers to *realize the ways that students learn with web tools* (12 mentions, see Fig.6) and in turn it can support the *design of appropriate technology-based learning tasks* (18 mentions, see Fig.6) resulting in the *adoption of a student-centric learning approach. Furthermore, the personal part of PLE can increase the encouragement of students to find/share learning resources* (12 mentions, see Fig.6), resulting in the improvement of teacher's TPACK, i.e. the knowledge that the teacher needs to know in order to be able to teach with technology (Mishra & Koehler, 2006). As remarked by participants, one of the main issues to adopt the PLE's concept by teachers is their estimation about the required changes in their teaching process (7 mentions, see Fig.6) which can be improved by the improvement of teacher's TPACK, which in turn can increase the tendency of teacher toward technology (4 mentions, see Fig.6).



As remarked by participants, *the social hub of PLE* (4 mentions, see Fig.6) is useful to *identify students' and teachers' preferred web tools and learning resources* (4 mentions, see Fig.6) and can facilitate the *exchange of good practices* (4 mentions, see Fig.6) with regard to the teaching and learning usage of web tools. As a result, the *social hub of PLE* can assist teachers in *identifying the usefulness and learning values of web tools* (23 mentions, see Fig.6). As remarked by participants, *identifying the usefulness and learning values of web tools* has an enviable position in *improving educational* *process* (9 mentions, see Fig.6) and increasing the *teachers' tendency toward technology and teacher's TPACK*. Furthermore, *identifying the usefulness and learning values of web tools can support teachers in the selection of appropriate web tools* (20 mentions, see Fig.6), resulting in the *design of appropriate technology-based learning tasks*.

Participants asserted that the combination of the *personal part of PLE* and *social hub of PLE* can support the *creation of an interactive learning environment* (6 mentions, see Fig.6) by providing opportunities for students to enrich their learning experiences by using digital tools and collaborating with each other around the content and technology.

The teachers also remarked that not only students but also other teachers should be able to share their experiences, good practices, and success stories regarding integration technology as well as the learning values and benefits of web tools by using the prototype. One teacher emphasized this requirement as below:

> *Teachers have always some ongoing educational activities and projects. They have an unceasing need to know about tools to support these activities. The social hub of PLE should provide a place for teachers to share their tools and the ways that they use them. This information can be very helpful for other teachers with same needs and projects.*

6. Documentation and reflection to produce design principles for developing the proposed solution

The results have revealed the main sorts of knowledge, skills, and support teachers require to facilitate PLE-based teaching and learning processes including:

- Identifying the technological preferences of students
- Realizing the ways that students use and learn with web tools
- Identifying the usefulness and learning values of web tools
- Defining clear criteria to assess, evaluate, and introduce the learning affordances and benefits of web tools by students and teachers
- Selecting appropriate web tools to support different phases of teaching and learning processes
- Designing appropriate learning tasks by using selected web tools
- Encouraging students to choose and use web tools, reflect on and share their learning values
- Becoming aware of other teachers' practices and success stories with web tools

Addressing these requirements can improve the educational process not only by helping teachers to establish a student-centric learning environment, but also by supporting the "situated professional development" of the teachers. Situated professional development addresses teachers' specific needs within their specific environments by allowing them to gain "new knowledge that can be applied directly within their classrooms" (Ertmer & Ottenbreit-Leftwich, 2010). In this regard, Kennedy (cited in Ertmer & Ottenbreit-Leftwich, 2010) noted that the most important feature of a professional development approach is a strong focus on helping teachers understand how students learn specific content, and how specific instructional practices and tools can support student learning outcomes.

This approach to the teachers' professional development conforms with the recently emerged paradigms in teaching theories that emphasize teaching and learning are intertwined and state "teaching practices and theories of teaching should be based on knowledge and theories of how students learn" (Vermunt & Verloop,1999). From the PLEs perspective, learning is a student-driven self-regulated knowledge constructing process. In this regard, as stated by Turker & Zingel (2008), the organization of learning resources by students in a PLE into meaningful learning activities toward achieving learning goals can be considered as act of instructional design, corresponding to the forethought phase of Zimmerman's self-regulated learning model. Accordingly, this calls for theories of teaching that are based on an analysis of students' learning process ongoing throughout their PLEs.

We derived the following design principles from the research findings to guide developing the next version of the prototype:

- Teachers need to know students' technological preferences and the ways they use web tools in order to implement a student-centric teaching and learning approach and support their professional development process. Addressing this requirement calls for the addition of a monitoring and analyzing functionality to the prototype to observe the personal parts of students, trace their use of each tool, and provide appropriate information about the usage pattern of web tools.

- The personal part of PLE should provide students with appropriate technological choices. The level and scope of these choices is an important factor influencing the students' control. While a restricted personal part can lead to poorly tailored learning experiences and students' boredom and demotivation, a limitless freedom will lead to the teachers' loss of control on the students' interaction with technology. In this situation, dialogue between teacher and students is the best solution to make decision about the scope of students' technological choices.

- The results of this study indicate that the adoption of PLE-based learning by teachers strongly depends on the teachers' estimation of the required changes in their teaching process. According to Guskey (1995), the amount of change individuals are asked to make is inversely related to their probability of making the change. Hence following a step-by-step technology integration approach by focusing on teachers' immediate needs and facilitating small changes within teaching and learning practices appears to be an effective long-term strategy to implement PLEs. Also, presenting inspiring models of PLE and describing how they can support different teaching and learning scenarios can improve the teachers' tendency toward the adoption of the PLE-based learning.

- The PLE prototype should provide opportunities for teachers to share their examples of "good teaching" that include the integration of technology. These examples can help teachers to develop confidence by hearing about or observing other teachers' successful efforts. As asserted by Ertmer & Ottenbreit-Leftwich (2010) , "observing successful others can build confidence in the observers who tend to believe if he/she can do it, then I can too."

7. Conclusion

In this paper, a new implementation and deployment model to develop PLEs in educational settings has been proposed. The model aims to put students in a higher level of control in the educational process by acknowledging and corroborating their role as active learners, contributors, and designers. The results of this research indicate that the teachers' perceptions are positive regarding the potential of the technological prototype, built upon the model, to improve the educational process. Also, the results provide the sorts of knowledge, skills, and support teachers require in order to facilitate PLE-based teaching and learning. Based on these findings, the research offers design guidelines to improve the next version of the prototype. Further research is needed to apply these guidelines, and test and evaluate the modified version of the prototype from the teachers' and students' perspectives.

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From the field

Conceptual Quilting: A Medium for Reflection in Online Courses [▲]

SUMMARY

Encouraging reflection in learners studying online is challenging. Yet reflection is often a priority learning outcome. Creative teaching strategies can help create learning environments conducive to reflection. One teaching strategy developed to encourage reflection in online courses is called conceptual quilting (Perry & Edwards, 2010). Conceptual quilting is an arts-based strategy that invites students to create virtual quilts by piecing together words, ideas, metaphors and concepts from a course or unit that they found most transformational. Completed quilts are shared electronically by posting them in an online "quilt gallery" for all students in the class to browse. The conceptual quilting activity is usually situated at the end of a unit (or course) as a summary reflection activity. This reflective activity influences the sense of community in the online class environment, helps to personalize learning, furthers class discussion, encourages development of self-knowledge, and aids knowledge retention. Conceptual quilting is appropriate for online graduate and undergraduate courses.

Tags
reflection, conceptual quilting, online education, online teaching, distance education

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1. Conceptual Quilting: A Medium for Reflection in Online Courses

Encouraging reflection in student studying online is challenging. Yet, cultivating reflective practice remains a priority learning outcome when teaching online. In a distance educational milieu, creative teaching strategies can help bridge the physical gap between instructors and students creating a learning environment conducive to reflection. One teaching strategy developed to encourage reflection in online courses is called conceptual quilting (Perry & Edwards, 2010).

Conceptual quilting is appropriate for online graduate and undergraduate courses. Conceptual quilting is usually situated at the end of a unit (or course) as a summary reflection activity. The idea for this activity derives from the craft of quilt-making. Learners are invited to create virtual quilts by piecing together words, ideas, metaphors and concepts from a course or unit in a course that they found most transformational. Conceptual quilt-making requires learners to reflect on what they have learned, choosing important "take away" ideas and concepts to feature in their quilts. Conceptual quilts vary greatly from student to student demonstrating personalization of learning and acknowledging the value of diversity. This activity is none-graded and optional; however in our experience participation is almost 100%.

The conceptual quilts are created in a medium that can be shared electronically with the instructor and classmates. Students use various drawing software to produce their quilts, with a single PowerPoint slide being the most common. To develop conceptual quilts learners must review course materials and interact with themselves in a reflective way. The quilts become pictorial representations of their reflections on their experiences with course materials, classmates, and instructors. An example of a student-produced conceptual quilt is provided in figure 1.

Figure 1: Example of a Conceptual Quilt from an Online Course Called Teaching Health Professionals (Whelan, 2010)

Completed quilts are shared electronically with course instructors and posted in an online "quilt gallery" for all students in the class to browse. When quilts are shared with the class, discussion arises in online course forums regarding concepts depicted in the quilts. This discussion is often a resurgence of meaningful dialogue around a course theme furthering learning. One student's reflection often triggers reflections in classmates creating a reflection cascade. In this way reflection moves from a personal experience to a shared community exercise.

This further class discussion can occur spontaneously or be prompted by questions from the course instructor. For example, the instructor can deliberately ask students to view the conceptual quilts in the online gallery and provide a written online posting focused on common themes they see depicted in the quilts. The novelty of the array of quilts creates interest and excitement within the group making further discussion easy to elicit. In sum, conceptual quilting helps trigger reflection (both individual and group reflection) and learning is potentially solidified by further discussion. Students can be moved to analysis and synthesis if asked to thematically analyze the class quilts.

Instructors have noticed that the conceptual quilting activity influences the sense of community in the online class environment. The activity results in meaningful course content related interactions among classmates. Learners note that they get to know one another by viewing the words and images depicted in each person's quilt. Students commented that conceptual quilting makes a big difference to how students interact because people reveal something about themselves in what they choose to put in their quilts. In other words, creating and sharing quilts helps students get to know themselves and classmates. The resulting comfort level facilitates further meaningful discussion and interaction triggered in part because of what the conceptual quilts disclose about individuals. Further, themes reflected in the quilts posted in the quilt gallery help learners see, and value, both commonalities and diversities in their online learning communities. Students commented that the finished quilts are like self-portraits of the designers because they pull together personal threads and give a total package picture of each person. One student noted that she wrote a personal email to every person in the class to chat about what they had in common in their quilts. This person-to-person and group interaction potentially facilitates online community development.

Conceptual quilting was noted by learners as effective for developing self-knowledge. Conceptual quilting is a very personal exercise asking students to consider what metaphors, theories, insights etc. from the course meant the most to their learning. Students said that the quilt-making assignment caused them to really reflect on what they had taken from the course. Conceptual quilting also helped students to set personalized goals for future learning outcomes.

Students mention that the quilting activity helps them solidify their learning and to remember what they had learned. Ifenthaler, Masduki and Seel (2011) found that concept maps help students put in place building blocks of knowledge that translate into meaningful learning and retention of instructional materials (p. 41). We propose that conceptual quilting may work in a similar way to concept mapping giving learners scaffolding on which to secure ideas and concepts from a course through reflection that can lead to longer-term retention.

The sharing of completed quilts online is a way for students to acknowledge the impact that others (teachers and peers) had on their learning journey. As an end of course reflection activity, conceptual quilting effectively brings closure to a course and helps students acknowledge and say farewell to their classmates and instructor. This termination activity is an important step that may be neglected in some online class experiences (Perry & Edwards, 2010). Instructors comment that conceptual quilting facilities students effectively summing up the effect of a course on their learning and on their being in a way that is academically challenging and appropriate. Commonly quilts document course moments and acknowledge specific important contributions made by instructor and other students.

Face-to-face instructors may adapt virtual conceptual quilting for use in face-to-face courses. Students who learn face-to-face can be asked to independently create quilt squares and these squares can be pieced together to create a physical class quilt. Research focused on the potential educational benefits of conceptual quilting in the face-to-face environment is needed.

Online course designers and educators are challenged to consider teaching strategies such as conceptual quilting to enhance reflection in online course communities. Research on these types of strategies will contribute to growing theoretical understanding of the effect of such reflection activities in online graduate and undergraduate students.

From the field

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From the field

The e-Learning Café project of the University of Porto: innovative learning spaces, improving students' engagement in active and collaborative learning [▲]

SUMMARY

This paper reports the ongoing research project headed by the University of Porto (U.Porto) and the research group Centre of Spatial Representation and Communication

(CCRE), from de R&D Centre of its Faculty of Architecture (FAUP), which aims the design and study of hybrid spatial environments: e-Learning Centres.

The state of the art review discusses the significance of informal physical learning spaces for learning activities in academic education. The most important outcomes of research are mentioned, resuming the strategy applied for the e-Learning Café of Asprela. Outcomes from the daily activities and of studying critically its space configuration in relation to the users' social behaviour are addressed. Finally, the strategy for the design and upgrade of the new e-Learning Café for Porto's Botanical Garden is undertaken.

Our main objective is to present and discuss the contribution of the e-Learning Café project of the U.Porto and of the successful implementation of its program, focused on learning physical spaces able to combine social interaction with diverse pedagogical and cultural activities, all of which have proven to be an important relational dimension for all the people working or studying at U. Porto and an asset to foster the openness of the University to the society.

Tags
Informal learning, elearning, innovation, learning space, physical learning spaces

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Languages
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1. The importance of the physical space, spatial principles of design in learning activities: a short review

In recent years there has been a significant amount of debate regarding the importance of space and spatial design principles for learning. We can point out a few examples like: the "Designing Spaces for Effective Learning, guide for the 21st century" report by JISC exploring the relationship between space design and learning technologies; In the 2004 book by EDUCASE on the draft Learning Spaces; In 2005, EDUCASE Learning Initiative, focused on the informal design of learning spaces and studied design elements associated with the effectiveness of informal learning spaces, developing a guide for the design of diverse elements, assumptions and factors that contribute to the success when creating spaces for informal learning; the OECD-CELE project (Centre for Effective Learning Environments) began his studies in assessing the quality of learning spaces in 2005 and, recently "The research on Learning Space Design" from the Perry Chapman Prize (Painter et al, 2013)

Within this background, and focusing our attention to Portugal, we can say that there are an increasing number of activities related to the quality of teaching spaces in Portugal: a clear example of this is Park School with the Modernization Program for the Secondary Park School. Among various actions, we highlight the International Seminar «Doing School», which focused on the theme of Architecture Learning Spaces and In_Learning research project in IST/UTL.

In fact, it is important to mention that the University of Porto and its Faculty of Architecture are very interested in the study of spatial principles for designing spaces for learning activities with strong ICT integration and in their construction and architecture. This can be seen by the development of the research project that began in 2006 that aimed to design and study hybrid spatial environments: e-Learning Centres. The design, construction and evaluation of hybrid spatial environments - e-Learning Centres - in U.Porto constitutes a very important and strategic research program that aims to offer to the academic community a set of integrated environments, providing new spaces where social and learning activities are combined and where the whole academic community can meet, exchange knowledge, share experiences and work more effectively in groups, thus promoting interdisciplinary, innovation and entrepreneurship.

It can be said that in recent years, many things have changed within the learning world of universities and we have witnessed the emergence of learning spaces created to host diverse uses, where formal activities related to learning and studying are combined with the dynamics of socialization and where ICT has an important role. Within this context, the U. Porto and CCRE in FAUP are very interested in the study of spatial principles for designing spaces for learning activities with strong ICT integration.

In view of all this, we believe it is reasonable to admit that learning is an activity that will yield superior results if the environment where it takes place is a rich, dynamic and sustainable environment. In fact, as Whiteside (2009) states: "To create sustainable learning spaces, we must create community, take a holistic approach, use a common language, apply core pedagogical knowledge, and explore emerging technologies as a catalyst to engage faculty and students while we partner with others for pedagogy rich designs, assess learning in the new spaces, integrate ideas for Innovation, and revisit design methodologies."

Finally, it must be said that e-Learning Centres in U. Porto:

Asprela and Botanical Garden - design, building and evaluation of hybrid spatial environments constitutes a very important and strategic research program providing new spaces where social and learning activities are combined and where the whole academic community can meet, exchange knowledge,

share experiences and work more effectively in groups, thus promoting interdisciplinary and innovation.

2. e-Learning Café of Pólo da Asprela and the e-Learning Café of Botanical Garden

The U.Porto campus aims to offer various types of learning spaces covered by technology within its boundaries: e-Learning Centres. The e-Learning Café of Asprela and the e-Learning Café of Botanical Garden and their programs are important steps in that direction. The general objective is to offer new physical learning spaces that promote different types of communication among the users of university facilities, using ICT as the best means to structure and organize the university space. This project created a set of new dynamic learning spaces that integrate social and study activities constituting a strategic relational dimension for all the people implicated in some way with U. Porto.

The first e-Learning Café designed in U. Porto - e-Learning Café of Asprela – has been in use since 2008 and its new architecture took advantage of the open space configuration of the atrium, first floor room and double height ceiling areas of an already existing University building. Its program consists of four main interrelated spaces: Cafeteria / Bar, Multimedia room, Chill-out room and Work / Study room. The aim was to create a strong, coherent and flexible spatial design, linked to the new e-Learning Café program. A new set of interrelated spaces, having each one of those places, an individual ambience and design reinforcing its particular purpose or use, and the adoption of solutions that assured easiness for users or programmers to change some characteristics or ambiences of those spaces. The different ambiences that are created for each area are mostly the result of considering the new furniture and its layout as an important spatial design element for characterizing the space and by controlling the natural light and applying different types of artificial lighting to each individual area.

Figure 1: e-Learning Café of Asprela: main floor and first floor

2.1. Extending the Potential of Digital Multi-User Interactive Systems for the Outer Space of an e-Learning Centre: Architectural Design for the Arrangement and Design of Outer Space Garden of e-Learning Café of Asprela of U. Porto

The increased number of students using e-Learning Café of Asprela encouraged us to design a new program for the outer space of the building. The new proposal, U-thinking, aims to provide a solution of a coverage area, located on the back patio of the building making possible to use the garden for studying, working and for cultural activities regarding the arrangement of all the outdoor space surrounding the building.

The space is divided into two main areas protected with an innovative and distinctive coverage. Thus, at floor level we have two zones: a “more conventional” working/ studding area with chairs and tables next to a more informal comfortable zone where a granite bench defines the space that can shelter some cushions and “bean bags” for more a informal study and socialising area.

Partially covering the studding area, we designed an inflatable cloud that helps shelter and to define the space. The interior light can be emitted in a system of LED, allowing this space to be used at night.

One of our formal references for the cloud structure came from cartoons, since they typically represent someone’s thoughts in the form of a cloud. Thus, we adopted the form of a cloud for our structure, which symbolizes the materialization of everyone’s thoughts.

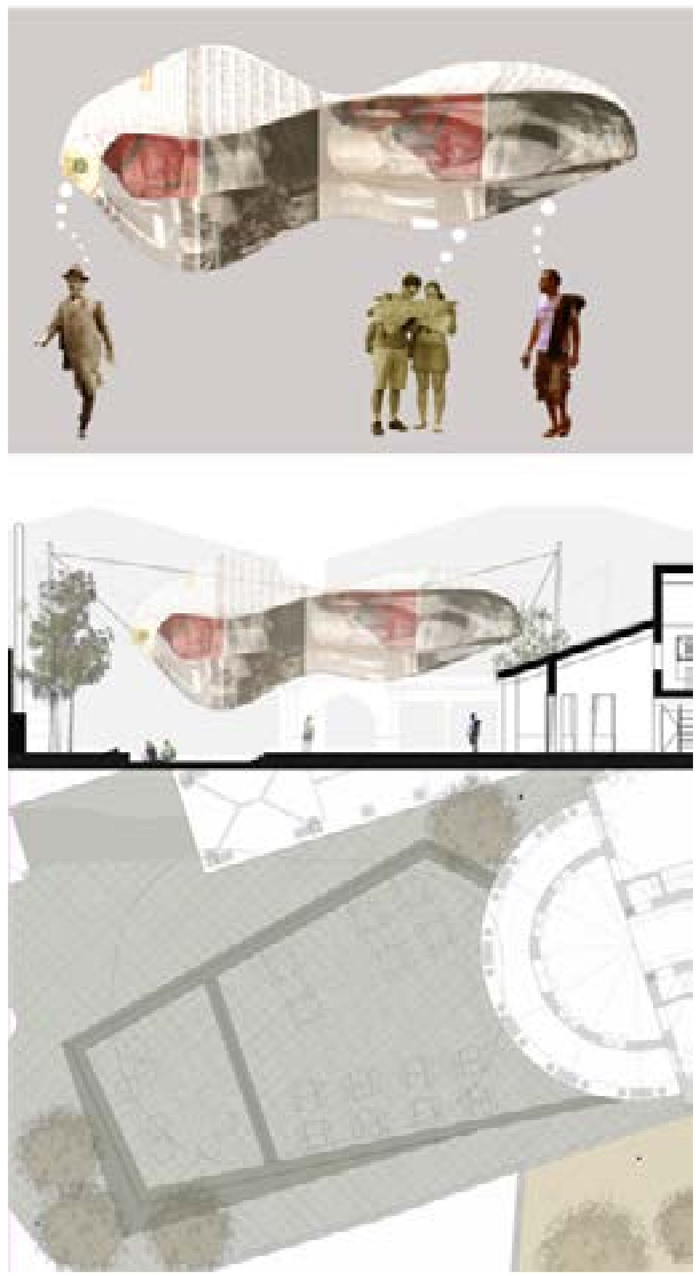

Figure 2: Section and plan of design project proposal for the outer space of e-Learning Café of Asprela

The interior of this structure can be illuminated whenever necessary showing on its surface dispersed phrases, thoughts or famous formulas considered to have been a mark of knowledge in the past. The iconography of the cloud shape representing the thoughts in the cartoons is, in fact, an allusion to the great thinkers and urges students to idealize. The technology embedded in the coverage structure will also allow projections of artistic interventions as well the implementation of interactive digital artifacts for reproducing, for example, the concentration of students in the space, the weather conditions or the state of user's emotions.

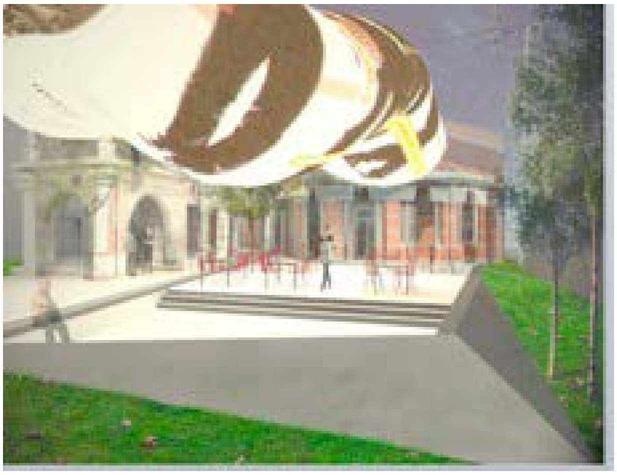

Figure 3: Simulation of the design project proposal for the outer space of e-Learning Café

2.2. e-Learning Centre for the Botanical Garden of the City of Porto: The Program and its Design

The design of the e-Learning Café for the Botanical Garden of the city of Porto was another important output coming from the e-Learning Centers in U. Porto research project and is the result of the upgrading and transformation of Salabert House located inside the Botanical Garden, which constitutes an important public space of identity of Porto. Within this context, the architectural design proposal is paying special attention to the genius loci of this place proposing the reconstruction of Salabert house to its original volume and typology and a new extension building.

The proposed design for this new e-Learning Café will contemplate, in addition to the diverse learning and socializing spaces, other spaces for integrated activities that are known to balance the learning process and ensure regular healthy routines (informal learning spaces, multifunctional spaces, flexible spaces capable of adapting to different needs, spaces for music and sport activities related to students posture and relaxation).

The program for the ground floor areas in the Salabert House contains the more public spaces: cafeteria / bar and break out spaces, and in the upstairs floor the space is distributed among working group room and individual working room areas. The

new building will have a reception area where there will be dynamic data on for communicating interactively information related to the continuous monitoring, real-time occupation and programming of the e-Learning Café. Then, next to this "open space" area, we find the "chill out" room that will allow the implementation of collaborative projects and a significant interaction with technological artefacts, this area will also have specific technology with a design focused on body position, correct working postures and allowing high levels of performance and comfort.

We are also thinking of using the electronic communication system similar to the one utilized at the University of Strathclyde. In this new e-Learning Centre the interactive technologies will be present in many of its spaces, and may be temporarily used to change the perception of users / participants in relation to these spaces. Such initiatives, which interpret the individual's behaviour, provide a better awareness of the person itself and her place in the group and space environment. For this reason, they can improve the communication and interaction among the users of those spaces.

3. Program

The e-Learning Café of Asprela has a non-traditional schedule, it is open all year, 365 days, and throughout the year the opening hours are adapted to the needs of the users.

The e-Learning Café is mainly a place to stay, meet others and feel comfortable, were the design of the furniture and the arrangements of tables are cosy and relaxing. Nevertheless this space is also a place to communicate and socialize. To enhance these soft skills, several activities are proposed throughout the year, being all free of charge and open to all the academic community.

To respond to the need of preparing students to achieve increasing levels of communication and collaboration skills and to be able to foster the acquisition of knowledge and encourage attaining excellent and significant outputs, the e-Learning Café of U.Porto brought up the "Show yourself" initiative, which is captivating students, researchers and professors.

The main goal of the "Show yourself" initiative is to bring to the e-Learning Café work developed in different research units of the University, namely the work coming from the Young Researchers Project of U.Porto. Furthermore, these events aim

to contribute to a better understanding of the research work done by different groups of students who also use this space to learn and socialize. The idea, besides other things, is to create a positive and strong dynamic around the "e-Learning cafe", where it assumes a role of "showcase" of these activities and of the University.

Many significant examples of this event could be described as, for example, the session with Around Knowledge, a start-up's company created by three former U.Porto students, all with different backgrounds and this fact was one of the strong points of the session, as they explained the importance of working in multidisciplinary teams and how this impacted on their company. The final product of the session was the launching of an application for smartphones specifically developed for the e-Learning Café. The goal for this session was achieved as the public, mainly students from different curriculum areas - arts, engineer, and science among others -, perceived the importance of multidisciplinary teams to develop successful products and services for the market.

Another example was the session with the research group of the project "Sem+nem- moving houses". This session was particularly interesting, as the team concentrated on very important aspects of sustainability and on a vision of the future development of construction. This project takes place on the vanguard of Architecture and Engineering, pursuing the concept of "house as a living element", adapting and offering the best quality of the inhabitant's life. A dwelling that interacts with the environment and solar luminosity variations, recreates at each moment a new interior and exterior space, adapting itself to the daily routine, changes its appearance during the day, follows the sun's course, and feeds from it. The impact of the session was mainly the understanding of the key steps to make an idea work.

We also invited the OSTV channel to the e-Learning Café. The

OSTV is a global and unique way to make TV, where most of the contents arrive through an international network of collaborations. It's a channel open to all creators and artists. During the session, the first Creative Camp was launched.

Two weeks of intensive creative workshops and art work, in a village at the northern of Portugal where students of all areas of knowledge experiment and learn in a different way. Several of the students that attended the session at the e-Learning Café were interested and attended the Creative Camp.

4. Conclusions and Further Work

Accordingly, U. Porto as a higher institution concerned with the quality of their learning facilities took the redesign of this e-Learning Centre as a priority, especially after 5 years of its outstanding results (Neto et al 2010) (Vieira et al 2009) (Neto et al 2008), (Neto et al 2007). It can be said that the e-Learning Café is now a place of reference for all the academic community. The interaction and the personal enrichment are the base of all the activities developed and as will be seen next, with the new proposed design for its exterior gardens, this program will be even more consolidated and enriched.

It seems reasonable, taking into account all that has been synthesised in this paper, to say that the present studies and results suggest the need for a new form of learning and social environment characterized by different activity settings, small-group activities and strong ICT integration. Moreover, when speaking about efficiently embedding technology in architectural spaces for learning and social activities, interactive digital artefacts can play a key role for strengthening the interaction of students, teachers and university staff with those spaces and foster new ways for them to communicate, study and work within these learning environments.

Nevertheless, for all the above to happen, it seems to us that universities have to be willing to change their facility planning process, their buildings programs, design and both integrate critically and use actively technology in their learning environments. We believe that this has been the case of U.Porto with the e-Learning Café of Asprela program, the new design proposals of U-thinking, e-Learning Design of Outer Space Garden and the new e-Learning Café for Botanical Garden, plus the research conducted until now focused on these issues, which all constitute important steps in that direction.

The results on the evaluation of this e-Learning Centre obtained until now are very significant and confirm the important principles that have been encountered in literature review and the important characteristics that have been pointed out for the architecture of rich learning and socializing spaces. In fact, with the experience and the results obtained until now with this e-Learning Centre of Asprela, we can say, in general terms, that articulated and flexible spaces able to manage different uses are of paramount importance for encouraging strong interchange of ideas and diverse social interaction within a learning environment. (Vieira et al,2009) (Neto et al, 2009) (Neto et al, 2007).

In fact, having seen how social areas in the university environment are important to enhance the learning and studying process and to create an overall atmosphere with which students can identify and feel a sense of ownership of the environment where they study and socially interact (Joss, 2011), we created a set of rich and diverse interactive social places in our Learning Centres that are also able to integrate some level of customisation by students It is worth pointing out that the research and design of learning and socializing spaces with strong ICT integration developed by the CCRE group until now shows that, in contrast to the visual art media, the interactive environments takes the body of the visitor and ensures their action/motion in space. This could be clearly seen through the several workshops with interactive media held with students in the multimedia room of e-Learning Café of Asprela, and can also, in some way, be concluded after reading several writings of diverse authors (Bullivent, 2005; Castle, 2007; Hertzberger, 2005) and several case studies already pointed out in this paper.

Finally, we give some evidence that backs up what many authors assert for, and this is that architecture in general, and in these type of learning environment programs in specific, should integrate a spatial evaluation system in their design process (Sanoff,2001; Brown,2005; Schaller and Huley,2004) explaining also how we have conducted our evaluation of the e-Learning Café of Asprela. In our opinion, this should be the most secure and reliable base for proposing physical improvements to university buildings since evaluation is a method of identifying needs and making possible the correction and the upgrade of these spaces in accordance to their functions. As a matter of fact, it could be seen until now that articulated and flexible spaces, which incorporate digital interactive artefacts that are able to manage different uses, are of paramount importance for encouraging strong interchange of ideas and diverse social interaction within a learning environment. Also, very significant, are the results obtained for the performance of the learning environment of e-Learning Café of Asprela and its diverse places for Socialization, Individual Study, Group Study and Cultural Activities, which corroborate the importance given to them in literature review and case studies presented in this paper. It seems, therefore, that they should be considered of ultimate significance for building a rich learning and study ambience supporting a community of inquiry.

Thus we believe that it is by integrating technologies and architectural digital artefacts actively in the design process that these can (1) foster communication and interaction between

people; (2) allow for different levels of privacy and types of activities within a university facility or program; (3) open these university places and programs to the city and abroad.

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A New Direction for the Learner Experience. Engaging Students in Participatory Design of a 21st Century Classroom Chair-Desk [▲]

SUMMARY

Classroom chair-desks tend to be uncomfortable and not appealing to the student. A patent search using the term "chair-desk" reveals that students today are sitting in exactly the same rigid plastic seat, bolted to a metal-frame, high-pressure polyurethane-topped student chair-desk as their parents or grandparents did more than a half century ago in 1953. When the five major school furniture manufacturers in the United States were asked what research they relied on for their furniture designs, the response was that they did not rely on any and so have adopted a one-size-fits-all philosophy (Parcells 1999).

In an effort to put an end to one-size-fits all design of learning environments this paper presents a detailed account of the participatory design approach followed by a high school engineering technology class from Hopewell High School, Virginia, USA to re-design the traditional school chair-desk as part of their efforts in the 2010 Lemelson-MIT InvenTeams program. With a belief that students should experience an optimum state of active-dynamic learning the team used a participatory design approach to innovate an inclusively designed, accessible student chair-desk that adapts to its user's need of healthy, ergonomic movement resulting in an improved chair-desk experience and ultimately an enhanced learning experience. Key milestones achieved, challenges encountered, and relationships forged during the design and fabrication process of this desk are also highlighted.

Tags

school desk, inclusive design, accessibility, student achievement, learning

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1. Introduction

Classroom chair-desks tend to be uncomfortable and not appealing to the student. After conducting preliminary patent research our team made the shocking discovery that students are sitting in exactly the same rigid plastic seat, bolted to a metal-frame, high-pressure polyurethane-topped student chair-desk, as their parents or grandparents were more than a half century ago in 1953 (Figure 1) (Chapman, 1953).

Figure 1. Chapman patent drawing of chair-desk circa 1953

A study conducted by Parcells (1999) revealed that when the five major school furniture manufacturers in the United States were asked what research they relied on for their furniture designs, the response was that they did not rely on any. Since ergonomic research has yielded few recommendations of new principles for the design of chair-desks in the school workplace the majority of manufacturers in the student desk industry have adopted a one-size-fits-all philosophy. This is evidenced in studies such as those done by Georgia Panagiotopoulou (2003) about classroom furniture dimensions versus anthropometric measures in primary school which indicate a mismatch between the students' bodily dimensions and the classroom furniture available to them.

In 2010, as part of the Lemelson-MIT InvenTeams initiative, a group of Engineering Technology students from Hopewell High School, in Hopewell, Virginia, USA set out to re-design the traditional school chair-desk. Our chair-desk design is an attempt to put an end to the one-size-fits-all approach used in the design of classroom furniture found in most schools today. We believe students should experience an optimum state of active-dynamic learning. Our mission was to innovate a flexible student chair-desk system that adapts to its user's healthy need of ergonomic movement resulting in an enhanced learner experience and ultimately improve academic achievement. We were also committed to using inclusive, ergonomic and industrial design principles to create a product that will integrate seamlessly into the 21st century classroom giving rise to a new learning system that reinvents how furniture can be used in today's classroom.

In order to accomplish this it was critical for us to work closely with our target user group – high school students. Unlike many school furniture manufacturers, our primary goal in the design process was to make sure that we fully met the learning needs of the full range of students as this is who will benefit from our invention most followed by teachers, schools, and school districts in that order. In doing so, we decided that it was critical for us to accomplish the following to achieve a robust design:

1. Collect, understand, and incorporate target user experience feedback

2. Collect perceived user requirements

3. Observe target user interaction with current desks

4. Collect and utilize actual student anthropometric data rather than relying on furniture industry averages that typically do not take into account anyone younger than 18.

5. Design and develop a desk that incorporated key elements in its design from the work completed in items 1-4.

Literature Review

Chair-Desk Research

As mentioned previously, since ergonomic research has yielded few recommendations of new principles for the design of chair-desks in the school workplace the majority of manufacturers in the student desk industry have adopted a one-size-fits-all philosophy (Parcells 1999). This is evident in traditional chair-desk designs that are most commonly found in classrooms today such as patent#6604784(Bosman 2000) and patent#3020086 (Barber 1962). Furthermore, these desks are largely devoid of ergonomic design considerations and constructed with a metal frame to which is welded a simple flat top table and hard polyurethane seat.

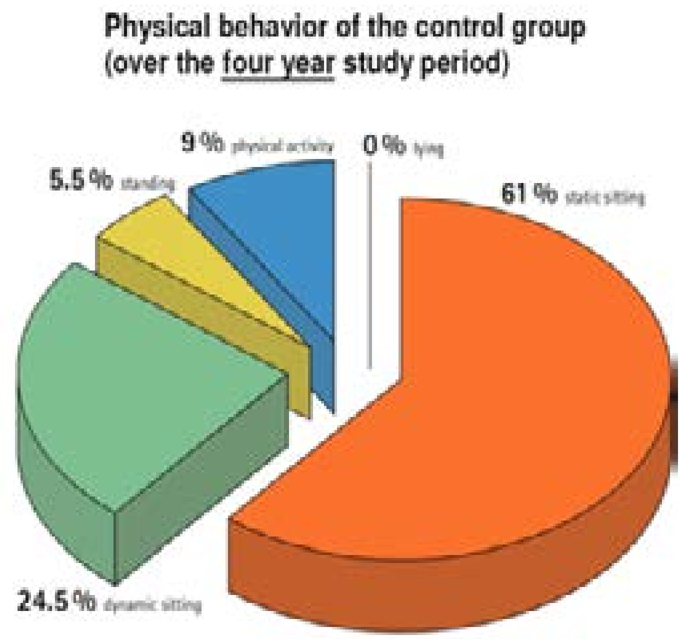


Figure 2. Control group data from Breithecker study

In the past decade, some improvements to the traditional chair-desk have been made. However, improvements are limited to one or two design considerations such as a more sleek frame design (patent #2722965 Chapman 1955 and#2678683 James 1954), addition of seat or desk height adjustment (see patent #3622199 Mitchell 1969 , #D505022 Mills et al 2003), or casters located at the base of the desk legs to allow for rolling on the floor (Patent #7571959 Griepentrog 2005).

A handful of competitive non-traditional student chair-desk technologies were also identified, but we felt that they were either not practical for classroom use, or relied heavily on non-sustainable materials. Examples include a chair-desk with a fastener-free, rocking chair design requiring plywood construction (patent #7168766 Pelletier 2005), a large, difficult to move round desk-chair (patent#6832561 Johnson 2001) and an uncomfortable, non-sturdy knockdown desk made of corrugated fibreboard materials (patent #4653817 Sheffer 1987).

Active-Dynamic Learning

Research into effective learning practices in the classroom yielded two scientific studies that promoted a new learning paradigm called active-dynamic learning.

The first was a German study by Dr Dieter Breithecker in Germany (Breithecker, 2005). He noticed that throughout the school day students are sitting down for an exceptional amount of time (Figure 2).

His solution to this was to promote a more dynamic environment where the user is more active by being able to walk around, stretch, and do exercise during learning. Through a span of four years he studied students whose teachers taught them by the normal method of teaching (control group) and students who were taught by the dynamic learning method (test group). He found that, in the students who were more active in their learning environment through furniture and teaching methods that allow movement, orthopedic posture and attentiveness actually improved over time whereas in the group who were static or sat still during class, orthopedic posture and attentiveness actually got worse (Figures 3 and 4).

This data firmly points to the need for a chair-desk designed for active learning that can promote better health and student achievement in the classroom.

"Spark", a book written by psychiatrist Dr. John Ratey also supports our idea of incorporating Active-Dynamic Learning into the classroom. Ratey states that students these days are not getting enough exercise; that they are spending too much of their time sitting in front of screens and monitors and not being active enough (Ratey, 2008). From the medical standpoint active learning would help combat the increasing number of illness caused by inactivity throughout the country. Benefits also come from the educational gains that active learning can provide. Through numerous experiments Ratey has also shown that students who maintain an active learning environment are shown to score better in both reading and mathematics exams (Ratey, 2008). Adopting this active-dynamic approach

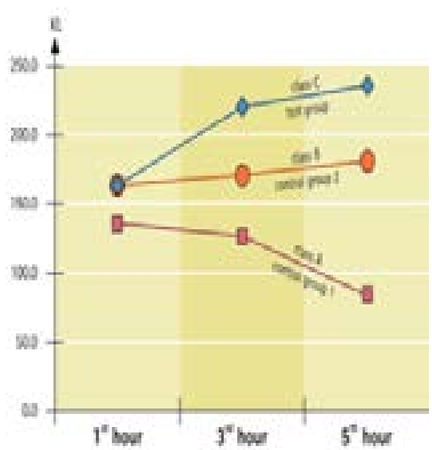


Figure 3. Concentration performance value (KL) in the performance endurance test

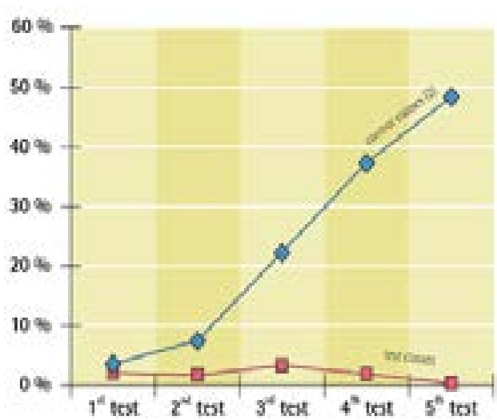


Figure 4. Excessive chest kyphosis pathogensis among study groups

for our chair-desk design would not only serve to increase the health and wellness of students but also increase their overall productivity and achievement level.

Description of Invention

Our team's invention consists of a student chair-desk that integrates seamlessly into the classroom allowing high school students to experience an optimum state of active-dynamic learning – learning that results from furniture that adapts to its users healthy need of movement. It will result in improvements in student health, well-being, attention-span, concentration and ultimately, student achievement while simultaneously incorporating the latest in inclusive, ergonomic and industrial design principles, and be cost effective.

The chair-desk has a slot modular architecture (Ulrich and

Eppinger, 2008) in that there are three different components that require an interface with some other chunk of the deskThe three components are the: 1) Chair (comprised of seat back, seat, and chair frame in blue outline); 2) Frame (comprised of H-joint and surface support base in red outline) and; 3)

Surface (comprised of height adjustable pole, articulating pole and surface itself in black outline). A basic sketch of these components can be seen in Figure 5.

The unique slot modular architecture of the chair-desk leads to several features and benefits that deliver on inclusive, ergonomic and industrial design principles and active-dynamic learning. These are outlined in Table 1 below.

As an entire system the chair-desk can be broken down quickly and easily to allow for easy nesting and storage as well as a packaged dimension of 3ft3.

Detailed, dimensioned drawings were not available at the time of writing this paper. This is an opportunity we wish to pursue as part of the next steps.

Chair	Frame	Surface
• Sleek yet ergonomically designed seat back that can be used in forward and backward seating positions • Flexi seat back that allows for soothing rocking motions or postural adjustments • Cushioned seat made of durable polyurethane material • Flexible yet strong tubular chair frame that accommodates for user's postural adjustments • Proprietary rotation and release mechanism that allows 360° seat rotation and quick release for easy cleaning of underside • Can easily be removed from rest of desk via pop-off I-beam and used as standalone chair • Convenient quick release carabineer clip affixed to top of seat back to hold bags and purses	• Strong yet durable tubular construction • Proprietary I-beam connects/ disconnects chair to/from surface base • Minimal interference with user's feet since located under seat • Easy slide floor contacts to aid in effortless movement across floor • Allows for double-sided entry/exit with no invasive bar hitting thighs • Height adjustable footrest to alleviate pressure on spine and promote healthy sitting posture	• Height can be adjusted vertically via single-handed quick release adjustment • Can be detached from chair as standalone desk in sitting position or as podium in standing position • Reading angle can be adjusted between 10-20° via single-hand quick release joint to promote healthy sitting posture and reduce eye strain • Girth adjustment via single-hand quick release knuckle joint through a range of 0.70m to accommodate a variety of body types • Made of translucent, 40% recycled, sustainable Chroma material • Can be sanded to refinish surface if scratched or dirty • Low sticking tolerance which makes gum removal a snap • Attractive blue colour to promote calm state of mind • Translucent which prevents unwanted "under the table" activity while still maintaining privacy • Proprietary pull out swivel wings to increase surface area for peripheral materials • Proprietary rotation and release mechanism that allows 360° surface rotation and quick release for easy cleaning of underside • Quick release lip to prevent surface materials from falling off • Counter-sunk neo-magnets with matching affixed magnets for paper hanging

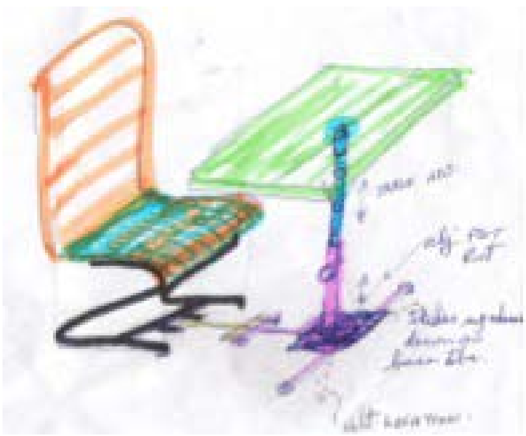


Figure 5. Basic sketch of modular chair-desk design

Design Process

Identifying the Problem

In January 2009 the team was asked to brainstorm three ideas for an invention that would solve an important problem. In the style of what-if-scenario brainstorming students were told that there were no limits to their invention ideas. An online Writeboard was set up so that each student could submit their ideas privately without influence from other students. With 9 students in the class a total of 27 invention ideas were submitted. These were then narrowed down to a list of the top 13. Next, the team applied an ideas ranking matrix/modified

Pugh chart to the top 13 ideas. Each student was asked to fill out a matrix from which scores were then added and applied to a summative matrix (Figure 6).

In spite of the temperature controlled pillow idea scoring highest the team agreed that the second highest scoring idea, re-designing the school chair-desk, was a problem that could more easily be designed and developed given available resources and one that appealed more in terms of potential for impact given their own experience with sitting in a school desk for six hours a day whilst experiencing pain, discomfort and distraction.

Problem Definition

"We will invent a student chair-desk that will incorporate the latest in ergonomic and industrial design principles, be cost effective, and will have a small carbon footprint. Our invention will integrate seamlessly into the classroom setting, set students in an optimum state of learning and remembering, and increase their overall level of student achievement." This was the very first iteration of the

	1	2	3	4	5	6	7	8	10	11	12	13
	Voice command dog door	InstaChill and Heat Microwave	Self-disp toothbrush	Bomb detector	Anti or radiation reducing cellphone add on	Stunted growth grass	Ipod app for school	Student friendly desk	Temp controlled pillow	Smaller, more efficient solar panels	Quiet turbine	Low heat turbine
Ability to complete on time	27	15	31	13	23	17	23	33	37	13	11	13
Member Interest	15	23	19	21	31	17	17	29	31	13	25	23
Practicality	27	23	33	25	29	23	25	35	33	17	19	19
Ease of building prototype (cost)	23	17	31	11	21	19	23	37	35	13	14	13
Public/Customer Interest and Value	23	33	19	15	37	31	17	35	37	25	31	29
Fun	15	27	13	21	20	17	13	29	31	13	25	23
Grand Total	118	138	146	106	161	124	118	198	204	94	125	120

Assign a number (1, 3 or 5) for each project under each factor. 1 being least and 5 being most

We'll combine everyones votes and the 3 projects with the greatest sums will be selected focused on

Final Idea Choice (as of 2/9)

Figure 6. Completed summative idea ranking matrix/modified Pugh Chart with final idea choice

problem statement created early in the design process.

However, as team members began creating mock-ups of alternative desk designs and talking about what features might be beneficial, work and discussion inherently revolved around high school students. The next iteration of the problem statement was changed to specifically reflect “high school students” rather than “students” generally.

Three months quickly passed from January through March during which time the team progressed from mock-ups to true-to-size prototypes of three alternative designs. Given the complexity of designing true-to-size prototypes and recent research findings on applying principles of inclusive design (Fletcher, 2006) and industrial design the team reached out to the Department of Industrial Design at Virginia Polytechnic Institute in Blacksburg, Virginia, USA for assistance. Interfacing with industrial design students and their professor revealed that the true strength of the desk design concepts lay in their modularity and accessibility. Both of these design features pointed to a desk that promoted healthy learning. This lead to further research about healthy learning and discovery of the active-dynamic learning concept based on the aforementioned research paper by Breithecker (2005). The team embraced this concept and changed the problem statement yet again to reflect these findings. The final statement reads:

“The Hopewell High School InvenTeam believes students should experience an optimum state of active-dynamic learning. Our mission is to innovate an accessible student chair-desk that adapts to its users needs. Our desk will benefit student health and well-being, result in an enhanced learning experience and ultimately, improve academic achievement. We are committed to using inclusive design principles and sustainable, cost effective materials to create a product that will integrate seamlessly into the 21st century classroom.”

Planning and Resource Allocation

The project was divided into four phases - a Planning Phase,

Design Phase, Build Phase, and Assembly & Analysis Phase.

To help track and organize deliverables within each phase four tools were deployed - a high level Gantt chart and rolling, four-week plan chart; a year-long deliverables and milestones calendar and; a short term (two week) action item spreadsheet.

From a team-member resourcing standpoint deliverables were classified into groups according to type of skill set required for completion. Skill-set sub-teams were then created by matching team member skill set to required skill set. In cases where team members had a skill set suited to more than one sub-team they were asked to choose the sub-team that interested them most. Sub-teams typically consisted of two or three people that would work together to complete one group of deliverables. For resource needs that the team could not meet directly they looked to the higher education and business community for support. Gracious support was provided from areas across office furniture, interior design, industrial design, graphic design, school furniture sales and distribution, tradeshow booth manufacturers, and metal fabrication

On the engineering side the team’s engineering mentor, affectionately known as “our savior”, Mr.Wilfred Frederiksen was an invaluable help. A retired mechanical engineer, and founder of his own engineering consulting company, Mr.Frederiksen helped to not only turn concept designs into a final engineered solution but also connected the team with companies that supplied certain materials and metal fabrication services.

Concept Evaluation

Inspired by the human-centered, design-based approach followed by the award-winning global design firm IDEO, the design approach began with an assessment of the limiting factors present in today's student desks. In what took approximately one week's worth of time the team was first asked to conduct an ethnographic study of their interaction with school desks. Observations were recorded by each team member during this time. The team then came together and used sticky notes to write down all of their observations. The sticky notes were then posted onto a white board in the classroom to make it easy for everyone to review each other's observations. The team was asked to study the entire board and identify possible category groupings that each one of the observation submissions could fall under. After completing this exercise the team came up with seven major areas of limitations each containing numerous limiting factors. These seven areas were: 1) Materials; 2) Usability and Comfort; 3) Safety; 4) Connectivity; 5) Mobility; 6)

Appearance/Aesthetics and; 7) Organization and storage

As part of concept evaluation user feedback was collected from other students in the school in order to be able to determine

analysis of all surveys to which there were over 75 respondents (statistically significant) a list of user requirements was distilled

(Table 2).

1. What do you find irritating about the desk that you use daily?
2. On a scale from 1 to 10, how comfortable is the desk?
3. What are some things you would like to see done to the desk to make your learning experience more enjoyable?
4. How many years have you used a desk provided by the school?
5. How does the desk make you feel mentally?
6. How does the desk make you feel physically?
7. Which of the following design elements for a desk would allow you to sit more comfortably in a desk longer?
8. Which of the following would allow you to be more productive while sitting in a dedsk?
9. Which of the following features would you like to see in a desk?
10. How do you feel about the spacing in the desk?
11. What features would you add to the desk?

Developing Alternative Solutions

Having identified a list of user requirements several mock-ups and working models of a proposed design solution were created on both small and large scales. The small scale mock-ups such as those shown in Figure 9 allowed for experimentation with how closely (or not) the team's list of limitations matched those of the general student population as well as to avoid design fixation and limit bias. The team spent approximately two months identifying primary and secondary users, creating online user feedback surveys, administering the surveys to each of our stakeholder groups and then analyzing the results. Figure 8 illustrates the survey questions used.

Primary stakeholders were identified as high school students.

Structure (Frame)	Chair	Surface
Reclining seat	arm rest	built in ruler on desk surface
Foot rest	swivel	replaclable parts
Storage area	conforming seat back material	place for laptops
Moves forward and back	cushioned seat	reticulary are for surface
Flexible spine	lumbar support	hook for bookbag
Seat moves up and down	back rest	different colors
Flexible seat support spine	adjustable seat height and lenght	recyclable “green parts”
Collapsable frame	memory foam	cover pulls out
Pouch on back for storage	swivel seat stops at certain point	reversible desk for left handers
Ball Bearings	durable material	illuminated desk top lighting and glow
Armrest	memory foam	leds on surface
Swibel Seat	flexible back	surface flips
	arms attach to either side	pivot point swing around
	connect at bottom in the middle	anti-defacing
	storage on back	swing out/slide out; wings from underside of surface (to make it bigger)
	leans back	flexible/bendable arm
	air bubbles for comfort	easy to clean no
		rust metal
		pivot move desk up/down, side to side non-stick surface (teflan) and xylan

The secondary stakeholder group was divided into 3 sub-groups which included teachers, custodians, and buyers. Upon several design features. They also provided for a feel of what may or may not work during fabrication and what direction would make sense for fabrication.

Four different versions of the desk were conceived and fabricated as true-to-size, full scale physical prototypes. Figure 10a-d illustrates student work on each of these.

A Pugh chart analysis (Table 3) was done to aid in objectively identifying the most-suitable final desk design concept.

The Pugh chart analysis confirmed that Desk 4 was the solution that would best meet collected user requirements.

Measurement and Testing

Significant testing was carried out during fabrication of the full scale prototypes. Due to the varying designs

Figure 9. Sample of Small Scale Basic Design Mock-Ups

Figure 10a. Work on true-to-size folding base concept prototype.

Figure 10b. Work on PVC frame and base concept prototype.

Figure 10c. Work on base concept.

Figure 10d. Work on surface and retractable surface wings concept.

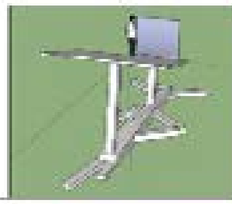
Description	Current Desk	Desk 1	Desk 2	Desk 3	Desk 4
Sketch					
(bad)1-10(good)					
Durability	9	7	8	8	9
Mobility	4	3	5	6	10
Safety	5	2	8	8	8
Structural Complexity	9	4	7	7	9
Easy to use	5	7	7	8	9.5
Affordability	8	6	6	6	6
Comfort	2	8	8	8	10
Aesthetics	1	4	5	6	9
Highest score best	5.375	5.125	6.75	7.125	8.8125

Table 3. Pugh Chart Analysis of Prototyped Desk Designs

the team was afforded the opportunity to experiment quite a bit with different materials. This included testing to determine what materials would work best from a composition, strength, durability, cost, and sustainability perspective. Due to the generous support of desk samples were acquired that were tested for suitability with design requirements.

Measurement and testing took on a variety of forms. First, it was critical to size the desk so that it could accommodate the target population

Anthropometric Measurement Type (in cm)	CJ	Jake	Justin	David	Average
Stature	73	68.5	66	64	67.9
P-Butt	20	19	18	18	18.75
Elbow Rest Height	11	10.5	9.5	11.75	10.7
Elbow to Elbow	17	16	20.5	17	17.625
Hip Breadth	15	14.5	16	14	14.9
Knee Height	22	20	20	19	20.25
Popliteal Height	20	18	17.5	16.5	18
Sitting Height Erect	39	37	36	36	37
Sitting Height Normal	35	35	34.5	33.5	34.5
Weight	158lbs	140lbs	180lbs	140lbs	154.5lbs

Table 4. Anthropometric results for team males under 18 years of age

body types. Since high school students vary so widely in body size and type standard anthropometric tables were used as a benchmark for measurements such as sitting height, hip width, and knee height. Realizing quickly that these tables did not include representative data for anyone under the age of 18 the team created their own anthropometric table for adolescents (Table 4). To do this body measurements of interest for each person on the team were measured which coincidentally happened to represent a wide range of body types. This data was then input into a spreadsheet from which a median value was calculated and used for the desk design.

Second, based on recommendation from the Virginia Tech Industrial Design team, a silhouette analysis was performed to test and analyze specifications required for design of an articulating surface adjustment that allows for adjustable surface height and girth travel. This exercise also provided the opportunity to observe how students interact with a desk. The procedure involved creating an approximate silhouette of the desk environment by using a poster board as a mock surface and an actual chair both of which were placed alongside white chart paper that was taped to a wall.

Fifteen students were asked to sit in the chair comfortably and to raise and lower the mock surface until a comfortable height was reached as shown in Figure 11.

The same was done for girth except this time the subject started with

Figure 11. Progression of silhouette exercise

	Surface Height G (cm)	Surface height B (cm)	Surface girth G (CM)	Surface girth B (CM)
	88	88	48	45
	75	86.5	48	43
	75	86	40	43
	74.5	79.5	37	42
	74.5	78.5	37	40
	74.2	78	36	39.5
	74	78	36	38
	74	77.5	35.5	37
	72.5	75.5	34	34.5
	72.5	75	33	34
	71.5	74.5	32	33
	71	74	32	32.5
	71	72.5	28	29.5
	69.5	72	28	28
		72		
average	74.1	77.8	36.0	37.1
median	74cm	78cm	35.75cm	37.5cm

Distance from chair bottom rail to back of pole 40 cm *girth equals distance from back of chair to surface *height equals distance from bottom of surface to floor

Table 5. Collected data from silhouette exercise to determine surface height and girth travel ranges

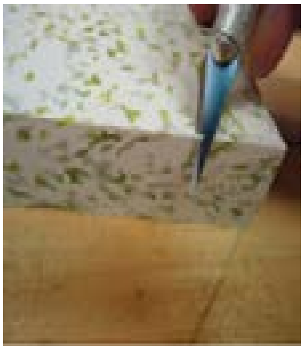


Figure 12a. Hardness test

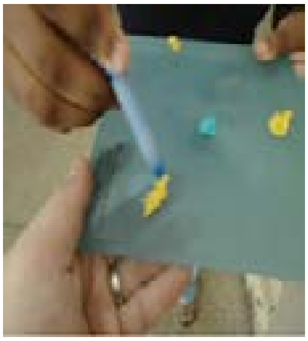


Figure 12b. Gum stick test

Figure 12c. Cleaning solvent test

the poster board surface against their stomach and slowly moved it out until a comfortable distance was reached. Once comfortable height and girth distances were established they were marked on the wall-mounted chart paper (Figure 11).

See Table 5 for collected data.

Material testing was also performed since durability was identified as a key user requirement and design feature. Testing consisted of putting proposed desk materials for either the seat

scenarios. In the case of proposed surface materials, these were subjected to a hardness test using X-acto knives, a pen test by writing on them with pen, a gum test involving sticking gum to different surface samples and a solvent test where cleaning solvents typically used by custodians were sprayed on and wiped off - all of these being possible scenarios in the classroom (Figure 12a,b,c).

The same testing procedure was carried out for evaluation of seat materials which were subjected to X-acto knife stabs, pencil and pen pokes, and pinching tests (Figure 13 a,b).

Figure 13a. Hardness test trial one Figure 13b. Hardness test trial two

During measurement and testing, feedback and insights about material choice, design ideas and prototype fabrication was also solicited from business and industry mentors. In most cases feedback sessions were carried out over Skype and email with notes recorded in an Excel spreadsheet for future reference. This was a great exercise because it provided for an objective outlook from subject-area experts which also made accepting the feedback a lot easier than if it were coming from one of our own less experienced team members.

Redesign

Refining design concept(s) encompassed constant revisions and tweaks necessitated by varying degrees of failure brought about by things such as measurement error, fabrication error, material failure under load and dissatisfaction from users during testing. This meant several versions of computerized drawings and prototypes wrapped up in an iterative cycle of design, create, evaluate, and tweak until things turned out exactly as they needed to.

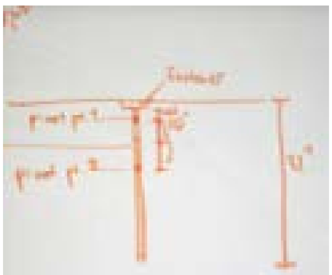
Fabrication of Final Prototype

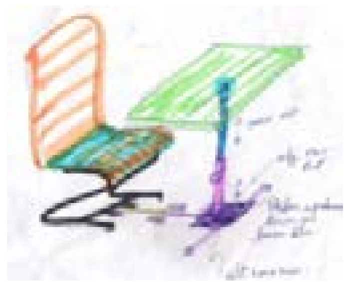
A three step approach was used to fabricate the final prototype.

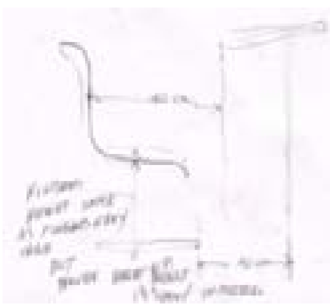
First, engineering mentor Mr.Frederiksen helped translate the team's design concepts into a final engineered solution on paper by drawing a series of as-built sketches as illustrated in Figure 14.

The second step involved transforming the sketches into reality through fabrication of the desk components. Metal welding was the primary method. Since on-site welding facilities were not available, nor were any team members trained in welding, help was solicited from local fabricators. Tubing and metal bars were provided by the team and essentially welded to order, with help from our fabrication partners, to create the swivel mount plate on the underside of the chair (Figure 15a), H-joint bracket

with corresponding mounts to join the chair to the base (Figure 15b) and the actual base unit which allowed for insertion of the surface into the base (Figure 15c). A surface to base insert plate was also fabricated (Figure 16). Assistance with bar bending was also provided in order to create frame mounts for the seat cushion and seat back (Figure 17).







Once the completed desk components returned from welding and bending the team finished the final step which involved any remaining fabrication and assembly consisting of cutting, abrading, drilling, and fastening the various desk components to one another. Since the chair and base were completed as shown in Figures 15 and 17 the majority of work at this stage involved assembling the pieces of the surface together.

Figure 15. Fabricated swivel mount plate (A), H-joint bracket (B) and base unit (C)

Figure 16. Fabricated surface to base insert plate.

The primary surface, constructed of an innovative 38% recycled content (9% post-consumer, 29% pre-consumer) material called Chroma made by 3-Form, is a translucent blue material that comes in a variety of other colors that the team agreed inspires learning and creativity. Furthermore, gum does not adhere to this material which is extremely practical in a classroom (Figure 12b). LED light from cell phones also travels through this material which would most likely prevent students from texting at inappropriate times. To this primary surface the swing out wings and surface mount components had to be attached using a strong two-part adhesive. In addition, the team had to route a pencil-channel into the top of the surface as well as round the surface corners using an orbital sander.

Ultimately, the team completed all required fabrication and our chair-desk - designed by students, for students - turned out better than ever imagined (Figures 18 and 19).

In the end, the chair-desk turned out so well that a film was made about our experience called “InvenTeens.” We invite you to experience our journey at http://www.youtube.com/watch?v=KFW8LzU1vLg

Conclusion

Figure 17. Fabricated seat and back support mounts.

Figure 19. Rendering of the final chair-desk design

Historically student chair-desks have been designed and manufactured with little to no attention to student-centered design considerations. To our knowledge, engaging students in participatory design of school chair-desks has never been carried out. It is no wonder that the student chair-desk design has gone virtually unchanged since its inception in the 1950's and subsequently given rise to the learning and health-related issues highlighted in this paper. Our chair-desk invention is the solution to this problem representing a change of direction for chair-desk design from a one size fits all approach to an inclusive, participatory design approach. However, from this project also sprang several unanticipated changes of direction.

Our chair-desk also symbolizes the change of direction for, or reversal of stigma commonly associated with, involving children and adolescents in the design of solutions, especially those related to learning. More often than not the valuable, first-hand, unencumbered insights of children and adolescents are overlooked or seen as a nuisance in today's adult-driven society. This experience proves that by engaging students as extreme users in the design of their own learning environment, a richer, more useable and adoptable solution can be designed.

Our efforts also highlight the importance of changing the direction of perceptions about the design of learning environments from static, forward-facing teacher-centric environments to dynamic, freely adaptable student-centric environments. In fact, our learnings from this project served to inform the classroom design and furniture procurement decisions made during renovation and remodeling of our current engineering technology classroom. Today, all of the furniture in our classroom is on wheels and fully mobile allowing for a myriad of reconfiguration options to suit the learning experience. Even students' chairs are on wheels which contrary to popular belief, has actually cut down on

Figure 20. The InvenTeam chair-desk project team.

behavioral disruptions since students can move or fidget as required in order to better focus during learning.

Our chair-desk also represents a change of direction for the learning experience paradigm. In many classrooms students struggle to make the connection between their learning and the real world. Our chair-desk is symbolic of breaking down that barrier and making the learning-real world connection crystal clear. This project provided opportunities for students to

engage with mentors and skilled professionals from within the local community and beyond on a regular basis. It provided the team with a perspective they could never have achieved from within the confines of their own classroom. They learned that, although outside perspectives may not always mesh with their own, an objective, open-minded environment across a diverse range of skills and disciplines contributes immensely to the quality of a designed solution and perhaps more importantly, to the quality of individual they will become as inclusive, open-minded thinkers and doers.

In the end the project team delivered on a proof of concept, not only for a new chair-desk design better suited for today's learner but also, for engaging students in the design of any solution with the potential to enhance the learning experience for today's learner.

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